AN EMPIRICAL INVESTIGATION INTO CURRENCY CRASHES, CAPITAL FLIGHT, AND THE INFLATION TAX

by

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(Under the direction of Professor William D. Lastrapes)

ABSTRACT

This research consists of an analysis of the predictability of currency crashes using an econometric model based on publicly available macroeconomic and financial data. Also, included is an investigation into the causes of capital flight from developing countries with an emphasis on devaluation risk. The empirical relationship between capital controls and governments' ability to increase revenue through the inflation tax is investigated. And a discussion of currency boards and dollarization is included. In the first section, I develop a simple hazard model for predicting currency crashes. The hazard model allows time-since-crash as an explanatory variable. I test the predictive power of this hazard model against two well-known econometric models and provide evidence that the length of time between crashes does assist in explaining and predicting future crashes.

Next, I investigate the relationship between the probability of devaluation and capital flight. I show that devaluation probability, as measured by the output of an econometric model, exhibits a positive relationship with capital flight across countries. Previous studies have shown the existence of a relationship between some devaluation expectation and capital flight, in an individual country over time. The research discussed in this section provides evidence that the probability of devaluation does indeed explain differences in capital flight between countries. Then, I investigate the relationship between capital controls and the inflation tax, across countries. Countries that have adopted controls on capital outflows should have a higher seigniorage-maximizing rate of money supply growth. Capital controls will limit the available substitutes for domestic currency, artificially raising domestic money demand and seigniorage revenue to the domestic government. Statistical evidence is provided, showing that capital controls do explain differences in seigniorage across countries.

Finally, I provide a discussion the currency board system and the policy of official dollarization. Argentina, after being on a currency board-like-system for a little more than a decade, devalued the peso in early 2002. Also included in this section is a short history of

Argentina's exchange rate policy and a discussion of policies imposed by the Argentine government that were clearly inconsistent with the ideas behind a pure currency board system.

INDEX WORDS: Devaluation, Exchange Rate Regime, Developing Countries, Capital Flight, Seigniorage, Capital Controls, Currency Boards, Dollarization

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CHAPTER 1

INTRODUCTION

This research consists of an analysis of the predictability of currency crashes using an econometric model based on publicly available macroeconomic and financial data; an inquiry into the causes of capital flight from developing countries using three different estimates of capital flight, with an emphasis on devaluation risk; an investigation into the relationship between capital controls and governments' ability to increase its revenue through the inflation tax; and a discussion of currency boards and dollarization.

In Chapter 2, I create a hazard model that predicts currency crises using fundamental macroeconomic and financial variables, based on the speculative attack models of Krugman (1979) and Flood and Garber (1984). I investigate the predictive power of this hazard model compared to that of the model developed by Frankel and Rose (1996) and to the power of the model described in Berg and Patillo (1998). The hazard makes sense from a theoretical standpoint, by allowing for time-without-a-devaluation as an explanatory variable. The theory behind the inclusion of this variable is that of the reputation effect. If investors and others believe that a government is serious about maintaining a fixed exchange rate, the less likely they will be to run on the currency. The longer the peg is maintained, the greater the government's credibility. Interestingly, the relationship between the length of time without a crisis and the probability of devaluation is found to be positive. It can be argued that all

fixed exchange rates are at risk because of the political hardships governments face when trying to maintain a lengthy peg. The collapse of an exchange rate regime may be inevitable event. According to Rogoff and Obstfeld (1995), a fixed exchange rate regime is a mirage because of the political realities governments face. The contribution of this study is that it is the first to apply and test out-of-sample, the hazard econometric model to the prediction of currency crashes. I find a positive relationship between the length of time without a crisis, and the probability of a currency crisis, which is contrary to the predicted relationship based on the reputation effect. Also, I find that the model does a better job predicting currency crises, both in-sample and out-of-sample, than the Frankel/Rose model and the Berg/Patillo model.

In Chapter 3, I investigate capital flight from developing countries. The goals of this chapter are to measure the magnitude of capital flight over the last twenty years and examine the causes of this capital flight. Macroeconomic policies in Latin American and other developing countries have been quite volatile over the last few decades, leading to debt crises, devaluations, high inflation, unsuccessful stabilization programs, and speculative international investment. It is these inconsistent policies are hypothesized to be the cause of large scale domestic capital flight. Chapter 3 investigates whether devaluation risk explains differences in capital flight from developing countries.

The primary hypothesis in Chapter 3 is that the probability of a devaluation explains differences in capital flight in a cross-section of emerging market countries. Three different estimates of capital flight are used in this analysis. These three estimation methodologies are described in World Bank (1985), Morgan Guaranty (1986), and Cuddington (1996). As a

proxy for the risk of a devaluation, I use the devaluation probabilities estimated for the analysis in Chapter 2. Capital flight should be higher in those developing countries that have a higher risk, as measured by the probability of suffering a devaluation. If residents and foreign investors expect a large-scale devaluation, they will move their assets to safer locations overseas.

This idea of using a devaluation probability as a proxy for the expectation of devaluation is similar to the econometric model in Cukierman, Edwards, and Tabellini (1992). In their paper, the authors use a model-generated probability of government change to explain seigniorage in a large sample of countries. Similarly, Dichev (1998) investigates whether the risk of bankruptcy, as measured by an estimated probability, is a significantly priced factor in stock returns. Because there is not a well-accepted theoretical model of capital flight, both OLS and IV estimates of the coefficient from the econometric model are included. The stochastic nature of the independent variable leads to the possibility of correlation between the independent variable and the error term. If this is the case, the parameter estimates in the regression will be inconsistent. Therefore, the instrumental variables procedure is described and applied to the data in Chapter 3.

The research discussed in Chapter 3 is a contribution to the large literature on the causes of capital flight. There have been a number of papers empirical papers attempting to explain capital flight. Cuddington (1986) investigates the causes of capital flight in a small sample of emerging markets and finds that real exchange rate appreciation is a significant factor in explaining this phenomenon. Rojas-Suarez (1991) discusses the correlation between domestic capital flight and foreign investment. Kant (1996, 1998) investigates the

relationship between foreign direct investment and domestic capital flight. Lensink, Hermes, and Murinde (2000) investigate whether political risk explains capital flight in a large cross-section of countries. This study contributes to the literature by being the first to investigate whether the probability of a currency crash explains differences in capital flight across countries.

In Chapter 4, I investigate the relationship between capital controls on the demand for money and their effect on seigniorage. By placing controls on the free flow of capital, governments not only make it more difficult for international investors to invest their funds in other countries, they also make it more difficult to substitute away from a weak and unstable domestic currency. By placing limits on the ownership of foreign currencies (and other foreign assets) to be used as a store of value, governments can increase the money supply and therefore seigniorage revenue, at a greater rate than they would be able to with widely available substitutes for domestic currency. The purpose of this chapter is to empirically investigate whether capital controls do indeed explain differences in seigniorage worldwide.

The idea that governments can maintain an artificially high demand for domestic currency with controls was initially outlined in Nichols (1974) and shown theoretically by White (1999). According to Nichols, residents will attempt to avoid the inflation tax by substituting into foreign currency and using domestic currency for transactions, only when absolutely necessary. Real seigniorage will be greater with a relatively higher real (domestic) money demand. If a government imposes capital controls, money demand will be artificially high because it is more difficult for residents to hold foreign assets. Using data taken from

the IMF's *International Financial Statistics* and World Bank's *World Development Indicators*, I investigate Nichols' principle that seigniorage will be higher in countries that have imposed capital controls. Governments impose capital controls as a means of raising revenue, conventionally and through the inflation tax. Therefore, it should be the case that differences in the average level of seigniorage between countries are explained by existence of capital controls in some countries. Even after accounting for various forms of traditional taxation, I find that capital controls do indeed significantly explain differences in seigniorage across countries.

In Chapter 5, I change the focus from an investigation into the predictability of exchange rate events and the explanation of seigniorage and flight capital, to a discussion of, and an argument for, fixed and more permanent exchange rate regimes. The benefits and costs of these arrangements are discussed in this chapter, along with a discussion of the money supply process in a true fixed exchange rate regime. Also included in this chapter is a short history of the Argentine currency board, from its implementation in 1991 to its collapse in January of 2002, and a discussion of the Panamanian and Liberian experiences with dollarized monetary systems. Even after the exchange rate mayhem in Argentina in early 2002, I argue that the benefits of these stringent exchange rate policies exceed the costs.

CHAPTER 2

A HAZARD MODEL FOR PREDICTING CURRENCY CRASHES

Financial and currency mayhem during the late 1990s in Latin American and East Asian countries led to greater interest in theoretical and empirical research on currency crises and a greater desire to develop models to help predict these crises. In this study, I develop a hazard model built with six macroeconomic variables for explaining currency crises. Also, I test the ability of the hazard model to predict crises, and compare its predictive ability to the well-known model developed by Frankel and Rose (1996) and to the model created by Berg and Patel (1999a).

In 1998, *The Economist* published an article discussing the problems with currency crisis modeling and the inability of investment banks and academics to create models able to predict large-scale currency devaluations, like those that took place in East Asia in 1997 and 1998. Mentioned in the 1998 article was a research paper by two IMF economists, Andrew Berg and Catherine Patillo. In that paper, Berg and Patillo (1999a) and in a similar paper, Berg and Patillo (1999b), the authors show that the existing econometric models would have done a poor job predicting the East Asian currency crises. Berg and Patillo base their study on the following scenario: if an analyst was armed with one of these models, calibrated on data from years prior to 1997, would he have been able to predict the large currency devaluations that took place in East Asia, specifically those in Singapore, Thailand,

and Malaysia? Powerful forecasting models are of great interest to policymakers, investment bankers, and academics. But according to *The Economist* and the research by Berg and Patillo, a powerful currency crisis model is not easy to create. This study contributes to the empirical currency crisis literature by asking the question, does a well specified hazard model provide better out-of-sample forecasts than two well-known currency crisis models?

Hazard models have been applied to other economic sub-disciplines, such as default prediction models (Shumway, 1996), mortgage prepayment models (Yongheng, Quigley, and Van Order, 1996), corporate financing possibilities (Pagano, M., F. Panetta, and L. Zingales, 1998), and ownership structure (Denis, D. J., D.K. Denis, and A. Sarin, 1997). For real estate finance, the hazard model is considered the norm. With the hazard model, the length of time between events is treated as an explanatory variable. For this study the event of interest is a currency crisis. The use of the hazard model allows the length of time between exchange rate events to help explain and predict crises. This study is the first to apply this type of econometric model to devaluation prediction.

The hazard model used for this function is justified by economic theory, with the sign of the relationship between time-without-devaluation and the probability of a devaluation expected to be positive. To investors, the longer a government is able to maintain an existing peg, the greater the belief that the government is serious about a fixed exchange rate. The reputation effect is one of the most important reasons given by advocates of more stringent exchange rate policies. It is in a government's best interest for international investors to believe the monetary authority intends to maintain the peg. Increased uncertainty will lead to lower foreign investment. It makes intuitive sense for a model designed to predict

currency crises to have the time without a crash as an input. Those countries that haven't devalued, should, everything else equal, be less likely to suffer a speculative currency crisis than those that have. These are the countries that will appear to international investors to be those with governments serious about the current exchange rate regime. In other words, these governments benefit from a positive reputation effect.

Also, in this chapter, I review the theoretical literature on "first generation" and "second generation" models of currency crises. Theoretical models have gone off in two directions. One type of model is concerned with the fundamental causes of these crises. Two early examples of these types of models are Krugman (1979) and Flood and Garber (1984), and belong to the first generation models. Later models incorporate the idea of self-fulfilling expectations and multiple equilibria into the causes of the crises. Some economists and politicians have used these theories to place blame on currency speculators, as in Obstfeld and Rogoff (1995), and to argue for the use of capital controls in preventing crises. The predictive model in this paper focuses on the fundamental causes of currency crises as developed in the first generation models. Both the first generation and second generation models will be discussed later in the paper.

The purpose of this paper is to apply the hazard model to currency crisis prediction models; test the ability of the hazard model to forecast recent crises; and compare the predictive power of the hazard model with the models discussed in Frankel and Rose (1996) and Berg and Patillo (1999). In Chapter 3, I apply the estimates of the probability of currency crisis to explain differences in capital flight from developing countries, which is based on the hypothesis that capital flight is explained by the risk of a currency devaluation.

What is a currency crisis?

Prior studies have used various definitions of currency crises, such as a large drop in the value of the domestic currency, a large drop in foreign exchange reserves, and a drastic shift from capital inflow to capital outflow over a given period of time. In this paper, I use the definition in Frankel and Rose (1996), with a currency crash defined as a 25% annual depreciation of the nominal exchange rate versus the U.S. dollar. Although the 25% depreciation is somewhat arbitrary, the purpose of this study is to compare the hazard model with the existing models. So I choose to define a currency crisis in the same way that previous authors do.

Because the definition of a crisis is a 25% annual depreciation of the nominal exchange rate, extreme depreciations and actual devaluations will be included as crisis events, while successful defenses of speculative attacks on currency regimes that lead to a large decrease in the monetary authorities' foreign reserves assets will not be included. Eichengreen, Rose, and Wyplosz (1995) make an attempt to include successful defenses in their definition of a devaluation.

A currency is devalued when the legal, or the value at which the monetary authority will purchase or sell domestic currency, is decreased. A currency is floated when the monetary authority announces that it will no longer peg its domestic currency to a foreign currency and allows the value of the currency to be determined in the market. In January of 2002, Argentina devalued the peso, which was fixed to the U.S. dollar, by 40%. The Brazilian real was floated in January 1999. Using this definition of a crisis, currency boards, pegged rate regimes, and floating rate regimes are all susceptible to currency crises.

Currency Crisis Theory

First generation currency crisis models such as Krugman (1979) and Flood and Garber (1984) were developed to better understand the exchange rate crashes in Mexico between 1973 and 1982 and in Argentina between 1978 and 1981. In those papers it is assumed that the expansion of the domestic money supply leads to a depletion of the central bank's foreign exchange reserves, forcing the central bank to lower the value of the domestic currency. In a later second generation paper, Obstfeld (1986) took this theory one step further. He allowed for the possibility of self-fulfilling expectations. In Obstfeld's view, currency speculation can drain the central bank's stock of international reserves and force a devaluation, even if the country's underlying fundamentals are sound. "If speculators set their sights on a currency, particularly that of a small country, how can its central bank possibly resist?" [from Obstfeld and Rogoff (1995)] A later paper by Corsetti, Pesanti, and Roubini (1998) was written in response to the joint financial and currency crises in Asian countries. This model focuses on the moral hazard problem created by the expectation of domestic government and international agency bail out. This is an example of a third generation model of currency crises. To summarize, first generation models are based on fundamental causes of crises. The models falling into the second generation camp allow for self-fulfilling expectations and multiple equilibria. And the third generation models are based on the idea of a moral hazard and its relation to exchange rate collapses.

The first models created by Krugman and Flood and Garber assume a small country that pegs its exchange rate to an anchor currency. The exchange rate regime considered is not a true fixed rate regime, in the sense that the country does not back its entire money

supply with foreign currency denominated assets. The domestic money supply is backed with both foreign and domestic assets, which means that the central bank has limited foreign exchange reserves.

In the early models, the domestic money supply can increase from an inflow of foreign currency which will increase the domestic money supply by increasing the stock of foreign currency reserves at the bank. Or the central bank can increase the money supply through purchases of domestic credit. If the domestic currency appreciates beyond the limit set by the peg, the central bank will buy foreign exchange reserves with its currency, causing the domestic currency to depreciate. And if capital outflows cause the domestic currency to depreciate, the central bank will buy its own currency with international reserves, increasing the domestic currency's value. Because currency crises are modeled as brought on by speculative attacks, the role of the currency speculator is included. With floating exchange rates, speculators profit on spot exchange rates by taking long or short positions. With a pegged exchange rate, speculators bet on the fluctuation of the currency within the band. If the speculators believe that the central bank will devalue sometime in the future, they will enter into short contracts. Suppose the Brazilian monetary authorities peg the value of the real to the U.S. dollar at four reals per dollar, and suppose speculators expect the real to be devalued. They will take short positions in the real, driving down its value. The Brazilian monetary authority will be losing reserves faster than it would be without the attack. The speculators' actions will force the devaluation to take place sooner than would otherwise be the case. With the Krugman and Flood and Garber models, something "fundamental" must lead the speculators to believe the monetary authority will devalue.

The early currency crisis models utilize a shadow exchange rate, which is the floating exchange rate that would prevail if the central bank's foreign exchange reserves were driven to zero.[1] With zero foreign reserves, the central bank can't defend the peg, and the currency will be floated. For the fundamental type models, it is assumed that two international arbitrage conditions hold: purchasing power parity and uncovered interest parity. The domestic money supply increases at a fixed rate. If we assume a small open economy, the foreign price level and interest rate don't change. Through purchasing power parity and uncovered interest parity, as the money supply increases, the central bank will have to purchase domestic currency to maintain the peg. An increase in the money supply will increase the price level and the nominal interest rate. Through the arbitrage conditions, the exchange rate will depreciate. This will drain its foreign exchange reserves, as the central bank buys domestic currency in an attempt to maintain the currency's value. Since it is assumed that the money supply continues to grow, eventually, the central bank will run out of reserves. The shadow exchange rate is the floating rate that would clear the foreign exchange market in a floating regime. Speculators are aware of the rate of money supply expansion and the floating rate consistent with the arbitrage conditions. Because the rate of money supply expansion is fixed, and the shadow exchange rate depends on the amount of money created, the exchange rate will continue to depreciate. When the domestic portion of the money supply has increased to the point that the shadow rate is equal to the fixed rate, the speculators will sell the currency. Why does the speculative attack occur right at the

1 The theoretical papers assume the policy response is to float the currency. These models assume a total drain of the foreign exchange reserves. The real world response is to float or devalue when the policy makers believe the reserves have fallen far enough.

point at which the shadow rate equals the pegged rate? Speculators know that reserves will reach zero when the shadow rate is equal to the pegged rate. The monetary authorities will end the peg at this point. But if speculators know that the central bank will be forced to float at this point in time, why don't they run earlier? If the central bank's reserves are driven to zero before the shadow rate equals the pegged rate, the currency will appreciate right after the central bank stops increasing the domestic money supply. Therefore, speculators attempting to gain by shorting the currency before the time at which the shadow rate is equal to the pegged rate, will suffer losses. According to the Krugman model, speculators will only run on the currency when the shadow rate is equal to the pegged rate.

Possibility of self-fulfilling expectations

The next step in explaining currency crises was to include a central bank as both a pegged exchange rate manager and a domestic monetary policy manager. Whereas the early models assumed a fixed rate of domestic money supply growth known by speculators, the second generation models, such as that of Obstfeld (1986), assume an optimizing central bank who manages exchange rate policy and monetary policy. If the money supply is increased, the authorities must sell international reserves to maintain the peg. With open capital markets, we know this is an inconsistent policy. Economists developed models to blame currency crises on speculation; crises are caused by self-fulfilling expectations on the part of speculators. The basic idea is that currency speculation can increase the cost of maintaining the peg to the point at which the costs to the domestic monetary authorities outweigh the benefits of keeping the peg, and the authorities choose to devalue.

One aspect of models involving self-fulfilling expectations is that the monetary authorities are assumed to minimize a loss function. The authorities must decide whether to keep the exchange rate pegged or to let it float. If the authorities choose to let the currency float, they face a reputation cost. International investors will fear an increase in the inflation rate since there is no longer an anchor, and this increased inflation expectation will slow investment and economic growth. The government also has to worry about the costs of devaluation expectations. If international lenders and speculators expect the central bank to float the currency, there will be a decrease in international funds available, which will drive up real interest rates and slow economic growth. The greater the expected depreciation, the greater the costs to the authorities of maintaining the peg. So the decision to float the currency is based on the costs of staying with the peg, with the possibility of speculators and lenders expecting a floatation which will lead to higher real interest rates, and the costs of abandoning the peg and facing the political costs and inflation expectations.

Suppose that speculators have two exchange rate expectations with a fixed peg. If the speculators expect the authorities to maintain the peg, the exchange rate expectation will be equal to the fixed rate. If speculators expect the government to float the currency, the expectation will be the rate based on the floating regime. As long as speculators expect the government to maintain the peg, the costs of maintaining the peg will not change. But, if speculators believe the government will devalue, the exchange rate expectation becomes the rate the government chooses after it floats the currency. This expectation change increases the costs of maintaining the peg. The greater the expected depreciation of the currency, the greater the costs of maintaining the peg. The expected rate of depreciation will eventually

reach a point where the costs to the government of maintaining the peg will exceed the costs of floating the currency, and the authorities will abandon the peg. One conclusion that can be reached by this type of analysis is that anything that shifts speculators' expectations about future exchange rate policy and leads to a high enough expected rate of depreciation, will cause the central bank to abandon the pegged rate. According to the self-fulfilling models of currency crises, even if macroeconomic fundamentals are sound, if speculators expect a floatation, the central bank may be forced to float because of the peg maintenance costs.

From this analysis, it would seem that a run on a currency or a currency crisis can happen to countries with not just pegged rates, but also countries with truly fixed rates. The only difference is that with pegged rates, the money supply is not backed 100% by international reserves. With truly fixed rates, 100% of the monetary base is backed with these reserves. A pegged rate regime with the money supply in check is maintaining a consistent policy. According to the self-fulfilling view, a currency crisis can hit this type of regime. Logically, a currency crisis could hit a country with a truly fixed rate, such as a country like Hong Kong with a currency board, as long as the costs of the peg exceed the benefits. But, Argentina aside, is this consistent with history? Schuler (1999) claims that of the 77 countries utilizing currency boards, there has been only one peacetime devaluation and four wartime suspensions of currency convertibility since 1849. Of the 185 countries with discretionary monetary authorities (central banks), 85% of them have devalued in peacetime or suspended in wartime.

Moral hazard

In response to the recent problems in Asia, economists have discussed the role of moral hazard in explaining joint financial and currency crises. Corsetti, Pesenti, and Roubini (1998), develop a moral hazard theory based on overinvestment, excessive international borrowing, and large current account deficits. If international lenders expect to be bailed out by an agency, such as the IMF or the U.S. Treasury, and domestic firms expect the government to provide payments if their projects fail, each will have an incentive to take on excessive risk. Once the international lenders refuse to roll over existing loans, the financial crisis hits. When the crisis occurs, the government steps in, and bails out the domestic firms. A bail out is equivalent to an increase in public liabilities that are not reflected by debt and deficit figures until the crisis occurs. The currency crisis induced by a large capital outflow is caused by the expectation of future debt monetization.

Previous empirical studies

The empirical analysis in this chapter was developed in response to Berg and Patillo (1999a), who analyze the out-of-sample predictive ability of the Frankel and Rose (1996) model. In their 1996 paper, Frankel and Rose investigate a large sample of developing countries using annual data from 1971 to 1992, and estimate a probit model on devaluation and non-devaluation data. The independent variables are classified into four categories: foreign variables, domestic macroeconomic variables, external variables, and debt composition. They find that the rate of growth of domestic credit is significantly associated with a crash: The greater the expansion of domestic credit, the more likely a crash. Also, a higher foreign interest rate is positively and significantly associated with a crash, which

could be interpreted as a shift by investors toward safer assets when their return gets higher relative to earlier returns. Also, GDP growth rate is significantly and negatively related to a crash, meaning that the lower the growth rate, the more likely a crash. And a higher ratio of foreign exchange reserves to imports lowers the likelihood of a crash, while foreign direct investment to total debt is negatively associated with a crash.

In a related article, Klein and Marion (1997) study the duration of exchange rate pegs using a sample of monthly data on seventeen developing countries and a logit econometric model. They estimate the monthly probability of a country abandoning its peg. The openness of a country is measured by exports plus imports over GDP. Klein and Marion find that a country's openness lowers the probability of peg abandonment. Also, an appreciated real exchange rate and a lower stock of foreign currency reserves significantly increase the probability of a devaluation.

In their paper on the Asian crisis, Corset, Passant, and Rabin (1998), using an index of financial fragility, analyze the variables associated with the speculative attacks on the exchange rate regimes that occurred in Asian in the late 1990s. Berg and Patillo (1999) test Frankel and Rose (1996) and two other models, to see if they had been able to predict the large scale devaluations that took place prior to and during the East Asian Financial Crisis of 1997. The next section in this chapter discusses the estimation of the probit model, which is used in both the Frankel/Rose and Berg/Patillo models.

The Probit Model

The probit model is a specific type of discrete dependent variable econometric model. For the study of currency crises, the dependent variable takes the value of zero or one. An

exchange rate regime is assumed to fail when the nominal value of the currency depreciates by 25% or more. For regimes that end in failure, the dependent variable for that observation is given a value of one. For a regime-year that is not considered a failure (the exchange rate did not depreciate by at least 25%), the dependent variable is given a value of zero. The currency crisis is considered the "devaluation event," and the crisis prediction model is designed to predict future devaluation events. It is clear that developing a model that predicts crises is a useful task, but it is not clear which is the best model for accomplishing this task. I claim that the hazard model, a model that accounts for time-without-failure, will do a better job predicting devaluations than a model that does not account for time.

Again, the purpose of a discrete dependent variable model is to explain or predict an event. In this study, the event is the failure of an exchange rate regime. The empirical model generates a probability of this exchange rate event as a function of independent variables. So if ***y*** is defined as the dependent variable for the model, then ***y*** is given a value of one if the event occurs, and a value of zero if it does not. So,

$$prob(y=1)=F(\beta' X) \quad (2.1)$$

$$prob(y=0)=1-F(\beta' X) \quad (2.2)$$

where ***X*** is the set of independent variables explaining the exchange rate event, $\boldsymbol{\beta}$ is the vector of parameters explaining the relationship between the independent variables and the exchange rate event, and ***F*** is the functional form describing the relationship. A discrete dependent variable model makes an assumption about the correct functional form of ***F***. In the case of the probit model, ***F*** is assumed to be the normal cumulative distribution function.

Why use the probit model over a simple OLS model? There are a few reasons listed in Greene (1997), but the most glaring reason for not using a linear model, is that a probability must be bounded between zero and one. In other words, as $\beta'X$ approaches ∞, $prob\ (y=1) = 1$, and similarly, as $\beta'X$ approaches $-\infty$, $prob(y=1) = 0$. The linear probability model, with $F(\beta'X) = \beta'X$, will generate probability estimates that may be less than zero or greater than one. Because of this fault, many econometricians use the probit model, with $F(\ )$ being the standard normal distribution, or the logit model, with $F(\ )$ being the logistic distribution. For the probit model, the probability of the event occurring is,

$$prob(y=1) = \int_{-\infty}^{\beta'X} \phi(t)dt. \quad (2.3)$$

With the currency crash prediction model, we are interested in the probability of devaluation. The probit models the probability of devaluation based on the relationship with a set of explanatory variables. In regression terms,

$$E[y|X] = 0[1 - F(\beta'X)] + 1[F(\beta'X)] \quad (2.4)$$

$$= F(\beta'X). \quad (2.5)$$

With the classic linear regression model, the estimated coefficients are thought of as the partial derivative of the dependent variable with respect to a given independent variable. But with probit or logit models, the function explaining the relationship between the dependent and independent variables is more complex. This means that the marginal effects on the dependent variable are more complex. The effect of a one-unit change of a regression on the probability of the exchange rate is modeled as,

$$\frac{\partial E[y|X]}{\partial X} = \frac{dF(\beta'X)}{d(\beta'X)}\beta \quad (2.6)$$

$$= f(\beta'X)\beta. \quad (2.7)$$

And specifically for the probity model,

$$\frac{\partial E[y|X]}{\partial X} = \phi(\beta'X)\beta. \quad (2.8)$$

We see that the slope, or marginal effect estimates are dependent on ***X***. For this study, I estimate the slopes as the means of each of the variables making up ***X***.

Discrete choice models are estimated using maximum likelihood, based on, in this case, the Newton-Raphson optimization method. The general discrete choice regression is modeled as,

$$prob(Y_1=y_1, Y_2=y_2, ..., Y_n=y_n) = \prod_{y_i=0} [1-F(\beta'X_i)] \prod_{y_i=1} [F(\beta'X_i)]. \quad (2.9)$$

Which can be written as the likelihood function

$$L = \prod_{i=1}^{n} [F(\beta'X_i)]^{y_i} [1-F(\beta'X_i)]^{1-y_i}. \quad (2.10)$$

Taking logs on the general model for estimation purposes, we get

$$\ln L = \sum_{i=1}^{n} [y_i \ln F(\beta'X_i) + (1-y_i)\ln(1-F(\beta'X_i))]. \quad (2.11)$$

And the log likelihood function, specifically for the probit discrete dependent variable model, is

$$\ln L = \sum_{y_i=1} \ln\phi(\beta'X_i) + \sum_{y_i=0} \ln[1-\phi(\beta'X_i). \quad (2.12)$$

And as always, the parameter vector, β is estimated at the first order conditions for ***ln L***, or

$$\frac{\partial L}{\partial \beta} = 0. \quad (2.13)$$

The β vector provides the estimates of the coefficients for the probit regression. Since we are interested in the marginal effects of a one-unit change of the regressors on the probability of default, the regression parameter estimates must be multiplied by the probability density function for the normal distribution, estimated at some value of ***X***. If we define γ as the vector of marginal effects, then,

$$\gamma = f\beta \quad (2.14)$$

where f depends on the ***X*** vector used.

The asymptotic covariance matrix for the maximum likelihood estimator is estimated by taking the inverse of the matrix of second derivatives of the log likelihood function, with respect to the parameter estimates. Let

$$H = \frac{\partial^2 \ln L}{\partial \beta \partial \beta'}. \quad (2.15)$$

and define

$$V = AsyVar[\beta]. \quad (2.16)$$

So the estimate of ***V,*** the asymptotic covariance matrix estimated by maximum likelihood regression models, is equal to the inverse of the matrix ***H***,

Because the estimated marginal effects are non-linearly dependent on the maximum likelihood parameter estimates, we can use the delta method to estimate the asymptotic

variance matrix of the estimated marginal effect vector, γ. Based on the explanation of the delta method in Greene (1997),

$$AsyVar[\gamma] = [\frac{\partial \gamma}{\partial \beta'}] V [\frac{\partial \gamma}{\partial \beta'}]'. \quad (2.17)$$

We know

$$\gamma = f\beta. \quad (2.18)$$

And if we let

$$z = X'\beta. \quad (2.19)$$

Then,

$$[\frac{\partial \gamma}{\partial \beta'}] = f[\frac{\partial \beta}{\partial \beta'}] + \beta [\frac{\partial f}{\partial z}][\frac{\partial z}{\partial \beta'}] \quad (2.20)$$

$$= fI + [\frac{\partial f}{\partial z}]\beta X'. \quad (2.21)$$

Because $df/dz = -z\,\phi$ for any z,

$$AsyVar[\gamma] = \phi^2 [I - (\beta' X)\beta' X] V [I - (\beta' X)\beta' X]'. \quad (2.22)$$

From the estimated covariance matrix of γ- the marginal effects, we can find the estimated standard errors of these marginal effects by taking the square root of each of elements on the diagonal.

Data

Table 2.1 lists the countries used in this analysis. The countries selected are based on data availability, with only developing countries included in the sample. There are 103

countries making up the sample with data from 1971 to 1996 for model estimation. Table 2.2 lists the data sources and definitions used in model estimation. All of the data are from published sources, with most variables from the World Bank's, *World Development Indicators* databases.

A devaluation is defined to be a 25% depreciation in the nominal exchange rate versus the U.S. dollar. Table 2.3 lists of all the crashes used the estimation of the FR and BP models. Each of these countries suffered a 25% decrease in the value of their currency during the given year.

Because some of these countries have been highly inflationary and have experienced consistent currency depreciation, a crisis is assigned if in the period prior to the crisis the exchange rate depreciated by less than 25%.

Frankel and Rose / Berg and Patillo

The previous two sections described the theory underlying the probit model used in both the FR model and the BP model, and a description of the data used in estimating the models. In this section, I describe the variables used and the results generated from the estimation of the two models. In their 1996 paper, Frankel and Rose (FR) develop a model for explaining currency crashes.

The data is taken from the World Bank's *World Data* database. FR define a currency crash as a 25% depreciation in the nominal exchange rate that is 10% more than the prior year's depreciation.

Table 2.1: Countries Used in Analysis

Algeria	Grenada	Panama
Argentina	Guatemala	Papua New Guinea
Bangladesh	Guinea	Paraguay
Barbados	Guinea-Bissau	Peru
Belize	Guyana	Philippines
Benin	Haiti	Romania
Bhutan	Honduras	Rwanda
Bolivia	Hungary	Samoa
Botswana	India	Sao Tome and Principe
Brazil	Indonesia	Senegal
Burkina Faso	Iran, Islamic Rep.	Seychelles
Burundi	Jamaica	Sierra Leone
Cameroon	Jordan	Solomon Islands
Cape Verde	Kenya	South Africa
Central African Republic	Lao PDR	Sri Lanka
Chad	Lebanon	St. Kitts and Nevis
Chile	Lesotho	St. Lucia
China	Liberia	St. Vincent and the Grenadines
Colombia	Madagascar	Sudan
Comoros	Malawi	Swaziland
Congo, Dem. Rep.	Malaysia	Syrian Arab Republic
Congo, Rep.	Maldives	Tanzania
Costa Rica	Mali	Thailand
Cote d'Ivoire	Mauritania	Togo
Djibouti	Mauritius	Trinidad and Tobago
Dominican Republic	Mexico	Tunisia
Ecuador	Morocco	Turkey
Egypt, Arab Rep.	Myanmar	Uganda
El Salvador	Nepal	Uruguay
Equatorial Guinea	Nicaragua	Vanuatu
Ethiopia	Niger	Venezuela, RB
Fiji	Nigeria	Yemen, Rep.
Gabon	Oman	Zambia
Gambia, The	Pakistan	Zimbabwe
Ghana		

Table 2.2: Data Sources and Definitions

DEVAL	1 or 0 based on depreciation of nominal exchange rate. Source: IMF, International Financial Statistics
BANK	Commercial bank debt as a share of total external Debt (%). Source: World Bank, Global Development Finance.
CONCESS	Concessional debt as a share of total external debt (%). Source: World Bank, Global Development Finance.
VARIABLE	Floating rate debt as a share of total external debt (%). Source: World Bank, Global Development Finance.
PUBLIC	Public sector debt as a share of total external debt (%). Source: World Bank, Global Development Finance.
SHORT	Short-term debt as a share of total external debt (%). Source: World Bank, Global Development Finance.
MULTILATERAL	Share of debt lent by multilateral development institutions of total external debt (%). Source: World Bank, Global Development Finance.
FDI	Flow of foreign direct investment, as a percent of total external debt. Source: World Bank, Global Development Finance.
DEBTGNP	Total external debt, as a percent of Nominal GNP. Source: World Bank, Global Development Finance and World Development Indicators.
RESIMP	Gross international reserves . Source: World Bank, World Development Indicators.
RESM2	Gross international reserves of money + quasi-money. Source: World Bank, World Development Indicators.
CA	Current account balance, as a percent of nominal GDP. Source: World Bank, World Development Indicators.
OVERVAL	Deviation from purchasing power parity. Defined as the real exchange rate ($ per f.c. unit) minus the average real exchange rate for the period. Source: IMF, International Financial Statistics and author's calculations.
BUDDEF	Overall government surplus or budget, as a percent of GDP. Source: World Bank, World Development Indicators.
DOMCRGRO	Growth rate of net domestic credit. Source: World Bank, World Development Indicators.
GDPGROWTH	Growth rate of real GDP in local currency unit. Based on constant 1995 U.S. dollars. Source: World Bank, World Development Indicators.
OECDGROWTH	Growth rate of real GDP for the OECD countries (%). Source: OECD Economic Statistics.
FORINT	Weighted average of foreign interest rates: The sum of the lending rate for the United States, Germany, Japan, France, the United Kingdom, and Switzerland. Weights are equal to the share of total external debt denominated in the relevant currencies. Sou
OPEN	Exports + imports, over GDP. Source: World Bank, World Development Indicators.

Table 2.3: Currency Crashes Used in Frankel Rose and Berg Patillo Models

Country	Year	Country	Year
Burkina Faso	1994	Kenya	1992
Cameroon	1981	Madagascar	1991
Cameroon	1994	Mauritius	1979
Chile	1982	Mexico	1981
China	1994	Mexico	1994
Colombia	1985	Morocco	1983
Congo, Dem. Rep.	1976	Nepal	1991
Congo, Dem. Rep.	1987	Nicaragua	1993
Congo, Rep.	1981	Niger	1981
Congo, Rep.	1994	Nigeria	1986
Costa Rica	1981	Pakistan	1982
Cote d'Ivoire	1981	Paraguay	1984
Dominican Republic	1985	Peru	1981
Ecuador	1982	Philippines	1983
Ecuador	1995	Romania	1990
Egypt, Arab Rep.	1979	Rwanda	1990
Egypt, Arab Rep.	1989	Senegal	1981
Ethiopia	1992	Sierra Leone	1983
Fiji	1987	Sierra Leone	1995
Gabon	1981	South Africa	1996
Gambia, The	1981	Sri Lanka	1977
Ghana	1978	Sudan	1981
Ghana	1983	Syrian Arab Republic	1988
Ghana	1992	Togo	1981
Guinea-Bissau	1987	Turkey	1978
Hungary	1995	Turkey	1988
India	1991	Venezuela, RB	1984
Indonesia	1983	Venezuela, RB	1994
Jamaica	1978	Yemen, Rep.	1995
Jamaica	1983	Zambia	1989
Jordan	1988	Zimbabwe	1982
Kenya	1981	Zimbabwe	1991

They use a windowing procedure in which crashes that occurred within three years of each other are excluded. FR generate the percentage change in the nominal exchange rate using the difference of the natural logarithm of the exchange rate. In their model, the variables of interest are separated into four categories. These are, variables related to internal domestic macroeconomic conditions; variables that may explain external imbalances; variables relevant to international indebtedness; and foreign variables that may help explain the relationship between the vulnerability of the country in question to international macroeconomic conditions.

For domestic macroeconomic variables, FR include: (1) the total government budget surplus (+) or deficit (-), as a percentage of nominal GDP; (2) the growth rate of domestic credit; (3) the growth rate of real GDP per capita. To explain the relationship between currency crashes and external imbalances or variables that may make the country a more likely candidate for speculative attacks, FR include: (4) the ratio of total external debt to GNP; (5) the ratio of the monetary authority's foreign exchange reserves over the dollar amount of monthly imports; (6) the current account surplus (+) or deficit (-), as a percent of GDP (7) the degree of real exchange rate overvaluation, defined as the percentage difference between the real exchange rate for a given year and the average over the full sample between 1971 and 1996. FR include seven variables related to composition of capital flows or international debt. These are, (8) the share of total external debt lent by international commercial banks; (9) the share of debt that is concessional**;** (10) the percentage of external debt with a variable interest rate; (11) the share of debt lent to the public sector; (12) the share of total external debt that is considered short-term; (13) the share lent by multilateral

development organizations, including the World Bank and regional development banks, but not the IMF; (14) and the flow of annual foreign direct investment as a share of the total external debt stock. And finally, for foreign variables, FR include (15) the growth rate of real output for the OECD countries in American dollars, and (16) the foreign interest rate, which is defined as the weighted average of short-term interest rates for the United States, Germany, Japan, France, the United Kingdom, and Switzerland. The weights for the short-term interest rates are equal to the percentage of the debt of the country in question denominated in the currency of the six above countries.

FR estimate the relationship between these variables and currency crashes using a probit model. For this analysis, I replicate FR's model using the above variables and the sources listed in Table 2.2. For the FR model and the Berg Patillo model discussed below, the currency crashes used in estimation are listed in Table 2.3. Some of the data in the current sample may be different from the data used to estimate the original FR model due to data revisions in the World Bank data sets. Table 2.4 presents summary statistics of the variables used in the FR model. Table 2.5 lists the results of the estimation of the default (contemporaneous explanatory and dependent variables) FR model.

The slope estimates and standard errors of the slope estimates, were estimated using the method discussed in the prior section. Table 2.6 lists the predictive output of my estimation of the FR model. The default model is estimated using contemporaneous currency crashes and explanatory variables, whereas the predictive model is estimated using the explanatory variables lagged one year.

Table 2.4: Frankel Rose Summary Statistics

Variable	Mean	Median	Std Dev	Min	Max
BANK	0.193	0.152	0.180	0.000	0.862
BUDDEF	-0.038	-0.031	0.046	-0.316	0.082
CA	-0.049	-0.040	0.071	-0.467	0.170
CONCESS	0.335	0.279	0.258	0.000	1.000
DEBTGNP	0.599	0.467	0.607	0.018	9.428
DOMCRGRO	0.216	0.186	0.216	-0.522	0.995
FDI	0.049	0.014	0.131	-0.180	2.218
FORINT	0.053	0.049	0.025	0.000	0.152
GNPPERCAPGRO	0.039	0.043	0.055	-0.185	0.264
MUTILATERAL	0.244	0.190	0.185	0.000	0.889
OECDGROWTH	0.028	0.030	0.014	-0.005	0.057
OPEN	N/A	N/A	N/A	N/A	N/A
OVERVAL	0.010	-0.027	0.313	-0.999	1.728
PUBLIC	0.744	0.774	0.154	0.178	1.000
RESIMP	3.209	2.535	2.504	0.039	12.467
RESM2	N/A	N/A	N/A	N/A	N/A
SHORT	0.141	0.115	0.109	0.000	0.798
VARIABLE	0.220	0.193	0.191	0.000	0.868

Table 2.5: Frankel Rose Default Output

Variable	Slope	Std Error	P-Val
INTERCEPT			
BANK	-0.015	0.085	0.862
BUDDEF	-0.020	0.144	0.892
CA	-0.027	0.103	0.790
CONCESS	-0.049	0.050	0.326
DEBTGNP	0.019	0.009	0.029
DOMCRGRO	0.046	0.091	0.610
FDI	-0.038	0.071	0.587
FORINT	0.527	0.262	0.045
GNPPERCAPGRO	-0.251	0.105	0.016
MUTILATERAL	-0.089	0.055	0.107
OECDGROWTH	0.079	0.458	0.863
OPEN	N/A	N/A	N/A
OVERVAL	0.057	0.018	0.002
PUBLIC	-0.027	0.072	0.713
RESIMP	-0.004	0.003	0.198
RESM2	N/A	N/A	N/A
SHORT	-0.018	0.091	0.843
VARIABLE	-0.133	0.090	0.138

Table 2.6: Frankel Rose Predictive Output

Variable	Slope	Std Error	P-Val
INTERCEPT			
BANK	-0.046	0.022	0.036
BUDDEF	0.057	0.144	0.691
CA	-0.083	0.102	0.414
CONCESS	-0.046	0.053	0.384
DEBTGNP	0.011	0.009	0.229
DOMCRGRO	0.049	0.028	0.082
FDI	-0.212	0.122	0.083
FORINT	0.142	0.258	0.582
GNPPERCAPGRO	-0.108	0.106	0.308
MUTILATERAL	-0.112	0.058	0.053
OECDGROWTH	-1.254	0.453	0.006
OPEN	N/A	N/A	N/A
OVERVAL	0.057	0.019	0.002
PUBLIC	-0.023	0.070	0.746
RESIMP	-0.004	0.003	0.146
RESM2	N/A	N/A	N/A
SHORT	0.066	0.093	0.474
VARIABLE	-0.120	0.060	0.046

For the in-sample and out-of-sample predictive testing of the currency crisismodels, the predictive model is used. For a forecasting model to be useful, the data must be correlated with the dependent variable, prior to the realization of the dependent variable. Because the probit model is non-linear, the slope coefficients are equal to a one unit change in the probability of default with respect to a one unit change in the explanatory variable. In Tables 2.5 and 2.6, and also the output tables associated with the BP model, the slope coefficients are estimated at the mean of the explanatory variable in question. In Table 2.5, a one percent increase in real exchange rate overvaluation will increase the probability of devaluation by .057%. And an increase in GNP per capita growth will decrease the probability of devaluation by .25%.

From an explanatory standpoint, Table 2.5 shows us that real exchange rate overvaluation, the debt/GNP ratio, and the foreign interest rate are all positively and significantly correlated with currency crashes; while GNP per capita growth, reserves/imports, the multilateral share of debt are negatively related to crashes. In other words, countries with an overvalued real exchange rate and a high debt/GNP ratio are more likely to suffer a currency crisis. Countries with a high GNP growth rate and reserves/imports are less likely to suffer a crisis. The explanatory results are similar for the predictive model.

Table 2.7: Frankel Rose Model In-sample Prediction

50% Cutoff		**Actual**	
Predicted	**Tranquil**	**Crash**	**Total**
Tranquil	948	64	1012
Crash	2	0	2
Total	950	64	1014

25% Cutoff		**Actual**	
Predicted	**Tranquil**	**Crash**	**Total**
Tranquil	935	57	992
Crash	15	7	22
Total	950	64	1014

Table 2.7 shows the results of a test of in-sample predictive ability of the FR model. A well performing predictive model should separate the countries at risk for a currency devaluation from those countries that are not. Since the probit model estimates a probability of devaluation, for those country-years for which a currency crash actually occurred, the model should generate a higher output than for those for which it did not experience a crash. Table 2.7 tests two uses of the model: first, a devaluation probability of greater than 50% is considered a predicted crash by the FR model; second, all estimated probabilities of 25% or greater are considered predicted crashes. If we look at the 50% criterion, we see that a total of 1014 country-years were analyzed, with 64 of these observations being considered crashes. Again, this is a test of in-sample predictive ability. For the 50% criterion, a crash is correctly called if the estimated probability is greater than 50% for the year in which there was an actual crash. A country-year in which there was no crash is considered a tranquil observation. At the 50% criterion, there were 948 observations found to be tranquil by the model that were actual tranquil observations. And the model found 64 actual crash observations to be tranquil. The FR model also found two observations to be crashes, meaning that only two probabilities were generated that were greater than 50%. Of these two, a crash did not occur in either period.

The data used to analyze the model at the 25% level also consisted of 1014 country-years and 64 crashes. If we look at the results using the 25% criterion, we see that there were 935 actual tranquil observations that were also picked to be tranquil by the model. The model found 57 actual crash observations to be tranquil. The FR model estimated 15 actual tranquil observations as crashes, meaning that these observations had probabilities of greater

than 25%, but were not actual crash observations. There were seven correctly predicted crash observations.

From these results, it appears that the FR does not predict crashes incorrectly. But, from these results, it is also clear that the model does not accurately predict actual crashes in terms of either the 50% or 25% devaluation probability criterion. It may be that these two criteria are too stringent. The purpose of currency crash prediction model is to separate risky countries from less-risky countries. A model that is able to distinguish between two countries in terms of their devaluation probabilities may provide us with benefits.

The BP model

Berg and Patillo (1999a) developed a model similar to that of FR. In fact, the Berg and Patillo (BP) model was developed in response to the 1996 Frankel and Rose model. BP tested the predictive ability of the FR model and determined that they would be able to explain past currency crises and predict future crises better by making two changes to the FR model. First, the excluded the reserves to monthly imports variable and replaced it with the reserves/M2 ratio. This ratio is more closely aligned with the speculative attack literature, and they find it to perform better as an explanatory variable. BP also include a variable equal to the value of imports plus exports divided by GDP, added as a measure of the size of the international trade sector of the country in question.

Table 2.8 shows some summary statistics for the BP model. Table 2.9 shows the default output for the probit model based on the BP's seventeen variables. Both of the variables that BP added to the FR model are statistically significant and are negatively related to currency crashes. The variable OPEN is equal to the value of annual plus the value of

exports divided by nominal GDP. For the BP model, if this variable increases by 1%, the probability of devaluation will decrease by .05%. And a 1% increase in the reserves/M2 ratio will decrease the devaluation probability by .059%. With the BP model, we also see that countries with a high debt/GNP ratio, an overvalued real exchange rate, and a high foreign interest rate will increase the devaluation probability. While countries with high GNP per capita growth, a high level of total debt that is concessional, high foreign currency reserves over M2, and a high degree of international openness will be less likely to suffer a currency crash. Looking at the predictive output summarized in Table 2.10, we see the results are similar. From both FR and the BP, it appears that international reserves, GNP growth, the degree of international openness, and real exchange rate overvaluation are all significantly related to an increased probability of currency devaluation. The in-sample predictive ability of the BP model is summarized in Table 2.11. Just like with the results of the analysis on the FR model, there are two possibilities for a correctly predicted currency crash: the first, a devaluation probability greater than or equal to 50%; the second, a probability greater than or equal to 25%. We saw in the earlier results that the FR model did not overly select crash predictions, i.e., it did not generate a large number of Type II errors. But we also saw that the FR model generated a large number Type I errors. In other words, it missed a large number of actual crashes. There were 1009 country-years used to estimate the BP model. Of these 1009 observations, only 64 were actual crashes. Using the 50% cutoff, the model predicted 943 actual tranquil observations to be tranquil, and 64 actual crash observations to be tranquil. The BP model also predicted two actual tranquil observations to be crashes. Similar to the FR model, the BP model estimated only two probabilities greater than 50%.

Table 2.8: Berg Patillo Summary Statistics

Variable	Mean	Median	Std Dev	Min	Max
BANK	0.194	0.154	0.179	0.000	0.862
BUDDEF	-0.038	-0.030	0.046	-0.316	0.082
CA	-0.048	-0.040	0.071	-0.467	0.192
CONCESS	0.332	0.278	0.257	0.000	1.000
DEBTGNP	0.595	0.459	0.608	0.018	9.428
DOMCRGRO	0.217	0.187	0.219	-0.522	0.995
FDI	0.048	0.014	0.127	-0.180	2.218
FORINT	0.053	0.049	0.025	0.000	0.152
GNPPERCAPGRO	0.039	0.043	0.055	-0.185	0.264
MUTILATERAL	0.242	0.188	0.184	0.000	0.889
OECDGROWTH	0.028	0.030	0.014	-0.005	0.057
OVERVAL	0.009	-0.028	0.314	-0.999	1.728
PUBLIC	0.742	0.771	0.154	0.178	1.000
RESIMP	N/A	N/A	N/A	N/A	N/A
RESM2	0.304	0.229	0.259	0.007	1.842
SHORT	0.143	0.118	0.109	0.000	0.798
VARIABLE	0.220	0.195	0.191	0.000	0.868
OPEN	0.665	0.551	0.371	0.063	2.078

Table 2.9: Berg Patillo Default Output

Variable	Slope	Std Error	P-Val
INTERCEPT			
BANK	-0.011	0.078	0.892
BUDDEF	-0.004	0.140	0.980
CA	-0.130	0.102	0.202
CONCESS	-0.085	0.047	0.071
DEBTGNP	0.018	0.008	0.026
DOMCRGRO	0.019	0.028	0.503
FDI	-0.002	0.056	0.975
FORINT	0.526	0.243	0.031
GNPPERCAPGRO	-0.202	0.098	0.038
MUTILATERAL	-0.051	0.053	0.331
OECDGROWTH	0.096	0.418	0.819
OVERVAL	0.057	0.017	0.001
PUBLIC	-0.014	0.068	0.839
RESIMP	N/A	N/A	N/A
RESM2	-0.059	0.032	0.062
SHORT	-0.038	0.087	0.662
VARIABLE	-0.136	0.081	0.095
OPEN	-0.051	0.022	0.019

Table 2.10: Berg Patillo Predictive Output

Variable	Slope	Std Error	P-Val
INTERCEPT			
BANK	-0.050	0.021	0.015
BUDDEF	0.069	0.138	0.619
CA	-0.195	0.099	0.050
CONCESS	-0.094	0.049	0.055
DEBTGNP	0.013	0.008	0.108
DOMCRGRO	0.017	0.027	0.526
FDI	-0.074	0.108	0.490
FORINT	0.203	0.237	0.393
GNPPERCAPGRO	-0.062	0.098	0.529
MUTILATERAL	-0.076	0.054	0.163
OECDGROWTH	-1.072	0.413	0.009
OVERVAL	0.057	0.017	0.001
PUBLIC	-0.017	0.065	0.797
RESIMP	N/A	N/A	N/A
RESM2	-0.058	0.031	0.061
SHORT	0.022	0.087	0.797
VARIABLE	-0.135	0.054	0.012
OPEN	-0.076	0.023	0.001

Table 2.11: Berg Patillo Model In-sample Prediction

50% Cutoff		Actual	
Predicted	**Tranquil**	**Crash**	**Total**
Tranquil	943	64	1007
Crash	2	0	2
Total	945	64	1009

25% Cutoff		Actual	
Predicted	**Tranquil**	**Crash**	**Total**
Tranquil	925	54	979
Crash	20	10	30
Total	945	64	1009

At the 25% cutoff level, the model found 925 actual tranquil observations to be tranquil and 54 actual tranquil observations to be crashes. The model estimated 30 probabilities greater than 25%. Of these, 10 of them were actual crashes, while 20 of them were tranquil observations. By comparing Table 2.11 with Table 2.7, we see that the BP model performs slightly better at separating crash observations from non-crash observations, at least in-sample.

The Hazard Model

Shumway (1999) applies the hazard econometric model to the prediction of default for publicly traded firms. In this section, I discuss the hazard model and its specific use in the creation of a more parsimonious model for predicting currency crashes. The hazard model allows time to failure as one of the explanatory variables in a discrete event predictive

model. In this case, the event is a 25% depreciation of the nominal exchange rate. The time to failure is the number of years before a currency crash. In the model, the dependent variable is equal to one if the country suffered a currency crash that year, or zero if not.

The hazard model is estimated with six economic variables and the natural logarithm of the age of the exchange rate regime, assuming a logistic distribution for the hazard function. Following naming conventions in hazard function modeling, assume a survivor function, $S(t, x; \beta)$ and a hazard function, $\phi(t, x; \beta)$, where t is the age variable, x is the vector of explanatory variables, and β is the vector of parameters for the two functions. For this model,

$$S(t,x;\beta) = 1 - \sum_{j<t} f(j,x;\beta), \quad (2.23)$$

and

$$\phi(t,x;\beta) = \frac{f(t,x;\beta)}{S(t,x;\beta)}, \quad (2.24)$$

assuming that $f(t, x; \beta)$ is the probability density function. So $S(t, x; \beta)$ is the survivor function, which gives us the probability of an exchange rate regime surviving (not suffering a devaluation) up to time t, and $\phi(t, x; \beta)$ is the hazard function, or the probability of the regime suffering a devaluation at t, conditional on the regime surviving to t. So the generic likelihood function for a hazard model is:

$$L = \prod_{i=1}^{n} \phi(t_i,x_i;\beta)^{y_i} S(t_i,x_i;\beta). \quad (2.25)$$

Shumway (1999) proves that a multiperiod logit model is equivalent to a discrete-time hazard model. Therefore, the hazard model above can be estimated as a logit model.

Because the hazard model used in this section does not require as many variables as the FR and BP models, I am able to include a larger sample of data when estimating the model. Table 2.12 lists the crash observations used to estimate the hazard model. For this model, I chose to include seven variables: six of these are used in the other models, and I've included the natural logarithm of the length of time from between currency crashes. The other six variables are, the ratio of total external debt to GNP; foreign direct investment as a share of total external debt; GNP per capita growth; M2 over international reserves held by the central bank; the degree of openness (exports + imports over GDP); and the degree of real exchange rate overvaluation. Table 2.13 shows summary statistics on the variables used in the model. Based on the FR and BP models, I expect there to be a positive relationship between the level of debt and crisis probability, and a negative relationship between FDI and crisis probability. Countries with positive GNP growth rates and low ratios of M2 to foreign reserves should be less likely to suffer a crisis. Also, countries with a large international trade sector should be less likely to suffer a crash, while countries with an overvalued exchange rate should have a higher probability of suffering a currency crisis.

Speculators will be less likely to run on a currency that is managed under a monetary authority that appears to be serious about maintaining the current regime. In other words, speculators expect that the longer the monetary authority maintains the fixed rate regime, the more serious the authority is about maintaining the peg: the positive reputation effect. Countries that have not maintained an exchange rate regime for a long period of time are the ones seen by speculators as more likely to use drastic exchange rate policy as a tool for lowering unemployment, interest rates, etc.

Country	Year	Country	Year
Algeria	1988	Kenya	1981
Argentina	1975	Kenya	1992
Argentina	1981	Lao PDR	1995
Benin	1994	Lesotho	1981
Bhutan	1991	Lesotho	1996
Botswana	1984	Madagascar	1981
Botswana	1996	Madagascar	1987
Brazil	1987	Madagascar	1991
Burkina Faso	1994	Malawi	1992
Burundi	1983	Mali	1994
Burundi	1988	Mauritania	1992
Cameroon	1981	Mauritius	1979
Cameroon	1994	Mexico	1976
Central African Republic	1981	Mexico	1981
Central African Republic	1994	Mexico	1994
Chad	1994	Morocco	1983
Chile	1982	Nepal	1991
China	1989	Nicaragua	1993
China	1994	Niger	1981
Colombia	1985	Niger	1994
Congo, Dem. Rep.	1976	Nigeria	1986
Congo, Dem. Rep.	1987	Pakistan	1972
Congo, Rep.	1981	Pakistan	1982
Congo, Rep.	1994	Paraguay	1984
Costa Rica	1974	Peru	1976
Costa Rica	1981	Peru	1981
Cote d'Ivoire	1981	Philippines	1983
Cote d'Ivoire	1994	Romania	1990
Dominican Republic	1985	Rwanda	1990
Ecuador	1982	Senegal	1981
Ecuador	1995	Senegal	1994
Egypt, Arab Rep.	1979	Sierra Leone	1983
Egypt, Arab Rep.	1989	Sierra Leone	1995
El Salvador	1986	South Africa	1996
El Salvador	1990	Sri Lanka	1977
Ethiopia	1992	Sudan	1981
Fiji	1987	Sudan	1985
Gabon	1981	Swaziland	1975
Gabon	1994	Swaziland	1981
Gambia, The	1981	Swaziland	1996
Ghana	1978	Syrian Arab Republic	1988
Ghana	1983	Tanzania	1992
Ghana	1992	Togo	1981
Guatemala	1986	Togo	1994
Guinea-Bissau	1987	Trinidad and Tobago	1985
Guinea-Bissau	1991	Trinidad and Tobago	1993
Guinea-Bissau	1996	Turkey	1978
Haiti	1991	Turkey	1988
Honduras	1990	Uganda	1991
Hungary	1995	Uruguay	1972
India	1991	Uruguay	1982
Indonesia	1978	Venezuela, RB	1984
Indonesia	1983	Venezuela, RB	1994
Jamaica	1978	Yemen, Rep.	1995
Jamaica	1983	Zambia	1989
Jamaica	1991	Zimbabwe	1982
Jordan	1988	Zimbabwe	1991

Table 2.12: Currency Crashes Used in the Hazard Model

Table 2.13: Hazard Model Summary Statistics

Variable	Mean	Median	Std Dev	Min	Max
DEBTGNP	0.617	0.431	0.709	0.009	9.428
FDI	0.054	0.013	0.278	-0.436	10.500
GNPPERCAPGRO	0.037	0.040	0.061	-0.246	0.403
LN(AGE)	1.910	2.079	0.839	0.000	3.296
M2RES	0.088	0.041	0.184	-0.684	3.034
OPEN	0.651	0.545	0.369	0.063	2.546
OVERVAL	0.022	-0.036	0.384	-0.999	5.657

The results of the hazard model are given in Table 2.14. I've chosen to estimate only the predictive version of this model since the purpose is to compare this type of model with the FR and BP models. The slope estimates of the parameters are estimated at the means of the independent variables, and are included in the table. We also see the standard errors of the slopes which were estimated using the Delta method. The ratio of M2 to foreign currency reserves held by the central bank positively and significantly increases the probability of a currency crash. A 1% increase in the M2/reserves ratio will increase the probability of a crash by .047%. The ratio of total external debt to GNP and the degree of real exchange rate overvaluation also significantly increases the likelihood of a crash. The measure of the degree of openness (imports plus exports divided by GDP) significantly decreases the probability of a crash, with a 1% increase in this ratio lowering the probability of devaluation by .058%. And in this model, FDI over GDP and GNP per capita growth do not significantly explain differences in currency crash probability, although the signs on both of these coefficients are negative, which is consistent with the FR and BP models.

Table 2.14: Hazard Model Predictive Output

Variable	Coefficient	Std Error	P-Val
INTERCEPT			
LN(AGE)	0.045	0.011	0.000
M2RES	0.047	0.016	0.003
DEBTGNP	0.010	0.005	0.045
OPEN	-0.058	0.018	0.002
FDI	-0.103	0.085	0.224
OVERVAL	0.026	0.009	0.004
GNPPERCAPGRO	-0.049	0.072	0.496

The coefficient on the natural logarithm of the age variable is statistically significant. Interestingly, the empirical relationship is a negative one. The hypothesis stated earlier in this chapter was that there should be a negative relationship between the age of the exchange rate regime and the probability of a currency crash, because of the reputation effect and increased credibility of those governments that are able to successfully maintain a fixed exchange rate regime. I believe that speculators would be less likely to "run" on a currency if they feel the central bank is serious about maintaining the existing regime. But, the information in Table 2.14 disproves this hypothesis, even accounting for the domestic variables such as GDP. Simply, this means that the longer a regime lasts without a devaluation, the greater the likelihood of the regime suffering a devaluation. Obstfeld and Rogoff (1995) claim that fixed exchange rate regimes are a "mirage".

The purpose of this chapter is to create a model that predicts currency crashes using annual data. The positive relationship was not expected, but we do see that the coefficient is significant on the age variable, and therefore, it should help predict crashes. So, how well does this hazard model succeed is predicting actual crashes, in-sample and out-of-sample?

Table 2.15 shows the results for in-sample predictive analysis. As can be seen in the table, the hazard model, because it relies on only seven variables, as opposed to sixteen for the FR model, allows a greater sample size for both crash and tranquil observations. There were 1767 annual observations used, spanning from 1971 to 1996. Of these 1767, 1653 were tranquil observations, while the remaining 114 were treated as crashes.

The top portion of Table 2.15 shows the 50% probability cutoff level. At the 50% level, the hazard model generated1760 probability estimates less than 50%. Of these, 1648 of them were actual tranquil observations and 112 were actual crashes. The model generated seven crash predictions (greater than 50% probability estimates). Of these, five were actual tranquil observations and two were actual crashes. If we look at lower portion of the table which is the 25% cutoff level, we see that the hazard model estimated 1736 observations with probability estimates less than 25%. These are the predicted tranquil observations. Of these, 1636 were actual tranquil observations and 100 were actual crashes. Of the 31 observations with an estimated probability of 25% or greater, 14 of these were actual crashes, while 17 were tranquil observations.

Table 2.16 shows the relative predictive ability of the three currency crash prediction models. A model built to predict currency crashes should separate risky observations from non-risky observations. Table 2.16 rank-orders the devaluation probabilities and shows the percentage of the crash observations within a given population percentile.

Table 2.15: Hazard Model In-sample Prediction

50% Cutoff		Actual	
Predicted	**Tranquil**	**Crash**	**Total**
Tranquil	1648	112	1760
Crash	5	2	7
Total	1653	114	1767

25% Cutoff		Actual	
Predicted	**Tranquil**	**Crash**	**Total**
Tranquil	1636	100	1736
Crash	17	14	31
Total	1653	114	1767

The purpose of the Berg and Patillo (1999a) paper and the article in The Economist were to discuss that ability of economists to create models that predict currency crashes, *out of sample*. Unfortunately, there weren't many countries after 1996 with exchange rate depreciations that meet the criterion to be included as a crash. Table 2.17 summarizes the percentiles of the population within which these crash observations fall.

From Tables 2.16 and 2.17, it appears that the hazard model does a better job separating the risky observations from the less-risky observations. In Table 2.16, we see that of the 114 in-sample crashes, the hazard model generated probabilities in the top decile for 46 of these. Of the 64 used in the FR model, 18 had estimated probabilities in the top decile, while the BP generated top decile probabilities for 24 of these in-sample crashes.

Conclusions

In this chapter, I create a hazard model using a limited number of macroeconomic variables, that predicts currency crashes. I then test the predictive ability of the hazard model against the predictive ability of two well-known currency prediction models by Frankel and Rose (1996) and Berg and Patillo (1998). Neither the FR model nor the BP model accounted for time-without-devaluation. Both of these models include greater than fifteen macroeconomic and financial variables from World Bank data sets. For many of the countries used to calibrate the hazard model, these variables are not available. I argue that a hazard model, that accounts for time-without-devaluation, with only six variables, does a better job explaining and predicting currency crashes than the FR and BP models. Because the crash sample is small, the results may not be as sound as one would hope.

Table 2.16: In-sample Forecast Accuracy

Decile	Frankel Rose	Berg Patillo	Hazard
1	18	24	46
2	14	16	18
3	14	2	9
4	6	5	5
5	3	12	17
6-10	9	5	19
Possible	64	64	114

Table 2.17: Out-of-sample Forecast Accuracy

Decile	Frankel Rose	Berg Patillo	Hazard
1	1	2	4
2	2	0	2
3	0	1	1
4	1	1	2
5	1	0	0
6-10	1	2	5
Possible	6	6	14

But there is evidence that the hazard model is able to rank order countries at risk of a devaluation better than the other two models. I find a positive relationship between the age of the exchange rate regime and the probability of devaluation, which is contrary to the expected relationship based on the reputation effect. This relationship may have to do with the political realities of countries that have adopted stringent exchange rate regimes. Eventually, residents will demand looser monetary policy. Further research may show this. But, as is clear from the results, the time-since-devaluation model is positively and significantly related to the probability of devaluation. Everything else equal, the longer a country has maintained an exchange rate regime without a collapse, the greater the probability of an upcoming crash.

CHAPTER 3

CURRENCY CRASHES AND CAPITAL FLIGHT

This chapter investigates capital flight from developing countries. The goals are to measure the magnitude of capital flight over the last twenty years and to examine the relationship between capital flight and devaluation risk. As will be seen later in the chapter, the amount of capital flight varies greatly between developing countries. Some countries are net importers of capital, while other countries, like those in Africa and Latin America export large amounts of capital each year. Macroeconomic policies in many developing countries have been quite volatile over the last few decades, leading to debt crises, devaluations, high inflation, unsuccessful stabilization programs, and speculative international investment. Policies that lead to macroeconomic instability and domestic wealth depreciation will cause capital flight. One such fundamentally unsound policy is the attempt at a domestic monetary policy under a pegged exchange rate. As we know from the Monetary Approach to the Balance of Payments, the domestic money supply can only grow so fast with a pegged exchange rate. Countries that attempt to increase the money supply at a rate that is unsustainable with the level of foreign exchange reserves, will be at risk for a devaluation. It is hypothesized that these are the countries that experience large amounts of capital flight.

The focus of this study is on the relationship between devaluation risk and capital flight. The study asks the question: Can differences in capital flight between developing

countries be explained by the risk of a devaluation? Although the idea that devaluation risk leads to capital flight is not a new one, the methodology used to study this relationship is. I investigate the relationship from a cross-sectional perspective, using a generated probability of devaluation as a proxy for devaluation risk. It has been shown by Cuddington (1986) that there exists a positive relationship between capital flight and the risk of a devaluation in single country over time. This study investigates whether it is devaluation risk that explains differences in capital flight between countries.

There are two reasons for using the devaluation probability estimates as a proxy for devaluation risk. One, using the probability of devaluation is consistent with exchange rate theory. For a country with a pegged exchange rate, the expected devaluation is equal to the probability of devaluation times the magnitude of the exchange rate depreciation, given a devaluation. It is clear that in countries with a fixed or pegged exchange rate, returns on assets will be dependent on the expected exchange rate depreciation. In a pegged rate regime, the depreciation of the exchange rate is an uncertain event, and hence, the magnitude of the depreciation is also uncertain. Therefore, asset returns denominated in the domestic currency will be dependent on domestic interest rates, the expected magnitude of a devaluation, and the probability of the devaluation.

The second reason for using the generated probability estimate is simply that there are not many other variables suitable for use as a proxy for devaluation risk. My goal with this research is to explain why some countries on average experience large amounts of capital flight, while others experience smaller levels of flight or possibly even net capital inflows. Cuddington (1986) used the degree of real exchange rate appreciation as a proxy for expected

depreciation. And some authors have used the difference between the black market exchange rate and the official pegged rate. I believe that the better proxy for devaluation risk is a model-generated probability estimate. It may not be the case that an overvalued exchange rate is a sign of an upcoming devaluation. This study investigates average capital flight over time, so even if we did believe that real exchange rate appreciation is a useful proxy for an upcoming devaluation, it might be difficult to generate average overvaluation. And data on black market spread over the official exchange rate is not available for most countries. The better proxy for devaluation risk is the output of a devaluation risk model.

The countries included in this analysis are listed in Table 3.1. Three estimation methods from prior papers are used for the measurement of capital flight and in the empirical analysis in this chapter. These are, a residual method of the World Bank, as described in World Bank (1985); another version of a residual method, known as the Morgan Guaranty method, described in Morgan Guaranty (1986); and a version of what is known as the hot money method, which is described in Cuddington (1996). I use three estimates for the empirical investigation because of the difficulties in finding an all-encompassing definition of capital flight. As a proxy for the expectation of a devaluation, I use the devaluation probabilities that were generated for the analysis in Chapter 2. The hypothesis is that capital flight is greater in those developing countries that have a higher risk, as measured by the generated probabilities, of suffering a devaluation. This idea of using a probability estimate as a proxy for the expectation of devaluation is similar to that methodology used by Cukierman, Edwards, and Tabellini (1992) who use a generated probability of government

change to explain differences in seigniorage in a large sample of countries.[2] And to Dichev (1998), who investigates whether the risk of bankruptcy, as measured by a model-generated probability estimate, is a significantly priced factor in stock returns.

Because there is not a widely accepted theory that explains the causal relationship between devaluation risk and capital flight, the econometric modeling is not as straightforward as applying a simple OLS model with some measure of capital flight as the dependent variable and the devaluation probability as an independent variable. There is the possibility of correlation between the dependent variable and the regression error term. An instrumental variables estimation method is applied along with the simple OLS model to investigate the statistical relationship between capital flight and devaluation risk.

This study is the first to show a relationship exists between the probability of devaluation and capital flight from a cross-sectional perspective. Previous researchers have shown that domestic inflation is associated with capital flight, which presumably is based on imperfect indexation of domestic asset returns. In an inflationary environment, capital is expected to be shifted to a safer market to avoid the inflation tax. It has also been shown that real exchange rate appreciation is related to capital flight. Real exchange rate appreciation is hypothesized to be a signal of an upcoming currency crash, based on the theory of purchasing power parity. If the domestic price level is increasing faster than the foreign price level, either domestic inflation will have to decrease at a greater rate than foreign inflation, or the exchange rate will eventually depreciate.

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[2] Cukierman, Edwards, and Tabellini (1992) is reviewed in Chapter 4 of this paper.

Table 3.1: Countries Used in Analysis

Algeria	Guinea	Peru
Antigua and Barbuda	Guinea-Bissau	Philippines
Argentina	Guyana	Portugal
Bangladesh	Haiti	Romania
Barbados	Honduras	Rwanda
Belize	Hungary	Samoa
Benin	India	Sao Tome and Principe
Bolivia	Indonesia	Saudi Arabia
Botswana	Iran, Islamic Rep.	Senegal
Brazil	Jamaica	Seychelles
Burkina Faso	Jordan	Sierra Leone
Burundi	Kenya	Singapore
Cameroon	Lao PDR	Solomon Islands
Cape Verde	Lesotho	South Africa
Central African Republic	Liberia	Sri Lanka
Chad	Madagascar	St. Kitts and Nevis
Chile	Malawi	St. Lucia
China	Malaysia	St. Vincent and the Grenadines
Colombia	Maldives	Sudan
Comoros	Mali	Suriname
Congo, Rep.	Malta	Swaziland
Costa Rica	Mauritania	Syrian Arab Republic
Cote d'Ivoire	Mauritius	Tanzania
Djibouti	Mexico	Thailand
Dominican Republic	Morocco	Togo
Ecuador	Myanmar	Trinidad and Tobago
Egypt, Arab Rep.	Nepal	Tunisia
El Salvador	Nicaragua	Turkey
Equatorial Guinea	Niger	Uganda
Ethiopia	Nigeria	Uruguay
Fiji	Oman	Vanuatu
Gabon	Pakistan	Venezuela, RB
Gambia, The	Panama	Yemen, Rep.
Ghana	Papua New Guinea	Zambia
Grenada	Paraguay	Zimbabwe
Guatemala		

Cuddington (1986) investigates the causes of capital flight in a small sample of emerging markets and finds that real exchange rate appreciation is a significant factor in explaining this phenomenon. Other studies on empirical explanations of capital flight are Rojas-Suarez (1991) who examines the correlation between domestic capital flight and foreign investment. Kant (1996, 1998) investigates the relationship between foreign direct investment and domestic capital flight. And Lensink, Hermes, and Murinde (2000) investigate whether political risk can explain capital flight in a large cross-section of countries. In a literature related to that on capital flight, Mizen (1996) investigates foreign currency deposits in Uruguay and their relationship to the maintainability of the fixed exchange rate regime. He concludes that the level of foreign exchange reserves and dollar denominated bank accounts are cointegrated. The holding of foreign currency, know as currency substitution or dollarization is technically defined as the use of a foreign currency as a *medium of exchange.* Obviously, it is hard to find an accurate measure of foreign currency circulating in an economy. Kamin and Ericson (1993) attempt to do this using recorded currency flows between the U.S. and Argentina, while most other studies like Mizen (1996), Savastano (1996), and Ramirez-Rojas (1985) use data on foreign currency (dollar) denominated bank accounts held in domestic banks. Mizen's (1996) hypothesis that the maintainability of the exchange rate regime leads to the holding and use of foreign currency domestically, is similar to the hypothesis in this chapter. Mizen investigates the holding of foreign currency domestically, while I investigate the movement of funds into foreign currency denominated assets overseas.

The rest of this chapter is set up as follows. The next section defines capital flight and discusses some of its harmful effects. Then, I discuss the estimation of the three different measures of capital flight and generate the estimates. Later in the chapter, I empirically examine the relationship between devaluation risk and capital flight. Finally, I offer a discussion of these results and some conclusions.

Capital Flight: What is it?

Domestic investors in all countries should purchase assets in foreign countries as a way of diversifying their portfolios. We know that investors in the United States purchase shares of equity in companies located overseas, which is not considered capital flight. Clearly, all developed and developing countries experience capital outflows. But what is it that distinguishes what economists call capital flight from ordinary capital outflows? Perhaps this can be answered by Kanitz (1984) who asks, 'Why is it that when an American puts money abroad it is called "Foreign Investment" and when an Argentinian does the same, it is called "Flight Capital"?' This idea is the starting point for some capital flight estimates: All private capital outflows from developing countries should be considered capital flight. Other economists argue that abnormal capital outflows should be viewed as capital flight, while normal capital outflows should be seen as portfolio diversification. Most empirical studies begin with the hypothesis that capital flight is a response to high levels of uncertainty and high expected losses on domestic assets. Clearly, when one attempts to investigate the relationship between capital flight and other economic variables, it would seem to be important to distinguish between capital flight and ordinary capital outflows. But, from a measurement perspective, distinguishing between the two is quite difficult. Economists have

developed different methods to measure the amount of capital flight and even different definitions of capital flight have been used in previous research.

Cuddington (1986) claims that capital flight typically refers to short-term speculative outflows known as "hot money," and bases his capital flight estimates on this hot money definition. The World Bank (1985) and Morgan Guaranty (1986) provide a definition of capital flight based on the idea that, because of the difficulty in separating abnormal from normal capital outflows, capital flight should be considered all private capital outflows. In this study, I use three different estimates of capital flight as defined in Claessens (1997). These will be referred to as the World Bank, the Morgan Guaranty, and the Hot Money methods. I've included average capital flight estimates for 95 countries, over 1981-1997. Prior to this, the largest sample in terms of countries and periods, was the study by Lensink, Hermes, and Murinde (2000), in which they provided estimates for 84 developing countries, for the 1971-1991 period.

Is Capital Flight Harmful?

Capital flight is not necessarily bad. To a government whose job is to maintain policies that lead to economic growth, increasing capital flight may be considered a signal that its current policies are not working the way they were intended to work. In a sense, capital flight is domestic residents' way of "voting with their feet." If residents are unhappy with current monetary or fiscal policy, moving their funds overseas is a way of avoiding wealth diminishing policies. Governments should respond to capital flight by adopting policies that reduce the incentives for residents to move their assets out of the country. Macroeconomic policy should react to capital flight in a way that benefits residents.

Clearly, investors in developing countries will diversify their investment portfolios by purchasing assets in foreign countries, which is considered ordinary, rational behavior. And it is possible that in the short run, capital flight may be somewhat helpful by giving governments a signal that residents are unhappy with current policies. As we will see in this chapter, there are countries that over time, experience more capital flight than others. For these countries, the government is not altering its policies in response to domestic capital flight. These governments are clearly choosing policies that give domestic residents reason to move funds out of the country as a way of avoiding high expected losses on domestic assets. And it is this ongoing capital flight is harmful to a developing economy. There are considered to be two harmful effects of domestic capital flight to a developing country. These are, a possible slowdown in economic growth and a reduction in the tax base. Developing countries borrow internationally with many loans denominated in a foreign currency. Residents of developing countries borrow from countries such as the U.S., and return some of the funds to the countries of origin in the form of capital outflows. Funds are borrowed from developed countries and invested, not within the domestic economy, but in the country from which the funds originated.

Foreign direct and portfolio investment occurs because the marginal product of capital is higher in developing countries than in developed countries. Therefore, investment returns should be higher in developing countries. The fleeing of capital from markets where it is relatively more scarce and relative more productive to markets where it is less scarce and less productive, is inefficient. If domestic capital remained at home, developing countries may be

able to relieve some of their debt burden, and may not need to borrow such large amounts internationally.

Capital flight may slow economic growth by lowering investment. If domestic capital flight is large enough, it may offset the gains from foreign capital for domestic investment. Countries that are relying on foreign capital may run into trouble if the foreign investment dries up. Also, capital flight will drain foreign currency reserves held by the central bank. If the government is attempting to maintain a peg, or the government has dollars denominated debt, capital flight may lead to a currency crash.

Because capital flight, by definition, is made up of investments in other countries, and therefore, investments that are not taxed domestically, capital flight will erode the domestic tax base. In theory, a social welfare maximizing government will change its policies as residents respond to what they perceive as unstable policies. In reality, erosion of the conventional tax base sets a country up for an increase in the inflation tax, also known as seigniorage. Because capital flight erodes the domestic tax base, to a country maintaining a pegged exchange rate, capital flight exacerbates the problem. The government increases either its borrowing or it cranks up the printing press.

Developing countries rely on foreign currency denominated loans and foreign direct investment. Not only does capital flight work as a signal to the domestic government of harmful policies, it also works as a signal to foreign investors and lenders, of harmful macroeconomic policies. If lenders believe that the erosion of the tax base will lead to inflationary finance, foreign investment and lending will slow. Domestic capital flight is a signal to foreign investors of an increased risk of the inflation tax.

To summarize, international capital mobility is good. But when a government that is unwilling to change policies in response to capital flight but finds a way to continue to finance its spending, capital flight is a problem. Therefore, the causes of capital flight need to be understood along with policy ideas that reduce the amount of capital flight.

Causes of Capital Flight

One explanation of capital flight is based on the hypothesis that foreign capital inflows lead to capital flight because the inflows increase the availability of foreign exchange, making it easier for residents to move money overseas. Kant (1996, 1998) investigates this issue. Cuddington (1987b) investigates the macroeconomic causes of flight from a sample of four Latin American countries: Mexico, Argentina, Uruguay, and Venezuela. In three of these countries, Mexico, Uruguay, and Venezuela, a positive and significant relationship was found between the U.S. interest rate and Cuddington's capital flight estimate. Also in Mexico, Uruguay, and Venezuela, a proxy for expected exchange rate depreciation, measured by the real effective exchange rate minus its long-run average, led to greater capital flight. For Argentina, the coefficient on the lagged value of this variable was found to be positive and significant.

In another study, Pastor (1990) investigates the determinants of domestic capital flight in eight Latin American countries and finds that financial incentives, changing inflation, the availability of foreign finance, domestic growth, and tax policy explain capital flight. An overvalued real exchange rate, accelerating inflation, increases in the difference between the yield on U.S. and domestic assets all tend to increase capital flight, while increases in the domestic GDP growth rate relative to U.S. growth decreases capital flight.

Rojas-Suarez (1991) hypothesizes that domestic capital flight is a function of investors' perceived default risk on individual countries' external debt. She claims that decreased international lending after 1982 can be explained by an expectation of increased default risk, which she proxies by the difference between the implicit yield to maturity on countries' external debt and the yield on a six-month U.S. T-bill. Because of the low number of observations, she estimates the raw correlations between a capital flight measure similar and the proxy for default risk. She finds some evidence of her hypothesis in the data. Kant (1996, 1998) investigates whether foreign direct investment stimulates domestic capital flight. He claims that foreign direct investment may lead to greater capital flight because it provides residents with necessary foreign currency. If it is economic mismanagement that leads to capital flight, there should be a negative relationship between foreign direct investment and capital flight. Using contemporaneous correlation analysis, he finds a negative relationship between these two variables. Kant claims that policies that attempt to offer a better climate for international investment will also lead to smaller flows of domestic capital out of the region. Kant (1996) investigates this relationship over the years 1974 through 1992, for three regions: East Asia and the Pacific, Latin America and the Caribbean, and Europe and the Mediterranean. In Kant (1998), he examines the relationship on individual countries over 1974-1992 and finds similar results.

Lensink, Hermes, and Murinde (2000) investigate the relationship between political risk and capital flight. Their study includes the largest sample of countries and periods that had been used in the literature. According to the authors, many economists claim that political uncertainty and instability stimulate residents to move their wealth into more stable

political environments, as a way of hedging political risk. Lensink, Hermes, and Murinde were the first to attempt to econometrically model the relationship between political variables and capital flight.

Data

All data used in this study are from published sources. The three different methods for estimating capital flight will be explained in more detail in the next section. The majority of these data were taken from the IMF's *Balance of Payments Yearbook*. The other variables thought to explain capital flight were taken from *International Financial Statistics* and the World Bank's *World Development Indicators* CD Rom.

Different Estimates of Capital Flight

In this section I describe the three capital flight estimates used in this chapter. These are known as the World Bank method, the Morgan Guaranty method, and the Hot Money method. Three estimates are used because of the difference in definitions of capital flight and the uncertainty surrounding the accuracy of the Balance of Payments data. These three methods have all been used by previous authors in their attempts to measure capital flight. Table 3.2 summarizes the different accounts in the Balance of Payments figures. The presentation of the data in this format allows us to discuss the three estimates of capital flight.

Because of the difficulty in separating normal from abnormal capital outflows, flight capital may be measured by simply summing the figures measuring outflows. With reliable balance of payments data, capital flight should equal,

OTHER CAPITAL + BONDS + BANKS FOREIGN ASSETS.

Table 3.2: Data Sources and Definitions for Capital Flight Estimates

CURRENT ACCOUNT	Current Account. Source: IMF, Balance of Payment Statistics
NET EQUITY FLOWS	Net Direct Investment, Net Portfolio Investment in Equities. Source: IMF, Balance of Payment Statistics
OTHER CAPITAL	Other Short-term Capital of Other Sectors: Source: IMF, Balance of Payment Statistics
BONDS	Portfolio Investment, Other Bonds: Source: IMF, Balance of Payment Statistics
BANKS FOREIGN ASSETS	Change in Deposit Money Banks' Foreign Assets: Source: IMF, International Financial Statistics
RESERVES	Reserves. Source: IMF, Balance of Payment Statistics
ERRORS AND OMISSIONS	Net Errors and Emissions. Source: IMF, Balance of Payment Statistics
OTHER OFFICIAL CAPITAL	Other Long-term Capital of Resident Official Sector. Source: IMF, Balance of Payment Statistics
EXTERNAL DEBT	Change in External Debt. Source, World Bank: Global Development Finance

And if we make the assumption that all unmeasured outflows were outflows of private capital only,

CAPITAL FLIGHT = OTHER CAPITAL + BONDS + BANKS FOREIGN ASSETS + NET ERRORS AND OMISSIONS.

This says that simply, capital flight is equal to private capital flows plus net errors and omissions in the IMF's Balance of Payments accounting data.

The capital account figures in the BOP data are less reliable than those for the current account. Therefore, economists have come up with estimates for capital flight based on the

Balance of Payments identity, which says:

CURRENT ACCOUT + CAPITAL ACCOUNT = 0.

The accounts listed in Table 3.2 summarize the BOP data by breaking it into the current account and pieces of the capital account. Using the information in Table 3.2, the Balance of Payments identity can be shown as,

CURRENT ACCOUNT + NET EQUITY FLOWS + OTHER CAPITAL + BONDS + BANKS FOREIGN ASSETS + RESERVES + ERRORS AND OMISSIONS + OTHER OFFICIAL CAPITAL = 0,

which can be rewritten as,

OTHER CAPITAL + BONDS + BANKS FOREIGN ASSETS + ERRORS AND OMISSIONS = - (CURRENT ACCOUNT + NET EQUITY FLOWS + RESERVES + OTHER OFFICIAL CAPITAL),

The current account data is estimated more accurately than the capital account data, so we can use the balance of payments identity to solve for an estimate of capital flight. From above we know that capital flight can be measured as the negative of private capital flows plus net errors and omissions,

OTHER CAPITAL + BONDS + BANKS FOREIGN ASSETS + NET ERRORS AND OMISSIONS.

Based on the BOP identity, capital flight can be estimated as:

CURRENT ACCOUNT + NET EQUITY FLOWS + RESERVES + OTHER OFFICIAL CAPITAL.

Because of differences in the true definition of capital flight and questions about the accuracy of the balance of payments data, three estimation methods are used. These are explained in detail below, starting with the World Bank method.

The World Bank (WB) method:

Both the World Bank and the Morgan Guaranty method attempt to measure capital flight indirectly. Previous analysts have used what is known as the residual method for estimating capital flight from the balance of payments data. With residual methods, the estimate of capital flight is equal to the residual of the sources of funds, or funds entering the country, minus the uses of funds, or funds leaving the country. Sources of funds can be measured by ***NET EQUITY FLOWS + OTHER OFFICIAL CAPITAL***, while uses of funds can be measured by ***CURRENT ACCOUNT + RESERVES***. Capital flight as estimated using the World Bank method is equal to:

CURRENT ACCOUNT + RESERVES + NET EQUITY FLOWS + EXTERNAL DEBT.

For this method, the change in external debt is taken from the World Bank's *Global Development Finance* data set. Estimates of capital flight using the World Bank method are given in Table 3.3

The Morgan Guaranty (MG) method:

The Morgan Guaranty method is similar to the World Bank method, in that it is based on the difference between sources of capital and uses of this capital. Like the World Bank estimation method, the Morgan Guaranty method is based on the treatment of all private capital outflows as capital flight.

Table 3.3: World Bank Method - Average Annual Capital Flight (Mil. 1981-1997)

Country	Capital Flight	Country	Capital Flight
Algeria	$669.34	Madagascar	$-89.51
Argentina	$3,372.29	Malawi	$-36.09
Bangladesh	$179.81	Malaysia	$1,476.76
Barbados	$33.94	Maldives	$-5.58
Belize	$17.32	Mauritania	$4.98
Bhutan	$8.08	Mauritius	$28.50
Bolivia	$-212.44	Mexico	$2,404.62
Botswana	$-37.44	Morocco	$-50.71
Brazil	$2,411.44	Myanmar	$73.86
Burundi	$5.42	Nepal	$-118.77
Cameroon	$111.66	Nicaragua	$-635.79
Cape Verde	$0.98	Nigeria	$1,258.18
Central African Republic	$-10.76	Oman	$178.48
Chad	$19.57	Pakistan	$5.87
Chile	$-532.97	Panama	$286.81
Colombia	$658.15	Papua New Guinea	$177.81
Comoros	$-5.46	Paraguay	$-271.39
Congo, Dem. Rep.	$425.25	Peru	$-274.76
Congo, Rep.	$-215.73	Philippines	$-113.60
Costa Rica	$-165.44	Romania	$-729.63
Djibouti	$4.33	Rwanda	$-12.89
Dominican Republic	$1.76	Samoa	$0.51
Ecuador	$131.85	Sao Tome and Principe	$6.15
Egypt, Arab Rep.	$-663.26	Seychelles	$-11.73
El Salvador	$-8.44	Sierra Leone	$-19.76
Ethiopia	$348.23	Solomon Islands	$8.57
Fiji	$-32.04	South Africa	$147.60
Gabon	$99.73	Sri Lanka	$-151.17
Gambia, The	$16.81	St. Kitts and Nevis	$2.05
Ghana	$113.42	St. Lucia	$-1.92
Grenada	$-7.02	St. Vincent and the Grenadines	$7.01
Guatemala	$-168.37	Sudan	$293.55
Guinea	$28.19	Swaziland	$5.50
Guyana	$-18.86	Syrian Arab Republic	$795.83
Haiti	$-34.92	Tanzania	$-467.26
Honduras	$-55.59	Thailand	$500.74
Hungary	$533.15	Trinidad and Tobago	$256.40
Indonesia	$4,578.27	Tunisia	$16.90
Iran, Islamic Rep.	$-401.41	Turkey	$2,362.68
Jamaica	$-85.74	Uganda	$59.24
Jordan	$-203.40	Uruguay	$124.59
Kenya	$-113.53	Vanuatu	$11.12
Lao PDR	$29.88	Venezuela, RB	$2,664.86
Lebanon	$269.66	Yemen, Rep.	$-170.50
Lesotho	$24.64	Zambia	$-52.32
Liberia	$82.66		

The difference between the two is that the Morgan method includes the figure for the banking system's foreign assets. If, over a year, banks in these countries have invested a greater share of their assets overseas than they have moved back home, the Morgan Guaranty method will generate larger estimates of capital flight than the World Bank method. The estimate of capital flight, based on the Morgan Guaranty version of the residual method is,

CURRENT ACCOUNT + RESERVES + NET EQUITY FLOWS + EXTERNAL DEBT + BANKS FOREIGN ASSETS.

The Hot Money (HM) method:

The last capital flight measure to be used in this chapter is known as the Hot Money method. Cuddington (1986) describes different versions of the Hot Money method for estimating capital flight. He claims that only short-term, private reported outflows of funds should be considered capital flight. The Hot Money estimate is the Balance of Payments figure for private short-term capital of other sectors plus the figure for net errors and omissions from the Balance of Payment data. So,

CAPITAL FLIGHT = -(OTHER CAPITAL + NET ERRORS AND OMISSIONS).

To summarize, three different models for estimating capital flight are used. These are, the World Bank method with,

CAPITAL FLIGHT = CURRENT ACCOUNT + RESERVES + NET EQUITY FLOWS + EXTERNAL DEBT

The Morgan Guaranty method, where,

CAPITAL FLIGHT = CURRENT ACCOUNT + RESERVES + NET EQUITY FLOWS + EXTERNAL DEBT + BANKS FOREIGN ASSETS.

And the Hot Money method with,

CAPITAL FLIGHT = -(OTHER CAPITAL + NET ERRORS AND OMISSIONS).

Actual Capital Flight Estimates

In this section I present the estimates of capital flight using these methods. Table 3.3 shows the average capital flight estimates using the World Bank (WB) method. The numbers given in the table are the averages by country, using annual data, for the period of 1981-1997. We see that Indonesia suffered the greatest amount of capital flight for this seventeen-year period, with an average of $4.5 billion. Also, at that the top of the list of countries are, Argentina, with an average of $3.4 billion, Venezuela, with an average of $2.6 billion, Brazil, with an average of $2.4 billion, and Mexico, also with an average of $2.4 billion. Positive numbers imply that the country on average, suffered net outflows of capital for the seventeen-year period.

Table 3.4 presents the estimates for the Morgan Guaranty (MG) method. From an earlier section, we know that the MG method is quite similar to the World Bank method, as both are based on the residual after subtracting uses of funds from sources of funds. The only difference between the two is the addition of BANKS FOREIGN ASSETS to the MG method. So it is expected that countries with high estimates based on the WB method will also show high capital flight using the MG method. Again, Indonesia tops the list with an average of $4.9 billion. Other countries with high estimated flight for the 1981-1997 period using the MG method are: Argentina, with an average of $4.3 billion (a significantly larger number than the estimate of $3.4 billion for Argentina using the WB method), Brazil, with an average of $3.5 billion, and Turkey, with an average of $2.9 billion.

Table 3.4: Morgan Guaranty Method - Avg Annual Capital Flight (Mil. 1981-1997)

Country	Capital Flight	Country	Capital Flight
Algeria	$652.49	Madagascar	$-85.02
Argentina	$4,288.61	Malawi	$-34.04
Bangladesh	$212.50	Malaysia	$1,778.55
Barbados	$50.60	Maldives	$-5.04
Belize	$18.63	Mauritania	$5.90
Bhutan	$9.72	Mauritius	$46.97
Bolivia	$-206.87	Mexico	$2,481.68
Botswana	$-25.21	Morocco	$-42.76
Brazil	$3,473.86	Myanmar	$82.08
Burundi	$5.93	Nepal	$-107.79
Cameroon	$115.84	Nicaragua	$-624.76
Cape Verde	$-8.54	Nigeria	$1,418.27
Central African Republic	$-11.32	Oman	$259.31
Chad	$20.63	Pakistan	$70.56
Chile	$-491.26	Panama	$147.10
Colombia	$776.10	Papua New Guinea	$183.77
Comoros	$-5.96	Paraguay	$-257.97
Congo, Dem. Rep.	$483.66	Peru	$-226.03
Congo, Rep.	$-214.91	Philippines	$280.97
Costa Rica	$-152.41	Romania	$-740.27
Djibouti	$1.27	Rwanda	$-9.84
Dominican Republic	$8.19	Samoa	$0.79
Ecuador	$176.08	Sao Tome and Principe	$-4.99
Egypt, Arab Rep.	$-397.41	Seychelles	$-10.35
El Salvador	$-4.40	Sierra Leone	$-19.67
Ethiopia	$384.78	Solomon Islands	$8.74
Fiji	$-27.28	South Africa	$334.70
Gabon	$102.48	Sri Lanka	$-112.19
Gambia, The	$16.85	St. Kitts and Nevis	$8.70
Ghana	$136.45	St. Lucia	$-0.33
Grenada	$-4.30	St. Vincent and the Grenadines	$9.30
Guatemala	$-165.28	Sudan	$283.16
Guinea	$-33.28	Swaziland	$10.65
Guyana	$-18.80	Syrian Arab Republic	$1,955.25
Haiti	$-28.31	Tanzania	$-455.38
Honduras	$-42.72	Thailand	$956.40
Hungary	$767.54	Trinidad and Tobago	$269.18
Indonesia	$4,913.71	Tunisia	$45.28
Iran, Islamic Rep.	$-272.89	Turkey	$2,946.66
Jamaica	$-56.08	Uganda	$67.61
Jordan	$-61.50	Uruguay	$361.46
Kenya	$-82.72	Vanuatu	$21.11
Lao PDR	$14.24	Venezuela, RB	$2,664.70
Lebanon	$407.34	Yemen, Rep.	$-843.22
Lesotho	$24.99	Zambia	$-46.50
Liberia	$79.61		

Average capital flight estimates based on the Hot Money (HM) method are presented in Table 3.5. The difference between the HM approach and the prior methods is the focus on short-term, speculative, or hot money flows. From an earlier section, we know that capital flight is estimated from just two accounts in the Balance of Payments data. These are OTHER CAPITAL and ERRORS AND OMISSIONS. In Tables 3.3 and 3.4, we saw Indonesia exhibited the greatest amount of capital flight. From Table 3.5, we see that China shows up with the highest amount of capital flight, with an average of $6.4 billion. Argentina again shows up at the top of the list with an average of $2.85 billion, Mexico with an average of $2.5 billion, and Venezuela shows up with an average of $2.15 billion using the HM method.

Interestingly, Indonesia, which had highest estimate using the two residual-based measures, shows an average of $708 million when the estimate is based on the HM method. And Turkey shows a negative $502 million using the HM method, which means that on average, Turkey experienced $502 million in capital inflows between 1981 and 1997.

Tables 3.6 through 3.8 show average capital flight estimates for the seventeen-year period, by World Bank region definition. In Tables 3.6 and 3.7, we see that the countries in the Europe and Central Asia cohort experienced the greatest dollar amount of capital flight. Using the WB method, this group of countries shows an average of $722 million, and an average of about $1 billion using the MG method. We see that the countries in the South Asia region experience the smallest amount of capital flight over this period, with an average of $14 million in inflows using the WB method and only $11 million in capital flight based on the MG method.

Table 3.5: Hot Money Method - Average Annual Capital Flight (Mil. 1981-1997)

Country	Capital Flight	Country	Capital Flight
Algeria	$-51.45	Malaysia	$-86.55
Antigua and Barbuda	$5.47	Maldives	$-6.39
Argentina	$2,858.35	Mali	$6.76
Bangladesh	$91.53	Malta	$-42.86
Barbados	$28.87	Mauritania	$-3.28
Belize	$0.91	Mauritius	$-67.99
Benin	$-4.96	Mexico	$2,513.81
Bolivia	$23.59	Morocco	$-135.35
Botswana	$-23.23	Myanmar	$-28.74
Brazil	$-746.46	Nepal	$-91.94
Burkina Faso	$-9.16	Nicaragua	$-4.93
Burundi	$-3.92	Niger	$-4.96
Cameroon	$70.65	Nigeria	$403.87
Cape Verde	$7.07	Oman	$93.91
Central African Republic	$8.34	Pakistan	$-42.43
Chad	$35.24	Panama	$213.60
Chile	$-391.54	Papua New Guinea	$-2.73
China	$6,391.19	Paraguay	$-257.27
Colombia	$329.33	Peru	$-418.85
Comoros	$3.73	Philippines	$567.89
Congo, Rep.	$-121.28	Portugal	$418.30
Costa Rica	$-109.24	Romania	$-395.76
Cote d'Ivoire	$41.21	Rwanda	$-17.33
Djibouti	$-3.15	Samoa	$-5.32
Dominican Republic	$18.30	Sao Tome and Principe	$-0.84
Ecuador	$-35.81	Saudi Arabia	$-6,487.93
Egypt, Arab Rep.	$83.95	Senegal	$10.61
El Salvador	$-1.37	Seychelles	$-8.43
Equatorial Guinea	$0.47	Sierra Leone	$-10.92
Ethiopia	$58.04	Singapore	$2,064.39
Fiji	$-5.81	Solomon Islands	$6.76
Gabon	$105.62	South Africa	$1,481.52
Gambia, The	$12.83	Sri Lanka	$-91.35
Ghana	$31.62	St. Kitts and Nevis	$-0.71
Grenada	$-2.10	St. Lucia	$-0.03
Guatemala	$-196.86	St. Vincent and the Grenadines	$-1.01
Guinea	$-12.23	Sudan	$-68.80
Guinea-Bissau	$7.79	Suriname	$-13.71
Guyana	$-2.93	Swaziland	$-24.62
Haiti	$-15.95	Syrian Arab Republic	$-197.88
Honduras	$-38.53	Tanzania	$-83.28
Hungary	$-537.35	Thailand	$-690.95
India	$-71.95	Togo	$-16.58
Indonesia	$708.87	Trinidad and Tobago	$90.99
Iran, Islamic Rep.	$-443.91	Tunisia	$-167.90
Jamaica	$-116.43	Turkey	$-501.97
Jordan	$-112.72	Uganda	$-5.62
Kenya	$-205.91	Uruguay	$51.57
Lao PDR	$-3.06	Vanuatu	$20.76
Lesotho	$-8.23	Venezuela, RB	$2,151.94
Liberia	$78.27	Yemen, Rep.	$38.02
Madagascar	$-38.22	Zambia	$-89.72
Malawi	$-63.25	Zimbabwe	$-66.46

Table 3.8 presents the capital flight estimates by region, using the HM method. The countries classified as other high-income experienced the greatest amount of capital flight with about $1 billion. The countries in the Middle East and North Africa experience the greatest capital inflows over the seventeen-year period, with an average $738 million. From Tables 3.6 through 3.8, we can conclude that capital flight is not strictly a Latin American phenomenon.

The estimates by the three methods are summarized by World Bank income definition in Tables 3.9 through 3.11. These show that capital flight is not limited to just low income countries either. Using the WB and MG method, the countries classified as upper middle income show up with the highest average of $760 million and $940 million, respectively, in Table 3.9 and 3.10. In Table 3.11, the HM estimates are given. The low income countries experienced the greatest amounts of capital flight when the Hot Money method is used to estimate the figures.

Table 3.6: World Bank Method - Capital Flight by Region (Mil. 1981-1997)

Region	Mean	Median	Std Dev	Min	Max
East Asia and the Pacific	$610.17	$10.19	$2,747.92	$-5,528.00	$17,808.50
Europe and Central Asia	$722.07	$13.90	$2,333.76	$-3,619.70	$6,729.90
High-income OECD					
Latin America and the Caribbean	$355.04	$6.58	$3,118.08	$-19,389.30	$24,760.30
Middle East and North Africa	$40.48	$63.70	$2,329.40	$-24,386.00	$5,224.50
Other high-income					
South Asia	$-13.84	$2.10	$554.99	$-3,320.50	$1,477.50
Sub-Saharan Africa	$60.61	$7.88	$665.43	$-4,563.10	$7,296.50

Table 3.7: Morgan Guaranty Method - Capital Flight by Region (Mil. 1981-1997)

Region	Mean	Median	Std.Dev	Min	Max
East Asia and the Pacific	$775.12	$14.60	$3,078.25	$-7,864.84	$19,445.87
Europe and Central Asia	$1,000.44	$104.23	$2,807.18	$-3,688.84	$8,412.90
High-income OECD					
Latin America and the Caribbean	$445.63	$12.39	$3,404.03	$-19,784.96	$25,279.04
Middle East and North Africa	$216.07	$130.87	$3,160.78	$-22,502.08	$12,231.01
Other high-income					
South Asia	$11.34	$-0.62	$584.39	$-3,299.64	$1,480.33
Sub-Saharan Africa	$76.03	$12.57	$699.03	$-4,575.90	$7,527.13

Table 3.8: Hot Money Method - Capital Flight by Region (Mil. 1981-1997)

Region	Mean	Median	Std Dev	Min	Max
East Asia and the Pacific	$628.85	$1.30	$3,022.00	$-6,746.00	$17,333.00
Europe and Central Asia	$-483.75	$-421.00	$895.74	$-4,472.00	$854.00
High-income OECD	$418.30	$285.00	$2,118.00	$-1,936.00	$4,416.00
Latin America and the Caribbean	$216.78	$-0.20	$1,738.00	$-14,448.00	$13,456.00
Middle East and North Africa	$-738.36	$-117.00	$3,247.00	$-26,355.00	$12,988.00
Other high-income	$1,042.69	$-9.44	$3,423.00	$-4,911.00	$15,667.00
South Asia	$-34.98	$-9.20	$425.73	$-1,910.00	$1,958.00
Sub-Saharan Africa	$40.65	$-2.10	$446.90	$-1,999.00	$3,643.00

Table 3.9: World Bank Method - Capital Flight by Income (Mil. 1981-1997)

Income	Mean	Median	Std Dev	Min	Max
Low income	$152.75	$9.01	$1,310.25	$-7,799.80	$13,473.40
Lower middle income	$-16.54	$1.51	$1,708.37	$-24,386.00	$17,808.50
Upper middle income	$762.12	$25.40	$3,689.82	$-19,389.30	$24,760.30
High income					

Table 3.10: Morgan Guaranty Method - Capital Flight by Income (Mil. 1981-1997)

Income	Mean	Median	Std Dev	Min	Max
Low income	$180.56	$12.78	$1,450.43	$-7,698.14	$15,028.86
Lower middle income	$74.52	$4.91	$2,149.45	$-22,502.08	$19,445.87
Upper middle income	$939.12	$56.60	$4,062.89	$-19,784.96	$25,279.04
High income					

Table 3.11: Hot Money Method - Capital Flight by Income (Mil. 1981-1997)

Income	Mean	Median	Std Dev	Min	Max
Low income	$165.05	$-4.00	$1,447.00	$-1,999.00	$17,333.00
Lower middle income	$-20.34	$-13.70	$1,135.00	$-6,746.00	$12,988.00
Upper middle income	$-5.01	$1.10	$2,925.00	$-26,355.00	$13,456.00
High income					

Instrumental Variables Estimation

The regressor-of-interest in this chapter is the probability of devaluation from Chapter 2. Because this independent variable is stochastic, there is a possibility that it may be correlated with the error term. If this is the case, the coefficient estimate will not be estimated consistently with the OLS regression model. The hypothesis tested in this chapter is that capital flight is dependent on residents' perception of exchange rate risk. It could be argued that the probability of devaluation is a function of capital flight. Capital outflows will decrease foreign currency reserves, which will increase the likelihood of a currency crisis. Because of this possibility, I've used the instrumental variables (IV) to estimate the relationship between devaluation probability and capital flight.

The general regression model looks like:

$$y = X_k'\beta + \epsilon_k \quad (3.1)$$

The dependent variable *y* is one of the three estimates of capital flight divided by nominal GDP denominated in dollars. Because the focus of this chapter is to explain capital flight cross-sectionally, the average of the capital flight/GDP ratio is estimated over the period 1981-1997. The independent variables, X_k, consist of six variables hypothesized to explain capital flight. These will be discussed in greater detail in the next section, but they are: SPREAD - the difference between the prime lending rate for the country in question minus LIBOR, which should lead to smaller capital flight, the greater the spread between the domestic rate and LIBOR; AID - official development assistance as a percent of GNP, which should lead to greater capital flight because foreign aid should make it easier to obtain foreign currency and therefore, easier to invest in foreign markets; INFLGDPDEF - the annual inflation rate as measured by the growth rate of the GDP deflator. This should also lead to greater capital flight as domestic investors move their funds out of the inflationary environment; FDI - the ratio of net inflows of foreign direct investment as a share of GDP, which should lead to greater capital flight because of the availability of foreign currency; BANK - bank and trade-related lending as a percent of GDP, which should increase capital flight; FRAKELROSE/BERGPATILLO - the devaluation probabilities estimated in Chapter 2, using the models of Frankel and Rose (1996) and Berg and Patillo (1998). The probability estimates are used to estimate the relationship between capital flight and devaluation probability.

The classical model is based on the assumption that the devaluation probabilities are independent, with capital flight being dependent on the probability of devaluation and the five other variables. Because the devaluation probabilities are generated regressors, there is a high likelihood that these variables are correlated with the error term, ϵ_i, in the above regression equation. This lack of independence between the dependent variable and the error term will lead to inconsistent coefficient estimates on the FRANKELROSE and BERGPATILLO variables in the regressions. To correct this problem and generate consistent coefficient estimates, I use the instrumental variables (IV) procedure. The IV procedure, which is also known as two-stage least squares (2SLS), will allow me to estimate a model like the one described above, and generate consistent estimates of the relationship between devaluation probability and capital flight. In short, the correlation between ϵ_k and X_k rules out the use of a simple OLS regression model. Therefore, IV is the procedure used to estimate the relationship. From the currency devaluation models in Chapter 2, the probability of devaluation is dependent on foreign exchange reserves at the central bank. We know that central banks attempt to defend their exchange rates in the foreign exchange market. Capital flight will lower the value of the domestic currency and will drain reserves, as the central bank defends the exchange rate. It could be argued that capital flight is increasing the probability of devaluation, and not that the increased devaluation risk is causing capital flight. For the OLS model to be considered acceptable for this study, I would have to make the identifying restriction that the parameter on the reserves variable in the devaluation probability model is equal to zero. This is not a legitimate restriction.

To estimate the above model with the IV procedure, I needed to find an instrument that is correlated with the variable in X_k that is thought to be correlated with ϵ_k. This is a cross-sectional study, with averages of variables used in the regression estimation. The averages are gotten from data from 1981 to 1997. For the instrument, I use the averages of the FRANKELROSE and BERGPATILLO variables for the period 1971 - 1980. The correlation of the instruments and the actual variables are 61% for the Frankel Rose estimates and 74% for the probabilities generated from the Berg Patillo model. As long as the prior period's average is correlated with the current period's average, and not with the error term, this will work as an instrument. And I think that this is justifiable. As long as the stochastic process that is assumed to generate reserves at the central bank for the 1971-1980 decade is independent of the process generating reserves for the 1981-1997 period, the instrument will be independent of the error term in the regression. For the other five variables, I use the variables themselves as instruments. This is safe as long as none of the other five variables in X_k are correlated with the error term, ϵ_k. For this model, that assumption is made. The matrix of the five variables themselves, and the instruments for the devaluation probability, will be known as Z_k. Algebraically, the IV procedure consists of two steps, or two stages of regressions. The first step is to project X onto Z, to produce X_h. So,

$$X_h = Z(Z'Z)^{-1}Z'X \quad (3.2)$$

And the next step regresses $\boldsymbol{y}$, the dependent variable on $\boldsymbol{X_h}$, to generate consistent coefficient estimates. Therefore,

$$b_{IV}=(X_k'X)^{-1}X_k'y. \quad (3.3)$$

Econometric Analysis

This section summarizes the results of the OLS and IV estimation of the model,

$$y=X_k'\beta+\epsilon_k \quad (3.4)$$

where y is the ratio of the average of the capital flight estimate divided by nominal GDP over the 1981 to 1997 period, X is the matrix of the explanatory variables consisting of five economic variables expected to explain capital flight and an intercept, also averaged over the 1981 to 1997 period. The variables in X are, SPREAD - the country's prime lending interest rate minus LIBOR, AID - official development assistance and net official aid as a percent of GNP, INFLGDPDEF - the annual inflation rate as measured by the growth rate of the GDP deflator, FDI - foreign direct investment as a percent of nominal GDP, BANK - bank and trade-related lending as a percent of nominal GDP, FRANKELROSE and BERGPATILLO - the estimated probabilities of devaluation as generated by the models in Chapter 2. For each of these five variables, the average for each country over the seventeen-year period is used as the explanatory variables in the regression model.

There is a strong likelihood of the stochastic variables FRANKELROSE and BERGPATILLO being correlated with the error term ϵ. To accommodate this concern, I use the instrumental variables procedure. As an instrument for these variables, I use the average of the generated probabilities for each country over the period 1971 - 1980. For this to be considered a legitimate instrument, it must be that countries that were at risk for devaluation in that period, were at risk for devaluation in the 1981 - 1997 period. And this is most likely

the case: The raw correlation of the instruments and the actual variables are 61% for the Frankel Rose estimates and 74% for the probabilities generated from the Berg Patillo model.

Table 3.12: Other Data Sources and Definitions

SPREAD	Prime customer lending rate minus LIBOR (3 mo.) Source: World Bank, World Development Indicators.
AID	Official development assistance and net official aid as a percent of GNP. Source: World Bank, World Development Indicators.
INFLGDPDEF	Inflation as measured by the annual growth rate of the GDP deflator. Source: World Bank, World Development Indicators.
FDI	Foreign direct investment, net inflows as a percent of GDP. Source: World Bank, World Development Indicators.
BANK	Bank and trade-related lending as a percent of GDP. Source: World Bank, World Development Indicators.
FRANKELROSE	Estimated probability of devaluation, using the Frankel and Rose (1996) model. Source: Chapter 3.
BERGPATILLO	Estimated probability of devaluation, using the Berg and Patillo (1998) model. Source: Chapter 3.

Six separate OLS regressions were run along with six IV regressions. I ran two regressions for each of the three estimates of capital flight. For each capital flight estimate, I use the FRANKELROSE and BERGPATILLO generated probabilities. The OLS regression estimates are presented in Table 3.13 through 3.18. As we can see in these tables, the coefficient on the devaluation probability variable is not significant for any of the six regressions. But the coefficient on the spread variable is negative and significant for all six models.

Table 3.13: World Bank/Frankel Rose OLS Estimates

Variable	Coefficient	Std Error	Prob > |t|
INTERCEPT	-1.140	2.515	0.654
SPREAD	-0.258	0.098	0.014
AID	-0.251	0.148	0.100
INFLGDPDEF	0.158	0.092	0.098
FDI	0.439	0.558	0.438
BANK	0.056	0.058	0.342
FRANKELROSE	0.192	0.200	0.345

Table 3.14: World Bank/Berg Patillo OLS Estimates

Variable	Coefficient	Std Error	Prob > |t|
INTERCEPT	-1.023	2.527	0.689
SPREAD	-0.256	0.100	0.016
AID	-0.229	0.145	0.125
INFLGDPDEF	0.150	0.100	0.146
FDI	0.452	0.573	0.436
BANK	0.057	0.059	0.336
BERGPATILLO	0.175	0.207	0.405

Table 3.15: Morgan Guaranty/Frankel Rose OLS Estimates

Variable	Coefficient	Std Error	Prob > |t|
INTERCEPT	-0.281	2.480	0.910
SPREAD	-0.266	0.097	0.010
AID	-0.277	0.146	0.067
INFLGDPDEF	0.161	0.091	0.088
FDI	0.473	0.551	0.398
BANK	0.043	0.057	0.459
FRANKELROSE	0.176	0.197	0.380

Table 3.16: Morgan Guaranty/Berg Patillo OLS Estimates

Variable	Coefficient	Std Error	Prob > |t|
INTERCEPT	-0.118	2.495	0.963
SPREAD	-0.266	0.099	0.012
AID	-0.256	0.143	0.083
INFLGDPDEF	0.157	0.099	0.125
FDI	0.474	0.565	0.408
BANK	0.044	0.058	0.455
BERGPATILLO	0.150	0.204	0.469

Table 3.17: Hot Money/Frankel Rose OLS Estimates

Variable	Coefficient	Std Error	Prob > |t|
INTERCEPT	-1.468	1.304	0.268
SPREAD	-0.104	0.051	0.051
AID	-0.161	0.078	0.045
INFLGDPDEF	0.063	0.048	0.200
FDI	-0.049	0.285	0.865
BANK	0.037	0.029	0.211
FRANKELROSE	0.150	0.101	0.148

Table 3.18: Hot Money/Berg Patillo OLS Estimates

Variable	Coefficient	Std Error	Prob > |t|
INTERCEPT	-1.605	1.333	0.236
SPREAD	-0.101	0.051	0.057
AID	-0.135	0.075	0.080
INFLGDPDEF	0.057	0.050	0.261
FDI	-0.001	0.294	0.998
BANK	0.039	0.029	0.186
BERGPATILLO	0.146	0.094	0.133

The results of the six IV regressions are summarized in Tables 3.19 through 3.24. In each of these six tables, the coefficients on the variables SPREAD and INFLGDPDEF are shown to be significant at the 5% level. The sign on the SPREAD coefficient is negative, which means that a greater spread between the domestic lending rate and LIBOR will decrease the amount of capital fleeing the country. Countries with a greater return on domestic assets should experience less domestic money leaving the country. The sign on the INFLGDPDEF coefficient is positive in each of the six regressions. Countries with a high rate of inflation will be more likely to experience capital flight. But, the independent variable of interest is the probability of devaluation. It is hypothesized that countries, which are perceived to be at risk of a devaluation, will be more likely to experience large amounts of capital flight. And we do see some evidence of this from these six regressions. Tables 3.19 through 3.22 show that for the WB and MG methods (the two residual-type methods of estimating capital flight in this chapter) the coefficients on both the FRANKELROSE and BERGPATILLO variables are significant at the 10% level. Looking at Table 3.23 and 3.24, we see that the coefficients on these two variables are significant at the 5% level. It is likely that residents are more likely to move short-term funds out of a country in response to a perceived risk of devaluation. If the country actually suffers a devaluation, residents will be able to move their funds back into the country, taking advantage of a much weaker domestic currency value. The idea behind the Hot Money methodology is that capital flight should be an estimate of short-term, volatile flows. Cuddington (1996), first argued that capital flight estimation should be based on the assumption that estimates should measure outflows that are short-term fluctuations, rather

than long-term trends. It makes sense that the Hot Money version of capital flight would exhibit the highest correlation with the risk of devaluation.

Table 3.19: World Bank/Frankel Rose Instrumental Variables Estimates

Variable	Coefficient	Std Error	Prob > |t|
INTERCEPT	-3.593	2.945	0.232
SPREAD	-0.311	0.095	0.003
AID	-0.212	0.140	0.143
INFLGDPDEF	0.187	0.080	0.026
FDI	0.448	0.528	0.403
BANK	0.069	0.058	0.238
FRANKELROSE	0.497	0.276	0.082

Table 3.20: World Bank/Berg Patillo Instrumental Variables Estimates

Variable	Coefficient	Std Error	Prob > |t|
INTERCEPT	-2.626	2.613	0.323
SPREAD	-0.315	0.093	0.002
AID	-0.198	0.137	0.160
INFLGDPDEF	0.177	0.078	0.031
FDI	0.503	0.524	0.345
BANK	0.063	0.056	0.267
BERGPATILLO	0.408	0.237	0.096

Table 3.21: Morgan Guaranty/Frankel Rose Instrumental Variables Estimates

Variable	Coefficient	Std Error	Prob > |t|
INTERCEPT	-2.902	2.936	0.331
SPREAD	-0.318	0.094	0.002
AID	-0.240	0.140	0.097
INFLGDPDEF	0.186	0.079	0.026
FDI	0.500	0.527	0.351
BANK	0.057	0.057	0.328
FRANKELROSE	0.508	0.275	0.075

Table 3.22: Morgan Guaranty/Berg Patillo Instrumental Variables Estimates

Variable	Coefficient	Std. Error	Prob > |t|
INTERCEPT	-1.900	2.601	0.471
SPREAD	-0.322	0.093	0.002
AID	-0.227	0.137	0.108
INFLGDPDEF	0.176	0.078	0.032
FDI	0.554	0.522	0.297
BANK	0.051	0.055	0.369
BERGPATILLO	0.414	0.236	0.090

Table 3.23: Hot Money/Frankel Rose Instrumental Variables Estimates

Variable	Coefficient	Std Error	Prob > |t|
INTERCEPT	-3.210	1.685	0.065
SPREAD	-0.146	0.054	0.010
AID	-0.135	0.080	0.100
INFLGDPDEF	0.091	0.045	0.050
FDI	-0.066	0.291	0.823
BANK	0.041	0.031	0.194
FRANKELROSE	0.366	0.160	0.028

Table 3.24: Hot Money/Berg Patillo Instrumental Variables Estimates

Variable	Coefficient	Std Error	Prob > |t|
INTERCEPT	-2.542	1.480	0.095
SPREAD	-0.149	0.051	0.006
AID	-0.114	0.075	0.136
INFLGDPDEF	0.090	0.042	0.041
FDI	-0.011	0.280	0.970
BANK	0.038	0.029	0.199
BERGPATILLO	0.273	0.129	0.042

As can be seen in Tables 3.13 - 3.24, the OLS and IV models give different results. The coefficients on the devaluation probabilities from the IV model are much greater than those for the OLS model. It must be the case that countries that were at risk of a devaluation during the 1981-1997 period, were also those countries at risk in the 1971-1980 period. The coefficients on the IV estimated model are higher because the OLS coefficients are not estimated consistently.

Conclusions

In this chapter I set out to measure capital flight over the last two decades and to investigate the relationship between capital flight and devaluation risk. The estimates of devaluation risk are the outputs of the Frankel and Rose, and Berg and Patillo models in Chapter 2. We have seen that along with the risk of devaluation, differences in capital flight can also be explained by the inflation rate and by the spread on the country's debt versus LIBOR. Everything else equal, countries with greater rates of inflation are more likely to suffer capital flight; countries with a higher yield spread on domestic debt over LIBOR are less likely to suffer flight - if residents can be compensated for taking risk they will keep their funds at home; and, countries that are more at risk for a currency devaluation are also those countries that suffer from higher capital flight. The policy implications from these results are clear: inflation and increased devaluation risk are variables that can be controlled by the government somewhat. To reduce capital flight, government should maintain lower inflation and lower risk of devaluation.

What about capital controls? Some economists have recommended capital controls as a means of protecting countries from speculative attacks. The controls are defended for

their ability to limit speculative capital inflows and outflows. These controls will also limit capital flight. But are these controls a feasible way to end capital flight? . If we believe the hypothesis that capital flight from developing countries is due to unstable macroeconomic policies, then it is the policy that needs to be changed. The solution to the problem of capital flight, according to the results in this study, is to lower the inflation rate and to stabilize the exchange rate system Capital flight is a free market response to a government-induced problem. Limiting residents' ability to invest where they please is not a solution to the problem. This paper shows that it is the maintainability of the exchange rate regime that determines capital flight. To slow capital flight and to correct the inconsistencies that lead to capital flight and other problems related to the belief in an unsustainable exchange rate regime, governments must adopt policies that convince residents and investors that it is their goal to maintain the value of investments denominated in the local currency.

CHAPTER 4

SEIGNIORAGE AND CAPITAL CONTROLS

Thanks to the work of Milton Friedman and Robert Mundell, it is well known that a country cannot maintain a domestic monetary policy, a fixed exchange rate, and a market open to the free flow of international capital. Some economists and policymakers recommend that nations keep the ability to influence the domestic money supply and the credibility of a pegged exchange rate, but place controls on the flow of capital. One of their arguments for capital controls is that they limit speculative possibilities. Currency speculators have been blamed for recent devaluations such as Britain in 1992, Mexico in 1994, and Thailand in 1997.

A less-discussed reason for the imposition of controls is the effect on the demand for money. By placing controls on the flow of capital, governments not only make it more difficult for international investors to get their money out of the country, they also make it more difficult, and in some cases illegal, for domestic residents to substitute away from a weak and unstable domestic currency. By placing limits on the ownership of foreign currencies and other foreign assets to be used as a store of value, governments can increase the money supply and therefore seigniorage revenue, at a greater rate than they would be able to with widely available substitutes for domestic currency. The purpose of this chapter is to empirically investigate the relationship between capital controls and the level of seigniorage

in a cross-section of countries. The idea that governments can maintain an artificially high demand for domestic currency with controls was initially outlined in Nichols (1974). According to Nichols, residents will attempt to avoid the inflation tax by substituting into foreign currency and using domestic currency for transactions when absolutely necessary. As will be shown below, real seigniorage is higher with a relatively higher real (domestic) money demand. If a government imposes capital controls, money demand will be artificially high because residents are not able to hold foreign assets. According to Nichols, inflation should be lower. Using data taken from the IMF's *International Financial Statistics* and World Bank's *World Development Indicators*, I investigate Nichols' primary principle, that seigniorage will be higher in countries that have imposed capital controls. The testable hypothesis of this chapter is, because governments may choose to use capital controls as a means of increasing their seigniorage revenue at a given level of money demand, there will be a positive empirical relationship between seigniorage and capital controls.

This study contributes to the seigniorage literature in a couple of ways. First, it investigates the effect of capital controls on seigniorage, accounting for the deadweight loss of conventional taxation. Click (1998) finds that seigniorage is higher where per capita income is lower. Per capita income is an indicator of the government's ability to collect tax revenue: the lower the income, the less-developed the tax collection technology. Secondly, this study tests the theory in White (1999) that says that seigniorage will be higher in those countries that have placed restrictions on the holding of foreign assets, even accounting for the change in the elasticity of money demand caused by the restrictions. This study will test this hypothesis. Table 4.1 lists the countries used in the empirical analysis, and Table 4.2

presents average annual seigniorage from 1981 to 1994 as a percentage of GDP and as a percent of total government spending. Annual seigniorage is defined to be the annual change in high-powered money. Seigniorage as a percentage of GDP is highest in Israel at 11.97%. The country with the lowest annual seigniorage is Switzerland with seigniorage just .0059 % of GDP.

Table 4.1: Countries Used in Analysis

Argentina	Gabon	New Zealand
Australia	Gambia, The	Niger
Austria	Germany	Nigeria
Bahamas, The	Ghana	Norway
Bahrain	Greece	Oman
Barbados	Guatemala	Pakistan
Belgium	Honduras	Paraguay
Benin	Iceland	Peru
Bolivia	India	Philippines
Botswana	Indonesia	Portugal
Brazil	Ireland	Saudi Arabia
Burkina Faso	Israel	Senegal
Cameroon	Italy	Singapore
Canada	Jamaica	South Africa
Central African Republic	Japan	Spain
Chad	Jordan	Sri Lanka
Chile	Kenya	Sweden
Colombia	Korea, Dem. Rep.	Switzerland
Congo, Rep.	Lesotho	Thailand
Costa Rica	Malawi	Togo
Cote d'Ivoire	Malaysia	Trinidad and Tobago
Cyprus	Mali	Tunisia
Denmark	Malta	Uganda
Dominican Republic	Mauritius	United Kingdom
Ecuador	Mexico	United States
Egypt, Arab Rep.	Morocco	Uruguay
Fiji	Nepal	Venezuela, RB
Finland	Netherlands	Zambia
France		

Table 4.2: Average Seigniorage, by Country (1981-1994)

Country	Seign/GDP	Seign/Expend	Country	Seign/GDP	Seign/Expend
Switzerland	0.0059%	0.0091%	Gambia, The	1.3348%	7.1800%
Belgium	0.0735%	0.1354%	Central African Republic	1.3416%	
New Zealand	0.1572%	0.4285%	Benin	1.3788%	
Canada	0.1775%	0.7504%	Philippines	1.4170%	9.2407%
France	0.1997%	0.4584%	Singapore	1.4780%	7.2926%
United Kingdom	0.2259%	0.5899%	Iceland	1.5543%	5.6561%
Norway	0.2439%	0.6516%	Spain	1.6061%	7.2161%
Cameroon	0.2492%	1.5636%	Sri Lanka	1.6196%	5.4009%
Gabon	0.3182%		Morocco	1.6422%	5.4129%
Niger	0.3243%		Kenya	1.7100%	5.4727%
Saudi Arabia	0.3614%		Mauritius	1.7965%	7.8180%
United States	0.3787%	1.7205%	Malaysia	1.8135%	6.3926%
Oman	0.3885%	0.9022%	Malawi	1.9916%	
Botswana	0.4038%	1.1389%	Nigeria	1.9920%	11.1250%
Australia	0.4096%	1.5961%	Venezuela, RB	1.9986%	9.4609%
Ireland	0.4250%	0.9934%	Nepal	2.0219%	11.6137%
Austria	0.4337%	1.1089%	India	2.0642%	12.8498%
Bahrain	0.4352%	1.4412%	Lesotho	2.0871%	2.0997%
Cote d'Ivoire	0.4451%		Dominican Republic	2.1379%	17.1771%
Barbados	0.4651%	1.5264%	Ecuador	2.1425%	15.1068%
Denmark	0.4951%	1.1632%	Colombia	2.2014%	18.5060%
Bahamas, The	0.5046%	2.4620%	Pakistan	2.2395%	10.2213%
Germany	0.5136%	1.6665%	Portugal	2.2811%	5.8089%
Congo, Rep.	0.5147%		Paraguay	2.3525%	23.2379%
South Africa	0.5208%	1.8714%	Ghana	2.3659%	18.1300%
Japan	0.5313%	3.2202%	Uganda	2.3769%	25.8516%
Netherlands	0.5450%	1.4375%	Cyprus	2.7487%	8.8360%
Trinidad and Tobago	0.5523%	1.7868%	Greece	2.7921%	8.1516%
Fiji	0.7066%	2.5962%	Mexico	2.9811%	12.1220%
Senegal	0.7590%		Malta	2.9898%	7.7429%
Chad	0.7954%	-0.5803%	Zambia	3.3464%	10.0506%
Indonesia	0.7989%	4.0991%	Jamaica	3.8060%	
Finland	0.8415%	2.4673%	Bolivia	4.3965%	20.6570%
Sweden	0.9321%	2.1540%	Costa Rica	4.4183%	26.0798%
Korea, Dem. Rep.	0.9495%	5.8971%	Jordan	4.9580%	13.4868%
Thailand	1.0012%	6.2994%	Egypt, Arab Rep.	4.9880%	12.7586%
Mali	1.0104%	3.7289%	Brazil	5.7654%	19.4837%
Honduras	1.0486%	5.1611%	Peru	5.9487%	37.5451%
Tunisia	1.0514%	2.9730%	Argentina	6.4311%	89.6980%
Togo	1.0777%		Uruguay	6.9879%	26.2508%
Italy	1.1403%	2.9521%	Chile	10.2142%	37.6109%
Guatemala	1.2466%	12.7954%	Israel	11.9729%	15.5175%
Burkina Faso	1.2873%	6.9249%			

Capital Controls: Types

In this section I discuss the different types of capital controls. The focus of this chapter is on capital controls and their relationship to domestic money demand. In the empirical work later in this chapter, I include only those controls on outflows of resident owned funds. The discussion of the various types of controls is included as a means of gaining a better understanding of the tools governments have at their disposal, although controls on outflows of resident-owned funds are consistent with the theory discussed later.

Simply, there are two types of capital controls: controls on capital outflows and controls on capital inflows. Two well-cited examples of the differing types of controls are those policies of Malaysia and Chile. Malaysia in 1998 imposed controls on outflows, hoping to slow foreign exchange reserve drain. And Chile from 1991-1998 had controls on inflows, as an attempt to slow the appreciation of the real exchange rate and to alter the composition of capital flows. From this discussion, it will be clear that controls on the outflows of resident owned funds should lead to decreased availability of substitutes for domestic currency.

In a lengthy paper released by the IMF, Ariyoshi, et al. (2000) discuss the different means of imposing controls on capital flows. In their 2000 paper, the authors discuss the different means of accomplishing the goals of limiting international inflows and outflows, and different countries who have, in recent years, adopted these types of policies. Along with the two types of controls, controls on inflows and controls on outflows, the authors discuss the means of accomplishing these. They break them into two main forms of implementation. These are, direct or administrative capital controls and indirect or market-

based controls. Direct or administrative controls restrict transactions through prohibitions, quantitative limits, or some sort of approval procedure, possibly through the central bank. The purpose of these direct controls is to lower the volume of international transaction within the country. Indirect or market based controls are meant to discourage international capital transactions, especially short-term or "hot money" transactions. In other words, this form of control is implemented to give investors a disincentive to move their speculative funds into the country. The more difficult and expensive it is to transact in a given country, the less likely investors will be to do so. Some of the means of implementing these market based controls are: 1) a dual (two-tier) or multiple exchange-rate system; 2) explicit taxation of international capital flows; 3) indirect taxation of cross-border flows, such as the controls on inflows implemented by Chile from 1991 - 1998; and 4) other types of indirect regulatory controls.

Two-tier or multiple exchange rate systems are used frequently by developing countries. With this type of control, different exchange rates are applied to different transactions. This type of control is usually imposed if the country feels that high short-term interest rates will impose a burden on domestic residents. The government hopes to make it difficult for speculators to take short positions against the currency, by instructing domestic financial institutions not to lend to borrowers hoping to use the credit for speculative purposes. Foreign direct investment and trade flows are exempt from the restrictions. The purpose is to make speculation involving domestic currency more difficult.

Explicit taxation of foreign currency transactions is another means of controlling international capital flows. A tax on international transactions will lower demand for

domestic assets by international investors, thereby decreasing the amount of funds entering the country. Also, taxes will decrease the demand for foreign assets by domestic residents through the rate of return of return on these assets. The decrease in foreign demand for domestic assets and the decrease in domestic demand for foreign assets will lower the amount of foreign currency entering and domestic currency leaving. With explicit taxation, not only does the government gain revenue from the tax, it also gains seigniorage revenue from the reduced supply of available substitutes for domestic currency. Governments may try to impose a relatively higher tax rate on short-term transactions as opposed to long-term, with the hope that long-term investments would not be as quick to exit, and hence, not as destabilizing.

Instead of explicit taxation, some governments have adopted policies that implement implicit taxation. One means of doing this is in the form of non-interest bearing reserve/deposit requirements at the central bank. Under this type of policy, financial institutions are required to deposit an amount of foreign or domestic currency as a proportion of the net inflows of foreign currency. These restrictions act as an implicit form of taxation on foreign currency transactions by reducing the amount of principal collecting interest at the domestic rate. Required non-interest bearing deposits may also be set up to discourage outflows. If outflows, or conversions of domestic currency to foreign currency also require a non-interest bearing deposit at the central bank, the return on foreign investments is lowered, and therefore, the incentive to invest outside the country is also lowered. For domestic residents, this artificially reduces the supply of available substitutes for domestic currency, and hence, will artificially increase domestic real money demand.

Also, governments have adopted policies that distinguish between certain types of investors. An example would be a tax on those investors who take short positions in the domestic currency. And, governments may discriminate between short-term investment versus long-term investment. Another would be a credit rating requirement for domestic borrowers wishing to borrow abroad. Both of these examples would succeed in limiting the amount of available substitutes for currency, and should increase the government's "collection" of real seigniorage. Both Ariyoshi, et al. (2000) and Fokerts-Landau, et al (1995) discuss some of the actual examples of the control types discussed above.

Capital Controls: Arguments and Use

Gregorio, Edwards, and Valdes (2000) investigate the effects of Chile's controls on the real exchange rate, the Chilean interest rate differential, and the composition of capital flows, using vector autoregressions. Chile, from 1991-1998, imposed non-interest bearing reserves requirements on foreign currency inflows. The authors found a short-run effect on the interest rate, but no statistically significant long-run effect the interest rate spread from Chile. They did detect a small decrease in the real exchange rate after the control imposition shock in 1991. But the most significant effect of the controls was on the maturity of capital inflows. The controls were shown to increase the maturity of the flows entering the country.

Countries have justified the use of capital as a mechanism to defend a pegged exchange rate from speculators like George Soros. In reference to the well-known hedge fund manager, Paul Krugman (1996) coined the title, "Soroi", for those who engage in currency shorting. The government of Malaysia even went so far as to blame Soros specifically for their country's exchange market mayhem in 1997. As a response to what

policymakers in East Asia call destabilizing capital mobility, some of these countries have argued for and even imposed capital controls. It is believed that during a currency or financial crisis, capital controls will slow the reserve drain by giving the central bank some time to implement a corrective policy. And controls are thought to limit speculative possibilities during crises. Krugman (1999) has argued that controls could be imposed during a currency or financial crisis and removed after the crisis has lifted. Malaysia imposed controls for this reason in the midst of the Asian Financial Crisis. According to Edwards (1999), this policy has not been shown to be harmful. Capital controls may slow the reserve drain, but may not stop it altogether.

Calvo and Reinhart (1999) justify the use of controls as a way to alter the composition of capital inflows. Controls may shift the types of inflows from more short-term speculative portfolio inflows to longer-term foreign direct investment. But they claim capital controls as a policy response to outflows or inflows, at best, offer a short-term solution.

In their lengthy discussion of examples of capital controls, Ariyoshi, et al. (2000) include arguments for controls as a means to reconcile conflicting policy objectives, such as a pegged exchange rate and an independent monetary policy. They also argue controls may be imposed to reduce pressure on an appreciating real exchange rate. It is hoped that controls on inflows will truly reduce inflows, which should slow the appreciation of the real exchange rate. For some developing countries, large inflows may prove to be inflationary. If so, capital controls may lower the inflation rate by reducing the amount of domestic money backed by international reserves. Now, this argument might hold for a truly fixed exchange rate regime, but only in the short-run. In the long-run, purchasing power parity will lower

the domestic inflation rate. And for pegged exchange rate regimes, sterilization of capital inflows remains a policy option for the monetary authority.

Another argument discussed in Ariyoshi, et al. (2000) is for the purpose of revenue creation. If the form of control is an explicit tax on foreign capital entering the country, this policy may not only discourage foreign capital from entering the country, it will also generate tax revenue for the imposing government. In a similar argument, in this study I claim that the capital controls on outflows may lead to higher rates of the inflation tax. As discussed below, we will see that theoretical models show the government is able to generate "revenue" by increasing the monetary base.

In the next section I discuss White's (2000) theory of capital controls and real seigniorage maximization. Then I discuss some simple statistics on seigniorage. Then I discuss the econometric evidence on the effect of capital controls on seigniorage. And in the last section of this chapter, I discuss the results of the empirical analysis.

Seigniorage

Seigniorage is defined as the revenue accruing to the government though the creation of money with a value greater than the cost of production. The increase in the price level due to the increase in the money supply and the resulting decrease in the purchasing power of money balances, is known as the inflation tax. Holders of money are "taxed" as the purchasing power of money balances drops due to higher rates of inflation. Bailey (1956), McCulloch (1982), and White (1999) discuss seigniorage in the context of a government whose function is to maximize revenue from inflation. For simplicity, it is assumed that money production is costless. Therefore, for every 1$ produced by the central bank, nominal

seigniorage is equal to \$1. If we let S be defined as nominal seigniorage and M as the stock of base money, then over a single period (a year), nominal seigniorage is the change in base money, or $S = \Delta M$. (In an economy without fractional reserve banking, seigniorage will be the change in the money supply).

Bailey (1956) analyzes the welfare costs of perfectly anticipated inflation. Obviously, there are costs to unanticipated inflation, such as the transfer of wealth from creditors to debtors. For simplicity, he analyses the costs of anticipated inflation. If inflation is perfectly expected, the costs are due to the decrease in value of cash balances. Bailey assumes that the real value of contracts remains constant (perfect indexation), so the only cost of inflation is the decrease in value of money held. It is also assumed that the growth rate of the money supply is equal to the inflation rate. The negative effect of seigniorage is therefore identical to the effect of an explicit tax on cash balances, and is known as the excess burden of taxation. This welfare cost of seigniorage can be measured by the area under the real money demand curve, with the inflation rate as the price on the vertical axis and the real quantity of money demanded on the horizontal axis. As the inflation rate (growth rate of the monetary base) increases, the real quantity of money demanded decreases. Intuitively, the value of holding money decreases. The higher the rate of inflation, the faster consumers are forced to spend their money; they have less time to shop around for the best prices as money begins to lose its role as a store of value. The area under the demand curve can be thought of as the convenience associated with holding money. The higher the inflation rate, the smaller the convenience of maintaining money balances.

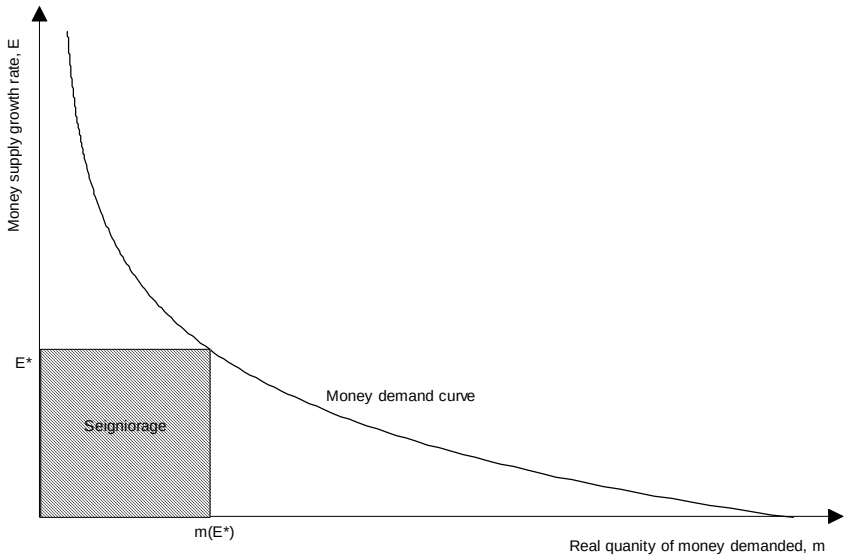
Seigniorage, a form of government revenue collection, can be modeled like conventional taxation. Real seigniorage is defined as nominal seigniorage divided by the price level, or $s = S/P$, where P might be the GDP deflator. Now, the inflation rate which is equal to the growth rate of the monetary base, can be thought of as the tax rate. And real money demand can be thought of as the tax base. Real seigniorage is therefore equal to the tax rate multiplied by the tax base, or

$$s=(\Delta M/M)(M/P) \qquad (4.1)$$

The growth rate of the money supply (the inflation rate) will be denoted by E, and real money demand will be denoted by m. So real seigniorage is denoted as

$$s=Em \qquad (4.2)$$

Figure 4.1: Real Money Demand Curve



Real money demand is a decreasing function of the money supply growth rate. The higher the inflation rate, the greater the cost of holding money balances. A government using seigniorage as a source of revenue has to balance the increase in the inflation rate with the decrease in real money demand. Figure 4.1 shows a plot of the real money demand Maximum seigniorage is the largest rectangle under the money demand curve. From the

microeconomic theory of a monopolist, profits are maximized when the firm raises its price up to the point where the elasticity of demand for the product is equal to -1. At this point, a 1% increase in price will lead to a 1% decrease in quantity demanded. The price increase is just offset by the decrease in quantity demanded. A seigniorage maximizing government will maximize a similar function. Seigniorage is maximized at the point along the real money demand curve where the elasticity of real money demand with respect to the inflation rate is equal to -1; a 1% increase in the inflation rate will lead to a 1% decrease in the real quantity of money demanded.

Assume a real money demand curve of the form:

$$m^d = e^{\beta - aE} \qquad (4.3)$$

with α and β as parameters and E as the inflation rate. From this equation, the higher the inflation rate, the smaller is the real demand for money. A seigniorage maximizing government increases the inflation rate until the elasticity of real money demand is equal to 1. Let ε_d denote the elasticity of demand for money, so

$$\varepsilon_d = (dm^d/dE)(E/m^d) \qquad (4.4)$$

and for the money demand function given above,

$$dm^d/dE = -ae^{\beta - aE} \qquad (4.5)$$

so,

$$\varepsilon_d = [E/(e^{\beta - aE})](-ae^{\beta - ae}) \qquad (4.6)$$

therefore,

$$\varepsilon_d = -Ea \qquad (4.7)$$

and at the point where seigniorage is maximized,

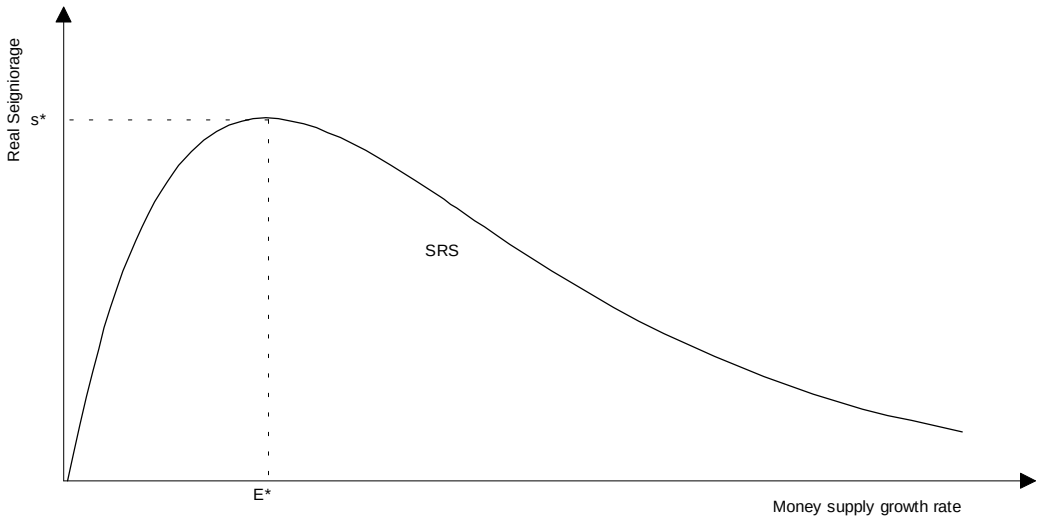
$$E^* = 1/a \qquad (4.8)$$

The seigniorage maximizing inflation rate depends on only one parameter, *a*, which is the semi-elasticity of real money demand,

$$a = (dm^d/dE)(1/m^d) \qquad (4.9)$$

Everything else equal, the higher the semi-elasticity of real money demand, the lower is the seigniorage maximizing rate of inflation. Figure 4.2 shows the steady-state seigniorage curve, with real seigniorage being maximized at a money supply growth rate of E*.

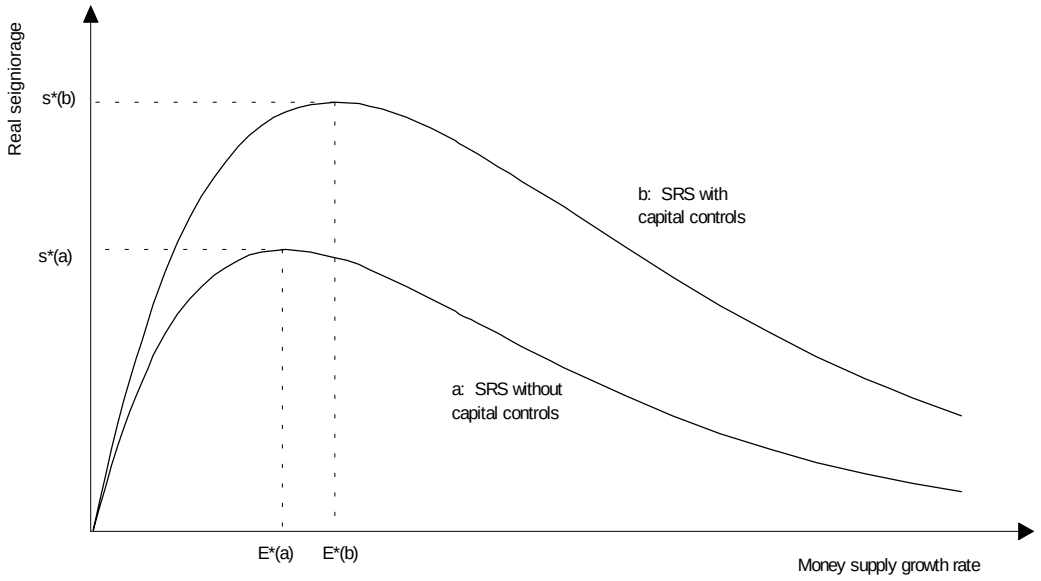
Figure 4.2: Steady-state Real Seigniorage



Nichols (1974) and White (1999) claim that restrictions on substitutes for domestic currency, such as capital controls, will reduce the absolute value *a*, the inflation elasticity of money demand and will increase real demand for money. Capital controls should also increase the parameter β. The effect of capital controls on the seigniorage maximizing inflation rate is shown in Figure 4.3. As can be seen from the figure, with capital controls imposed, the seigniorage maximizing rate of inflation is higher and the SRS curve takes off with a steeper slope. β can be thought of as the take-off parameter of the steady state seigniorage path. Seigniorage should be higher in those countries that have imposed controls, even after accounting for the elasticity of money demand. The parameter *a* is the semi-elasticity of real money demand. By limiting the number of substitutes available for

domestic currency, the proportional response of money demand to an increase in inflation is smaller than it would without the restrictions. Residents are hindered in their ability to substitute away from the domestic currency. According to White (1999), restrictions will increase real seigniorage, for any given rate of inflation due to the increase in the slope of β or the take-off parameter of the SRS path.

Figure 4.3: Steady-state Real Seigniorage with and without Capital Controls



Restrictions will increase both real seigniorage and the seigniorage maximizing rate of growth of the money supply. Easterly, Mauro, Schmidt-Hebbel (1995) showed that countries do not, generally, maximize seigniorage revenue. But, it is believable that countries with restrictions will be able to maintain a greater share of overall revenue with the inflation tax. [3]The rest of this chapter discusses previous empirical analyses of seigniorage and provides empirical evidence of a positive relationship between seigniorage and capital controls.

Previous Empirical Studies

From the previous theoretical analysis of seigniorage maximization, it is clear that countries that impose capital controls may be doing so to increase seigniorage for a given inflation rate. This was shown by the upward shifting Bailey curve. The focus of this paper is to test whether there is on average, a positive relationship between seigniorage and capital controls. The econometric methodology used is similar to previous papers, especially, Click (1998), Haslag (1998), and Cukierman, Edwards, and Tabellini (1992). These papers differ from earlier empirical studies of capital controls because they look at the different factors affecting seigniorage from a cross sectional perspective. They ask, what variables account for cross country variations in seigniorage? Less research has been done on seigniorage from a cross-sectional perspective than has been done on a seigniorage in a single country over time.

In a paper on the costs of official currency substitution, Fischer (1982) calculates a measure of the revenue to a government accruing from seigniorage for a large sample of

[3]See White (1999) for a discussion as to why governments may not maximize seigniorage.

countries. He calculates the ratio of the change in the monetary base to GNP and to total government revenue for a sample of developing and industrialized countries and finds that the rate of seigniorage is greater for developing countries than for developed countries. For some developing countries, it is as high as 5% of GNP a year and 10% of total government revenue.

Cukierman, Edwards, and Tabellini (1992) claim that countries with a more unstable and polarized system will have more inefficient tax systems, and will have to rely more on seigniorage. A higher level of seigniorage reflects higher costs of administering the tax system. A more unstable political system will lead to a less efficient tax system. Their hypothesis is that governments will take steps to maintain an unstable tax system, so that future governments, whose policies may be unpopular with the present government, will have a more difficult time raising revenue and implementing policies. The more unstable the government, i.e., the higher the probability of a change in government, the more likely it is that the tax system will be inefficient, and the more likely it is that the government will have to turn to seigniorage. To test their hypothesis, they estimate whether a selection of macroeconomic variables increases seigniorage. They investigate whether the sectoral composition of GDP affects seigniorage. For example, if the country has a large portion of its GDP from the agriculture sectors, the country will have to rely more on seigniorage since the agriculture sector is harder to tax. They also include measures of economic development: GDP per capita and a dummy if the country is industrialized. The more developed is the nation, the more developed will be the tax system, and the smaller the reliance on seigniorage. And as a final economic variable, they include a measure of urbanization. The

greater the percentage of the population living in urban areas, the easier it will be to tax these folks, and less likely it will be that the government is forced to rely on seigniorage.

In their paper, the economic variables are included to control for factors affecting seigniorage in a sample of countries. The focus of their paper is on the effect of political instability on seigniorage. As a proxy for the probability of government change as perceived by the current government, they estimate a probit model (0 for no government change, 1 for a change) with economic, political, and country specific dummies. The estimated probabilities of government change are averaged, and this variable is included in the cross-sectional regression. The authors find a positive and statistically significant relationship between the probability of a government change and the level of seigniorage. Edwards and Tabellini (1991), in a paper similar to Cukierman, Edwards, and Tabellini (1992), find the same positive and significant results for the proxy for political instability, but they include three variables for political weakness. Their empirical analysis is set up to test the difference between political instability and political weakness as explanatory variables for seigniorage. To measure the effect of political weakness, they use three different indicator variables to gauge the strength of the ruling government. Edwards and Tabellini claim that the less power the ruling party has, the greater the chance of conflict on tax policy, and the more likely it is that the government will rely on seigniorage. None of the political weakness variables are found to be significant, although, a positive and significant relationship was found between seigniorage and the instability measures.

In both of their papers, they use data on a large sample of countries over time. To make the cross-country comparisons, they take the average of the dependent variable (the two

different measures of seigniorage) and the average of the explanatory variables over a little more than a decade, using annual data. As will be discussed below, Click (1998), Haslag (1998), and I use similar econometric methodology.

Mankiw (1987) develops and empirically tests a model of government minimizing the social cost of raising revenue by intertemporally smoothing revenue collection through conventional taxation and seigniorage. His model implies three first order conditions that intertemporally optimal fiscal and monetary policy will satisfy. The government will equate the marginal social of cost of taxation today with the expected value of taxation in the future. Also, the marginal social cost of the inflation today will equal the expected value of inflation in the future. Most relevant to this paper, a social loss minimizing government will equate contemporaneously the marginal social cost of raising revenue through direct taxation with the marginal social cost of raising revenue through the inflation tax. This is the point of Mankiw's (1987) paper and the testable implication. An increase in the government's revenue requirement will lead to an increase in conventional tax collection and in the inflation rate. The testable implication is that the level of taxation moves with inflation and nominal interest rates.

Regressing the inflation rate and also the nominal interest rate on federal tax revenue over GDP with annual data over a thirty-year period, Mankiw finds a positive and significant relationship, even after controlling for government expenditures and the unemployment rate. Mankiw concludes that the non-stationary behavior of nominal interest rates and inflation can be explained by optimal tax policy.

This chapter builds on the work of Click (1998) and Haslag (1998). Click (1998) assumes a social welfare maximizing government and finds in a cross-section of countries, optimal tax theory explains 40% of the cross-country variation in seigniorage and 90% of the variation in conventional taxation. According to Click, a social welfare maximizing governments will rely more heavily on seigniorage when the deadweight loss of conventional taxation is high and the loss due to seigniorage is low. Seigniorage will be a relatively greater share of government revenue when the deadweight loss of conventional taxation is higher.

As a proxy for the deadweight loss of seigniorage, he uses the elasticity of the demand for money. The greater the elasticity of the demand for money, the greater the deadweight loss of a higher inflation rate. For the deadweight loss or the inefficiency of the tax system, Click uses per capita real income. The level of development indicates how efficient the tax system is, and therefore, is used as a proxy for deadweight loss. As the authors do in the previously mentioned papers, Click controls for different sectors in the economy.

Click finds a positive and significant relationship between the elasticity of money demand, and the level of seigniorage. The smaller the elasticity, the lower the deadweight loss of inflation and the more the government will rely on seigniorage. Also, the coefficient on per capita GNP is negative and significant. This is consistent with his hypothesis. A negative and significant relationship was found between the elasticity of money demand and conventional taxation.

Finally, Haslag (1998) investigates the effect of monetary policy on seigniorage. Using a sample of sixty-seven countries and data over the period 1965-1994, he shows a positive relationship exists between average seigniorage and the average money growth rate, and a positive relationship between seigniorage and the country's average reserve ratio. Haslag uses the familiar cross-sectional methodology. He averages the ratio of the change in monetary base over output for the sample period and regresses this on a combined money growth and reserve ratio variable. Haslag's hypothesis is that countries with high money growth rate-reserve ratio combination will rely more heavily on seigniorage than those that do not. His statistical evidence provides some defense of this hypothesis.

Capital Controls

Data on capital controls are taken from Cotarelli and Giannini (1997) and various issues of the IMF's *Annual Report on Exchange Arrangements and Exchange Restrictions.* The theory of seigniorage maximizing inflation rates and the effect of capital controls on these rates implies that controls on the use of foreign currency denominated assets as substitutes for domestic currency will allow the government to generate higher amounts of seigniorage revenue for a given level of inflation. Therefore, the capital controls of interest in this study are controls on the outflow of funds and specifically on the outflow of resident owned funds. A summary table in the *Annual Report on Exchange Arrangements and Exchange Restrictions,* provides data on these types of controls. If a country had this type of control in place during the year that country would be assumed to have a control in place during the entire year. That observation would be given a one as the capital control dummy variable. The information on each country is included in the Summary Features section of

the publication. In the publication, capital controls on resident-owned funds are defined as:

> *Restrictions (i.e., official actions directly affecting the availability or cost of exchange, or involving undue delay) on payments to member countries, other than restrictions evidence by external arrears and restrictions imposed for security reasons under Executive Board Decision No. 144-(52/510) adopted August 14, 1952.*

For those countries in this study that are not members of the International Monetary Fund, Cotarelli and Giannini (1997) generate a similar data point based on the individual countries' central bank documents.

Governments claim that restrictions are imposed to protect the exchange rate regime from volatile inflows that may lead to inflationary expectations and massive capital outflows. Some countries have blamed foreign currency speculators on exchange rate collapses, concluding that a tax on currency conversion, for example, will limit the amount of foreign speculation. This paper sets out to test whether these governments benefit from capital controls, apart from the exchange rate protection. Specifically the analysis focuses on controls on outflows of resident-owned funds. There are legitimate theoretical reasons as to why controls on foreign capital inflows might also lead to higher rates of seigniorage, but the definition used in this study is consistent with the Nichols' (1974) and White's (1999) descriptions of the effect of restrictions on domestic money demand, and hence, seigniorage.

Data and Methodology

This research is an extension of Click (1998) and Cukierman, Edwards, and Tabellini (1992). The focus of this paper is on seigniorage and capital controls. If domestic residents are restricted from holding non-taxable foreign assets, everything else equal, government

revenue should be higher. In his 1974 article, Nichols states the following principle;

The inflation that results from a given government deficit will be lower than otherwise if the availability of close substitutes for government money is curtailed.

And as a corollary of this principle:

The rate of inflation will be lower if the holding of foreign currency is restricted or prohibited.

According to Nichols, this is the reason why governments impose capital controls or restrictions on the free exchange of currency: to prevent the decline in domestic money demand that would occur in an inflationary environment. The decrease in money demand would lead to higher inflation. And this is the testable hypothesis: seigniorage should be higher in countries with capital controls because demand for domestic currency is kept artificially high through controls on residents' owning of foreign currency denominated assets.

Data are taken from the IMF's *International Financial Statistics* and *the* World Bank's *World Development Indicators* databases. The sample consists of annual data from 1981 to 1994 on 100 countries. Table 4.1 lists the countries used in the analysis. In Chapters 2 and 3 in this paper, only developing countries were investigated. But in this study, both developing and developed countries are used in the analysis. Twenty-two of the countries are classified as developed while the rest are considered to be developing countries. Table 4.3 lists the variables used in this analysis. SEIGNGDP is the dependent variable.

This is the annual change in the monetary base divided by nominal GDP.[4] The dependent variable in the econometric analysis is a relative measure of seigniorage. The ratio of the change in the monetary base over government expenditure is shown in Table 4.2. The next variable listed on Table 4.3 is the capital control dummy. This series is taken from the IMF's *Annual Report on Exchange Arrangements and Exchange Restrictions* and Cotarelli and Gianini (1997). It is a dummy for controls on outflows of resident-owned funds. Controls on outflows will limit the availability of these substitutes for domestic assets.

Summary statistics for the SEIGNGDP variable, based on the World Bank's region definition, are shown in Table 4.4. As can be seen from the table, seigniorage as a share of GDP is highest with an average of 3.9% in the countries classified as in the other high income cohort, which would be all high income countries outside of those in the OECD. This cohort also exhibits the greatest standard deviation for seigniorage over the 1981-1994 period. The lowest average seigniorage/GDP is for the group of countries in the OECD cohort, with an average of .65%. Table 4.5 shows summary statistics for the SEIGNGDP variable over the 1981-1994 period, broken down the World Bank's income definition.

Seigniorage/GDP is the highest, with an average of 2.62%, for those countries that fall in the upper-middle income classification. The high income countries show the lowest seigniorage/GDP, averaging 1.32% over the 1981-1994 period. This cohort also exhibits the second highest deviation around the average.

[4] For the econometric analysis, the log of the average of the ratio of high powered money to GDP over the sample period is used to cut back on outliers.

Table 4.3: Data Sources and Definitions

SEIGNGDP	Annual change in monetary base divided by GDP. Source: IMF, International Financial Statistics.
SEIGNEXPEND	Annual change in monetary based divided by government expenditure. Source: IMF, International Financial Statistics.
CONTROLS	1 or 0 based on capital control IMF capital control definition. Source: Cotarelli and Giannini (1997).
GOVEXPEND	Total expenditure of the central government as a percent of GDP. Excluded lending minus repayments. Source: World Bank, World Development Indicators.
DOMGOVFIN	Domestic financing to cover central government's budget deficit, as a percent of GDP. Includes all government liabilities except for currency issues or demand, time, or savings deposits with government. Source: World Bank, World Development Indicators.
GNPPERCAPGRO	Growth rate of GNP per capita. Source: World Bank, World Development Indicators.
AGPROD	Value added (value of output minus intermediate inputs) of the agricultural sector, as a percent of GDP. Source: World Bank, World Development Indicators.
INDPROD	Value added of mining, manufacturing, construction, electricity, water, and gas, as a percent of GDP. Source: World Bank, World Development Indicators.
INCOMETAX	Taxes on income as a percent of total government revenue. Source: World Bank, World Development Indicators.
TRADETAX	Taxes on international trade as a percent of total government revenue. Source: World Bank, World Development Indicators.

Table 4.4: Seigniorage by Region (1981-1994)

Region	Mean	Median	Std Dev	Max	Min
East Asia and the Pacific	1.114%	0.973%	1.092%	5.523%	-2.689%
High-income OECD	0.652%	0.368%	1.346%	12.835%	-6.015%
Latin America and the Caribbean	3.546%	2.338%	4.382%	37.697%	-12.187%
Middle East and North Africa	1.975%	1.270%	2.838%	13.455%	-2.333%
Other high-income	3.939%	1.351%	8.467%	49.298%	-3.127%
South Asia	1.986%	2.031%	0.698%	4.134%	0.341%
Sub-Saharan Africa	1.247%	0.945%	2.333%	14.540%	-8.477%

Table 4.5: Seigniorage by Income (1981-1994)

Income	Mean	Median	Std Dev	Max	Min
High income	1.321%	0.502%	4.129%	49.298%	-12.187%
Low income	1.413%	1.318%	2.136%	10.153%	-8.477%
Lower middle income	2.586%	1.883%	2.687%	15.071%	-2.689%
Upper middle income	2.616%	1.140%	4.573%	37.697%	-2.610%

Econometric Analysis

The results of the first and econometric analysis are summarized in Table 4.5. All of the standard errors shown in Table 4.5 and the remaining tables were generated using White's heteroskedastic consistent covariance matrix technique. The model shown in Table 4.5 was estimated with five independent variables, including the intercept. The dependent variable in is the change in the monetary base over nominal GDP. The independent variable of interest in this chapter, the capital control dummy, CONTROLS in Table, shows a positive and statistically significant relationship with SEIGNGDP. The other explanatory variables included in this first model are: GOVEXPEND, which is the total annual expenditure of the federal government as a percent of GDP; DOMGOVFIN, which is the ratio of central government's liabilities, except for currency or deposits with the government, as a percent

of GDP; and GNPPERCAP, which is GNP per capita. So the first regression, with results summarized in Table 4.6 focuses on seigniorage as a financing alternative. The relationship between SEIGNGDP and GOVEXPEND is expected to be positive. Governments with a greater share of total expenditure as a percent of GDP, should be more likely to tap another financing source, namely the inflation tax. Everything else equal, the governments with a large amount of outstanding liabilities should be more likely to rely on seigniorage as a means of lowering the real burden of these liabilities. And Click (1998) claimed that countries with a lower GNP per capita will be more likely to rely on seigniorage, as GNP per cap serves as a proxy for the deadweight loss of conventional taxation.

Table 4.6: OLS Estimates, Seigniorage Regression 1

Variable	Coefficient	Std Error (White)	Prob > |t|
INTERCEPT	-4.252	0.703	0.000
CONTROLS	0.608	0.359	0.096
GOVEXPEND	-0.081	0.395	0.838
DOMGOVFIN	0.050	0.119	0.675
GNPPERCAPGRO	-0.087	0.029	0.004

Along with the positive relationship between capital controls and seigniorage, in Table 4.6 we see a negative and significant relationship between GNPPERCAP and SEIGNGDP. This is consistent with Click's results. Countries with a higher share of GNP per person, will be less likely to rely on the inflation tax since these countries are the most likely to have a well-developed conventional tax system. The other two variables in this first

regression show up with insignificant coefficients. The coefficient on the DOMGOVFIN coefficient is positive, as was expected, while the coefficient on GOVEXPEND is negative.

In Table 4.7 the results for the second regression are summarized. For this model, two variables were added. These are, AGPROD, which is the value added of the agricultural sector of the economy divided by nominal GDP. The second variable added to the regression is INDPROD, which is the value added of the manufacturing sector. As can be seen in Table 4.7, the signs on the coefficients remain the same, including capital controls. And the coefficient on the capital controls variable is significant. Also, the expected relationship between AGPROD and seigniorage is negative. For those countries with a greater share of GDP from the agriculture sector, seigniorage is expected to be positive because of the difficulty in taxing the income generated from this sector. For those countries with a greater share of GDP from the manufacturing sector, the relationship is just the opposite. In Table 4.7, the coefficient on INDPROD is negative and highly significant. The results summarized in Table 4.7, show that even accounting for government expenditure, government liabilities, GNP per capita, and the value added in two different sectors in the economy, there exists a positive and statistically significant relationship between capital controls and seigniorage.

Table 4.7: OLS Estimates, Seigniorage Regression 2

Variable	Coefficient	Std Error (White)	Prob > |t|
INTERCEPT	-2.692	0.925	0.005
CONTROLS	0.553	0.344	0.114
GOVEXPEND	-0.573	0.280	0.045
DOMGOVFIN	0.091	0.104	0.384
GNPPERCAPGRO	-0.045	0.022	0.049
AGPROD	0.333	0.193	0.090
INDPROD	1.205	0.369	0.002

As a final check of the stability of the relationship between capital controls and seigniorage, I include the ratio of income taxes to total government spending and, the ratio of trade taxes to government spending. As can be seen in Table 4.8, the coefficient on the income tax ratio is negative, which is expected. This implies that the greater the share of income taxation, the smaller the reliance on seigniorage. And the coefficient on the variable is positive, as is expected, which implies that countries with a greater share of tax revenue coming from international trade are assumed to have inefficient tax systems.

Table 4.8: OLS Estimates, Seigniorage Regression 3

Variable	Coefficient	Std Error (White)	Prob > |t|
INTERCEPT	-2.853	0.879	0.002
CONTROLS	0.606	0.293	0.043
GOVEXPEND	-0.538	0.248	0.035
DOMGOVFIN	0.195	0.087	0.029
GNPPERCAPGRO	-0.019	0.018	0.285
AGPROD	0.333	0.197	0.096
INDPROD	1.515	0.320	0.000
INCOMETAX	-0.629	0.162	0.000
TRADETAX	0.065	0.079	0.417

Conclusions

These three regressions show there to be a relationship between capital controls and the amount of seigniorage that a government collects. By imposing capital controls that limit the availability of foreign substitutes for domestic currency, a government is able to increase its seigniorage revenue. This chapter presented evidence that backed the hypothesis in White

(1999) that says that restrictions on capital outflows will increase the seigniorage-maximizing rate of inflation.

There is the possibility that the relationship may be based on reverse causality: Countries that rely on greater levels of seigniorage are more likely to impose capital controls. It has been shown in prior studies that countries with a more unstable political system should have a more inefficient tax system, and will rely more heavily on seigniorage. It is believable that countries with a more inefficient tax system are also the countries that are more likely to adopt capital controls, possibly as an additional source of revenue. In certain cases governments may require the revenue from seigniorage and the revenue generated from capital controls. This chapter has shown that governments benefit from capital controls by forcing residents to hold a greater amount of domestic currency. Because of the effect on money demand, inflation should be lower in these countries. Lower inflation, seigniorage revenue, and revenue from capital controls are benefits from imposing controls. But, these controls do impose a cost on residents, and certain controls will impose a cost of foreign investors. The decision to impose controls will come down to the benefits to the government versus the costs to the residents who are limited in their ability to hold different assets.

CHAPTER 5

POLICY ALTERNATIVES: CURRENCY BOARDS AND DOLLARIZATION

The previous research discussed in the previous three chapters tested the predictability of currency crashes, the effect of devaluation risk on capital flight, and the effect of capital controls on seigniorage. In Chapter 3, it was shown empirically that devaluation risk leads to capital flight. Associated with large-scale capital flight is a reduction of the domestic tax base and slower economic growth because of the decreased supply of capital. It is clear that unstable exchange rate regimes are harmful to emerging market economies. The uncertainty surrounding the exchange rate regime is an unnecessary factor slowing growth in these emerging markets.

This chapter discusses currency boards and official dollarization as policy options for developing countries wishing to eliminate or at least, significantly reduce the risk of large-scale currency depreciation. Devaluation risk is harmful because it leads to macroeconomic uncertainty. This uncertainty will lead to increased borrowing costs for governments and domestic companies borrowing overseas, and may lead to a point at which no price is high enough to compensate lenders for taking risks in these countries. Adopting a currency board or officially dollarizing will reduce the risk of devaluation and lead to an increase in foreign investment and economic growth.

The Currency Board System

A currency board is a form of monetary authority whose sole job is to issue notes and coins at a fixed exchange rate. Unlike a typical central bank, a currency board does not attempt to conduct a domestic monetary policy. The currency board system is based on rules rather than discretion. There are no interest rate, inflation, or money supply targets. The currency board will maintain an exchange rate fixed to an anchor currency for which all current account and capital account transactions are conducted. To keep the currency board free from the risk of speculative-attack-induced devaluations, the monetary authority will back the monetary base with at least 100% foreign currency reserves.[5] And this backing of the monetary base by foreign reserves is set in law. For example, the Argentine currency board held at least 100% US dollar reserves backing the peso. And the Hong Kong Monetary Authority is currently required to hold at least 100% of the monetary base in U.S. dollar denominated assets.

In the traditional Krugman (1976) model of currency crises, a devaluation is based on the monetary authority being drained of foreign currency reserves. As was shown in Argentina in late 2001, a currency board may devalue because of political difficulties in maintaining the stringent exchange rate. But a currency board will almost never be forced to devalue because of a drain on its foreign exchange reserves. The reserves held by the currency board will be in the form of liquid, interest-bearing securities denominated in the anchor currency. The currency board earns seigniorage, with its profits being equal to the interest it earns on the securities minus its cost of operations. The money supply will be

[5]Most currency boards have historically not held more than 110% reserves.

backed with assets denominated in the anchor currency. The legal allowance of domestic assets backing the monetary base, would give the authority the opportunity to run a discretionary monetary policy through open market operations. It is not the job of a currency board to actively influence the money supply.

In January of 2002, Argentina, which had maintained a currency board system since 1991, devalued the peso by 40%. In the Argentine situation, the peso was devalued while the monetary authority maintained a 100% backing of the monetary base. Currently, the Hong Kong Monetary Authority is maintaining a currency board arrangement. And Estonia and Lithuania established currency board arrangements in the early 1990s, with both still in operation today. A discussion of the former Argentine arrangement along with a short history of what went wrong, will be included later in this chapter. Also included is a discussion of the Hong Kong currency arrangement and the monetary systems of the two Baltic nations, Estonia and Lithuania.

Currency Boards versus Traditional Central Banks

According to White (1999), typical central banks serve five main roles: acting as a banker's bank, having a monopoly of note issue, acting as a lender as last resort, regulating commercial banks, and conducting monetary policy. Simply, a currency board is not like a central bank because it does not serve these roles.

In its pure form, a currency board has two roles: to issue notes and coins while maintaining a fixed exchange rate, and to back 100% of its liabilities (the domestic monetary base) with the anchor currency. Therefore, a pure currency board will not serve as a banker's bank. But, in Argentina, Estonia, and Lithuania - three countries with currency board

arrangements, commercial banks are allowed to hold deposits at the monetary authority. And the Argentine and Lithuanian monetary authorities perform settlement of payments system transactions.

It is not necessary for a currency board to have a monopoly of note issue. Indeed, in a small, open country with a currency board and a well-developed domestic banking system, competitive note issue would enhance the benefits from the currency board arrangement. Currently, none of the existing currency board arrangements allow banks to issue notes competitively.

A pure currency board will not, in general, act as a lender of last resort. The 100% backing of the monetary base precludes the currency board from these types of operations. The monetary authority's foreign assets will be used as reserves to back the monetary base. But, the monetary authority may build up foreign assets to a level greater than 100% of the monetary base. If this is case, as it is Hong Kong, the authority will have excess reserves that could well be used for an LOLR role. And in both Estonia and Lithuania, excess foreign reserves are legally used for LOLR activities, but only in times of crises.

It should be the case that the 100% reserve requirement will rule out LOLR activity. This may be considered a benefit of the stringent policy, in that it should lower the possibility of moral hazard by banks based on the expectation of a government bail-out. It is argued by some that in times of crisis, the lack of an LOLR role may lead to a systemic problem if there is a shock large enough that it affects the entire financial system. For that reason, the Argentine, Estonian, and Lithuanian monetary authorities provide last-resort support to domestic banks.

For a pure currency board, there is no role as regulator of the banking system. If the government chooses to regulate the banking sector, which it will most likely do, it should do so with an agency other than the monetary authority. In the existing currency board systems, the monetary authority does in fact make rules for the banking system.

The structure of the currency board system rules out effective monetary policy. In some cases, the desirability of a currency board is a direct effect of a country's poor history of failed attempts at monetary policy. The credibility that comes along with the stringent exchange rate regime is a function of the lack of a discretionary monetary policy. As we will see in later in this chapter, the money supply is demand driven. Any attempts by the authority to influence the monetary base through purchases of domestic assets are not allowed under a pure currency board system. And for a less stringent currency board, such as that in Hong Kong, this type of discretionary action by the monetary authority lowers the credibility of the regime.

The Costs and Benefits of a Currency Board

Currency board arrangements are implemented because of the credibility that comes along with a rules-based versus a discretionary regime. Credibility is the reason why countries adopt currency board arrangements, and it is credibility that is seen as the greatest benefit of a currency board arrangement. The currency board arrangement lent credibility to Argentina in 1991 with its history of high inflation caused by poor monetary management. Also, for countries like Estonia and Lithuania who at the time of their regime adoption in the early 1990s, did not have a history of monetary policy performance, a currency board was a solution that immediately lent credibility to a new monetary authority. For countries with

a history of poor monetary policy or countries without a monetary policy history, the credibility of the rules-based regime should eventually cause domestic interest rates to converge to the rates of the anchor currency's country, which will in turn lead to increased international investment and economic growth. There is an exchange rate regime that provides even more credibility than a currency board arrangement, and this is the policy of official dollarization. As we saw in the late 2001 Argentinean experience, currency boards are not perfect. A currency board may devalue. Therefore, when comparing currency boards to the policy of official dollarization, the credibility benefit of the dollarization policy will exceed that of the currency board. The lack of the permanently fixed exchange rate with a currency board is seen as a cost when comparing currency board arrangements to the more stringent dollarization arrangement.

In comparing a currency board to the dollarization alternative, a benefit of the currency board is the ability of the monetary authority to collect seigniorage from the foreign assets backing its liabilities. A currency board will issue notes and coins to be used by residents. The rules of pure currency board state that it must maintain at least 100% of the monetary based in anchor currency denominated assets. These assets are to be liquid and they will pay interest. In the currency board arrangement, the monetary authority profits from the interest earned on its foreign denominated assets, minus the expenses it incurs in running the currency board. In an officially dollarized economy, there is not a domestic-currency-based money supply. The money supply is denominated in foreign currency with foreign notes and possibly coins being used in transactions, and prices being quoted in foreign currency. Simply, the country will not maintain a domestic money supply or

monetary policy at all. In a dollarized economy, all seigniorage accrues to the central bank issuing the money supply from which the country has chosen to link its exchange rate. In the cases of Panama and Ecuador, who both use the U.S. dollar, all seigniorage accrues to the Federal Reserve. A key benefit of the currency board versus the dollarization policy is that currency board collects interest from its foreign reserves.

Currency boards do not maintain a domestic monetary policy because of the structure of the system. If there are extreme enough shocks to the economy, the lack of a discretionary monetary policy could be a cost. I argue that the benefits of the currency board's inability to conduct a domestic monetary policy far exceed the costs of the lack of discretion.

Also, a currency board will not be able to act as a lender of last resort because of the restriction on its holding of domestic assets as reserves. Because of the requirement that a pure currency board backs the monetary base 100% with foreign currency reserves, there will not be assets on the monetary authority's balance sheet for LOLR activities. Any LOLR or monetary policy operations must be conducted with excess foreign reserves. The Hong Kong Monetary Authority retains all of the interest from its holding of foreign reserve assets, and uses this income to buy more foreign currency denominated assets. Any LOLR activity conducted by the HKMA must exceed the value of its excess reserves.

The Money Supply in a Currency Board System

In an economy with a currency board, there is no deliberate monetary policy. The money supply is demand determined. If demand for the country's exports increases, the money supply will increase. If there is an increase in demand for money, due to an increase in real GDP for example, the increase in money demand will be accommodated by the

banking system. The domestic money supply in a currency board arrangement is based on international economic relations. The greater the country's exports, the greater the liquidity available within the country. As we know from the Monetary Approach to the Balance of Payments, an overall balance of payments deficit will necessarily decrease the monetary base due to the decrease in reserves held by the currency board. If commercial banks are willing to increase funds available to those demanding money, a balance of payments deficit might not necessarily decrease the money supply. Under a currency board regime, it is only the monetary base that is backed 100% by foreign exchange reserves. M1, for example, is not necessarily backed 100%. If commercial banks are willing to make these loans, it is not necessarily the case that a BOP deficit will reduce a broader definition of the money supply. If the banks increase their domestic lending, the monetary disequilibrium may be accommodated by an increase in the money supply through the commercial banks. Therefore, this banking system is a crucial part of a successful currency board. If the government felt the need to try to manage aggregate demand through monetary policy, it would only be possible through the ability to convince the commercial banks to increase their domestic lending, possibly through tax breaks. Other than that, demand management, through monetary policy actions, is not possible.

The basic fixed exchange rate model states that as money flows out of a small country because of a balance of payments deficit. The deficit may be caused by a decrease in demand for the country's exports or by a domestic increase in demand for imports. Either way, the price level will decrease. As domestic prices decrease relative to those prices in the large country (the U.S.), dollars flow back into the smaller country to take advantage of those

relatively lower prices - the model of purchasing power parity. As the dollars flow back in, the money supply and spending increase, causing prices to increase. In an economy with a currency board and a well-developed banking system, fluctuations caused by the balance of payments adjustments are smoothed by changes in interest rates, and hence, the number of loans made by the banks in the domestic economy. If these banks are branches of large U.S. banks, they will have access to funds at the U.S. operations. Even if the banks are local, as long as they have access to or accounts at some affiliated U.S. banks, the possible changes in the domestic money supply due to a balance of payments deficit will be smoothed by increases in the banks' domestic lending.

What are the effects of a balance of payments surplus, in which more dollars are received from exports than are spent on imports? Because the domestic banks have more to lend, it should be the case that there is a decrease in the nominal interest rate in the short run (a liquidity effect), and an increase in inflation and therefore, also an increase in the nominal interest rate. As the price level increases, the price of exports will also increase, causing export demand to decrease, which will decrease the number of dollars entering the country, and will limit the extent of the increases in the price level.

Now, the changes in the domestic price level and hence, changes in the real exchange rate are understood to be the equilibrating mechanism in fixed exchange rate theory. With a well-developed international banking system, the real exchange rate is not necessarily as variable as predicted by traditional fixed exchange rate theory. As the domestic money supply is increased, because of an increase in demand for exports by the United States, nominal interest rates decrease, and the incentive to lend in the domestic country versus

lending to other countries, decreases. Therefore, banks will decrease their domestic lending to pay down debt to banks overseas or they will decrease lending domestically to increase lending overseas, taking advantage of the relatively higher interest rates. It is not necessary that the price level adjust drastically with balance of payment adjustments. As long as banks are indifferent or close to indifferent, which they should be without the devaluation uncertainty, as to whether to lend domestically or overseas, changes in the balance of payments can be accommodated through the banking system, and hence through changes in more flexible interest rates, versus less flexible price levels.

The Hong Kong Monetary Authority (HKMA)

The government of Hong Kong set up a currency board arrangement in October of 1983. The Hong Kong Monetary Authority fixes the value of the Hong Kong dollar to the U.S. dollar, at a rate of HK$7.8 = US$1. The HKMA is required to back the monetary base by at least 100% with U.S. dollar reserves. Interest earned on U.S. dollar denominated assets is used to purchase more dollar denominated assets, which leads to reserves/liabilities ratio of greater than one. With the excess reserves only, the HKMA is allowed to conduct lender of last resort activities. The HKMA also attempts to smooth interest rate fluctuations, which is a form of domestic monetary policy. And it also borrows and lends to the interbank market. (Balino and Enoch, 1997)

The Baltic Currency Board Arrangements

Estonia adopted a currency board regime in June of 1992. While the dollar is the most widely used anchor currency, Estonia chose to fix its kroon to the deutsche mark. Almost two years later in April 1994, Lithuania, impressed by the success of the Estonian

currency board, adopted a currency board arrangement. The Lithuanian talonas is fixed to the dollar at a rate of 4 talonas to 1 U.S. dollar. The monetary authority in Estonia is known as the Bank of Estonia, and the authority in Lithuania is known as the Bank of Lithuania. Both of these countries back the monetary base 100% with foreign currency reserves. The Bank of Estonia has the right to revalue the exchange rate, but devaluation must be done by an act of Parliament. But in Lithuania, the monetary authority has the right to change the exchange rate in either direction, but only in extreme circumstances and only in consultation with the government. Both the Bank of Estonia and the Bank of Lithuania retain interest from their holding of foreign currency denominated assets. And both are allowed to use excess reserves for LOLR purposes, but only in emergency situations. Also, both of the Banks run payment systems, while neither of them grants credit to the government. (Balino and Enoch, 1997)

Argentina's Former Convertibility Rule: What Happened?

In March of 1991, Argentina implemented a currency board arrangement in which the peso would be freely convertible into U.S. dollars at a rate of 1 for 1. In the new arrangement, the Central Bank of the Argentine Republic (CBAR) would back 100% of the monetary base with foreign currency denominated assets. The general public was given access to the monetary authority to exchange pesos for dollars at the fixed exchange rate. With the new exchange rate system, the focus of the CBAR was to maintain the exchange rate, in hopes of restoring credibility to Argentina's financial system. The belief was that the currency board would instill confidence and eventually lower inflation expectations. The new monetary system was successful at stabilizing the inflation rate. In 1989, annual

inflation in Argentina was 4,923%; in 1990, it was 1,343%. By the end of 1991, annual inflation had dropped to 84%, for the years 1992 and 1993, inflation was 17.5% and 7.4%, respectively. By 1994, annual inflation had fallen to 3.9%, and eventually to 1.6% in 1995. (Cavallo, 1996).

The inflation stabilization program, which was implemented in Argentina in the early 1990s, did not lead to negative GDP growth rates in the early years of the regime's existence. Gross Domestic Product declined at -6.2% in 1989, and grew at .1% in 1990, 8.9% in 1991, 8.7% in 1992, 6% in 1993, and by 1994, GDP was growing at 7.4%. Also, the credibility of the new regime instilled confidence in foreign investors, as is shown by the increase in foreign exchange reserves. In 1989, reserves at the central bank totaled $3.8 billion. By the end of 1994, reserves had reached almost $18 billion. In 1994, Mexico devalued the peso which added extreme uncertainty to emerging market investing, and helped drive capital out of Argentina and into safer markets. By March of 1995, capital flight had caused reserves at the CBAR to $12.5 billion. Because of the capital flight and the subsequent money supply decrease, the Argentine economy entered a recession after the second quarter of 1995. But, by the second quarter of 1996, the economy recovered and GDP grew at an annual rate of 3%. During the period of uneasiness caused the Mexican devaluation, the CBAR did not devalue or float the currency. Nor did they take drastic steps to increase domestic liquidity. The exchange rate remained fixed and the credibility of the currency board arrangement was reaffirmed. By June of 1996, reserves at the central bank had surpassed $20 billion.

In 1997, Argentine GDP grew 7.3%. By the end of 1998, GDP growth had slowed to 2%. And in 1999, gross domestic product declined by 5%. There are two external factors

related to Argentina's use of a currency board arrangement that may assist in explaining the economic decline experienced by the country in 1999. These are, the sharp depreciation of the Brazilian real in early 1999, and the strength of the U.S. dollar caused by the U.S. Fed's liquidity tightening in 1999 and 2000. The Argentine monetary authority suffered a double whammy in terms of international price competitiveness - the international value of the peso was appreciating due to dollar appreciation, and the value of the currency of Argentina's largest trading partner, Brazil, had fallen from 1.21 per dollar in January of 1999 to 2.30 per dollar in January 2001. In the export sector, Brazil had gotten more competitive than Argentina, especially since inflation in Brazil was not as high as would be expected after large-scale currency depreciation, which left Brazil with a cost advantage in exports over Argentina.

Both of these external events added to the hardships suffered by Argentina in 1999. And it is logical to conclude that these external events had a greater negative effect on the Argentine economy because of the strict rules of the currency board arrangement. But, these external factors are not enough to explain the financial problems suffered by Argentina that eventually led to the 40% devaluation of the peso in January 2002. The hardships suffered by Argentina in 2000 and 2001, which led to the collapse of the one-for-one exchange rate regime, were caused by the policies and the government's lack of credibility. And the financing of the policies led to a belief by international investors that the Argentine monetary authority, although it had the necessary foreign currency reserves, was willing to devalue the peso at the expense of credibility, to restore what was believed to be a lack of competitiveness in the export sector. It was the lack of credibility of the Argentine

monetary authority that led to capital flight in 2001. In 2001, foreign exchange reserves had dropped from $21.9 billion at the end of 2000 to $14.6 billion by the end of 2001 (Hanke and Schuler, 2002). The steps taken by the Argentine government during 2001 lowered credibility even further. In June, a multiple-exchange rate system was introduced. There was to be a devalued exchange rate for exports, a revalued rate for imports, and all other transactions would take place at 1-for-1 rate. Also in June, the government enacted a law that would link the peso to not just the dollar, but to a basket of 50% dollars and 50% euros. In early December, the government imposed a ceiling on interest paid in pesos. Later in December, Argentina imposed capital controls. Lastly, at the end of December, a proposal was announced that would allow the monetary authority to issue a currency parallel to the peso called the Argentino. (Hanke, 2002)

The currency board arrangement hindered Argentina's ability to respond to external events. And it also hindered the government's ability to spend excessively. One of the costs of a currency board arrangement is that devaluation remains a possibility. As we know from the Argentine case, not only does the monetary authority have to keep the financial resources to maintain a fixed regime, policymakers also have to be willing to suffer political repercussions of maintaining the peg through in an uncertain economic environment. For governments that may not be able to withstand the political pressure of maintaining a peg, there is a policy that ties the hands of the monetary authority even further than the currency board does: And this is the policy of official dollarization.

The Dollarization Alternative

Along with the fixed versus floating exchange rate discussions, there have been policy prescriptions for countries with unstable monetary systems that would have these countries officially adopt the currency of a major nation as their own. We know some currency boards are not immune from devaluations. For some countries, a more permanent and credible exchange rate regime may be necessary to generate confidence from international investors. This section consists of a review of the costs and benefits of dollarization (currency substitution), a discussion of the macroeconomics of a dollarized economy, and a discussion of two countries with recent dollarization experiences: Panama and Liberia.

Spontaneous currency substitution has taken place in many countries experiencing high rates of inflation. As the inflation rate increases, the domestic currency loses its function as a store of value and residents begin to hold some of their wealth in foreign currency denominated assets. If there are dollars, for example, circulating in these countries, it becomes easier for merchants to quote prices in dollars, leading to a diminished role for the domestic currency as a unit of account. As more dollars enter the domestic economy through legitimate international trade, the dollar begins to circulate as a medium of exchange. Governments in countries with a large amount of currency substitution may legalize transactions in foreign currency and allow foreign currency denominated bank accounts.

The spontaneous currency substitution that takes place in these countries with unstable monetary systems is not the same as the officially dollarized monetary system that exists in Panama currently and existed in Liberia until 1988. There have been many studies

that investigate the causes and effects of this currency substitution (see Sahay and Vegh, 1995; Savastano, 1996; Gruben and Welch, 1996), but not many on official currency substitution or dollarization. Official dollarization is the policy of the domestic government, in which a foreign currency is adopted and legally circulates as a medium of exchange, serves as a store of value, and is used as a unit of account. In an officially dollarized economy, Federal Reserve notes are used as currency, bank accounts are denominated in dollars, and government and private debt is denominated in dollars. Schuler (1998a) has sketched out a detailed proposal for official dollarization as a solution to monetary problems in Hong Kong, and a similar proposal for dollarizing Indonesia in Schuler (1998b). Currently, the Hong Kong and the Argentine monetary systems are near-currency board arrangements that give the monetary authority some discretion over monetary policy. Because the arrangements are not full-fledged currency boards, interest rates have been higher in Hong Kong and Argentina than in the U.S., even though the Hong Kong dollar and the Argentine peso are pegged to the U.S. dollar. The interest rate differential is due to the lack of stringent currency board laws. International lenders fear devaluation, and borrowers in these countries pay for it.

From this discussion, it will be clear that similar to the conditions necessary for a currency board to provide benefits to a country, a necessary condition for official dollarization to work optimally as a monetary arrangement, is the existence of an international banking system. Hong Kong is an open economy and an international financial center, and if dollarization is adopted, should be able to adjust to a balance of payments

deficit without the decreases in the price level that might occur in other fixed exchange rate economies without a well-developed international banking system.

Why Dollarization Over a Currency Board?

Most of the discussions, especially in the popular business press, have stated that currency boards or official dollarization are possibly policy solutions to currency crises in the East Asian emerging economies, in Brazil, and in Russia. Most of these discussions have focused on the devaluation problem. Many economists believe that the stringency imposed on the monetary authority by a currency board or currency substitution is worth the loss of independent monetary policy. With dollarization, devaluation as a policy option, is not available. Obviously, central banks of countries with a fixed exchange rate devalue when they fear that at the current peg, they will run out of foreign exchange reserves defending that peg. Most likely, there is something fundamentally unsound about the economy that is causing lenders to pull their money out of the country and speculators to sell the currency in hopes of profiting.

. If lenders and speculators believe that there is a possibility of devaluation, anything that will make them believe that the monetary authority is considering devaluation, will cause them to pull their money out of the country and to try to profit by selling the currency. The currency board, not wanting to lose its seigniorage, may choose the devaluation option. Or, the government may eventually decide that the pain caused by recession and unemployment is worse than the pain caused by devaluation. For monetary stability, dollarization may be the better choice.

Earlier in this chapter, I listed the five roles that define an institution as a central bank. These are, acting as a banker's bank, having a monopoly of note issue, acting as a lender as last resort, regulating commercial banks, and conducting monetary policy. A currency board is not a cental bank because it does not perform all five of the above roles. A country with a monetary framework based on official currency substitution, or dollarization, might have an institution to serves some of the rolls of a central bank.

The bankers' bank function handled by one or a few large U.S. or European banks. There is no reason why a government institution has to fill this role, especially in a small, developing nation. Smaller foreign and local banks could keep deposits at the large banks as they do in Liberia. Also, because there isn't a central bank, commercial banks in might form clearinghouse arrangements for clearing liabilities with other banks. Commercial banks will be members in the clearinghouse. If one of the member banks got into trouble, the clearinghouse could serve as the lender of last resort

Monopoly of currency issue is not a consideration in an officially dollarized economy. The currency is a major foreign currency. No domestic institution has monopoly of note issue. If the dollar is used as the official currency, a foreign institution, the U.S. Federal Reserve has monopoly of note issue.

The lender of last resort function could be served by large, foreign commercial banks. If there is a banking panic or if the money supply shrinks too much due to prolonged balance of payment deficits, the large banks could move in and make loans to the smaller banks, providing the needed liquidity. If the domestic government choses to regulate commercial banks, it can create another agency for bank regulation, or turn it over to an existing agency.

It is not necessary that this is done by a central bank. It is possible for two of the central bank's roles, serving as banker's bank and acting as a lender of last resort, to be taken care of by large, most likely, foreign commercial banks. The dollar or other foreign currency is the official money, so no domestic institution will have a monopoly of note issue. Regulation of the banking system could be taken care of by another government agency. And, the monetary policy function is lost in a dollarized economy, ruling out the possibility of hyperinflation caused by a seigniorage seeking central bank.

The Functioning of the Dollarized Economy

An officially dollarized economy will function in much the same way as an economy with a currency board arrangement. In a dollarized economy, with a well-developed banking system, such as Panama, the fluctuations caused by the balance of payments adjustments are smoothed by changes in the number of loans made by the banks in the domestic economy. If these banks are branches of large U.S. banks, such as the Bank of Monrovia which was the name of the Liberian operation of the First National City Bank of New York, they will have access to funds at the U.S. operations.

As with the domestic money supply under a currency board, the money supply in a dollarized economy is increased by balance of payment surpluses and decreased by balance of payment deficits. Because the domestic banks have more to lend, it should be the case that there is a decrease in the nominal interest rate in the short run (a liquidity effect), and an increase in inflation and therefore, also an increase in the nominal interest rate. As the price level increases, the price of exports will also increase, causing export demand to decrease, which will decrease the number of dollars entering the country and will limit the extent of

the increases in the price level. As is the case with a currency board, as the domestic money supply is increased, because of an increase in demand for (Panamanian) exports by the United States, nominal interest rates decrease, and the incentive to lend in the domestic country versus lending to other countries, decreases. It is not necessary that the price level adjust drastically with balance of payment adjustments. As long as banks are indifferent as to whether to lend domestically or overseas, changes in the balance of payments can be accommodated through the banking system. In a paper on the workings of the Panamanian economy, Moreno-Villalaz (1998), claims that the balance of payments adjustment process in the Panamanian economy works in this manner.

Economic Arguments Against Dollarization

Many of the arguments made for and against currency boards, hold for official dollarization. The greatest benefit of dollarization is the low probability of devaluation. For a dollarized economy to suffer a devaluation, it must change the dollarization policy. Dollarization is a signal of a permanent commitment to anti-inflationary policy. By adopting this policy, a developing country is turning its monetary policy to be determined by the U.S. Federal Reserve, and signaling its intentions to do so permanently.

Other than the sovereignty/national currency concerns, the loudest argument against dollarization is that the domestic government loses its seigniorage. According to Fischer (1982), the two major costs to a nation that is considering dollarization are the stock and flow costs of converting to another country's currency and the excess welfare burden imposed on the economy by giving up control over its money supply. Fischer finds that the initial cost of acquiring currency of another country is quite high, but his estimates are mostly likely

biased upward since in countries considering dollarization, there are already dollars circulating. The flow seigniorage argument is a legitimate one. Click (1996) estimates annual rates of seigniorage for a sample of ninety countries covering the period of 1971 to 1990. He finds that, on average, flow seigniorage is 2.5% of GDP and 10.5% of government spending with a range from .5% of GDP to 10%, and from 1% of government spending to more than 100%. From these studies, it appears that the loss of the ability to finance some of the government's purchases through money creation would be a legitimate reason why the government may not want to officially adopt the currency of another nation.

On the other hand, Moreno Villalaz (1999) considers the opportunity cost argument. He claims that countries, especially those with a currency board, hold a greater amount of foreign exchange reserves than the amount of currency held in Panama. Countries other than Panama earn short-term interest on reserves, but can't earn higher, long-term rates. Moreno Villalaz estimates the opportunity cost of the higher amount of reserves at a low, short-term rate versus the lower amount of currency held in Panama that earns zero interest. Using the same interest rate for both estimates, he finds that the opportunity costs are approximately equal. The opportunity cost of using the dollar as the official currency is no higher than holding foreign exchange reserves.

We know that central banks of countries that maintain fixed exchange rates must maintain foreign exchange as reserves. If the value of the nation's currency is pegged to the dollar, the central bank must buy and sell dollars to maintain the peg. Since the central bank already owns dollars as foreign exchange reserves, again, the initial seigniorage cost will be

lower than the stock cost estimated by Fischer (1982). Also there is already much unofficial dollarization in emerging market countries, which will also lower the stock seigniorage cost.

The Panamanian and Liberian Experiences

The most well-known example of a dollarized economy, prior to the official adoption of the dollar by Ecuador, is Panama, which has used the dollar as its official currency since 1904, when it gained independence from Colombia. Liberia was using the dollar officially, but started issuing its own notes in 1988 (Schuler, 1996). Before 1944, Liberia used the British pound, but switched to the dollar because of the large number of U.S. military bases in the country (Hildebrand, 1987). Both Liberia and Panama are export driven economies: Liberia's main exports are iron ore and natural rubber, whereas, in Panama fruits and shrimp, and services such as Canal operations and tourism, provide most of the export income. In a dollarized economy, being open is crucial since dollars enter the country through current and capital account transactions. Both of these countries have international banks located within their borders and these banks have access to funds from larger banks overseas. Therefore, balance of payment deficits that would, in an economy without international banks, lead to large decreases in the money supply, will be accommodated by increased domestic lending. Maynard (1970) provides an early look at the effects of the banking system in Liberia, and Moreno Villalaz (1998) discusses the modern Panamanian banking system.

Panama doesn't have a central bank and therefore, no foreign currency reserves are necessary to defend the foreign exchange value. Although, there is a national currency called the balboa that is used as a unit of account and circulates as silver coins. Inflation in Panama has followed closely with U.S. inflation, while interest rates are only marginally higher than

world rates but lower than interest rates in other Latin American countries. Liberia started issuing its own currency in 1988, and until then, the government didn't maintain gold or foreign exchange reserves. Before 1988, U.S. dollars were provided to the economy through private banks with one of these banks handling the government's accounts. In 1974, the National Bank was established which took over the government's banking. And in 1988, the National Bank of Liberia was converted into a central bank and began issuing its own currency, although dollars are still used for transaction purposes.

Ecuador

Ecuador floated is currency, the sucre, after Brazil suffered a currency crisis in January 1999. The Ecuadorian monetary authority suffered a speculative attack at about the same time of Brazil's crash. The government announced a policy that would adopt the dollar as the official currency of Ecuador on January 9, 2000. On March 13, 2000, the dollarization law was enacted that exchange sucres for dollars at a rate 25,000 sucres per 1 dollar.

The Relative Macroeconomic Performance of a Stringent Exchange Rate Regime

In Tables 5.1 and 5.2, which list average GDP growth and average inflation rates for a sample of Latin American countries, we see that Panama has performed relatively well. For the years 1970 to 1997, Panamanian GDP growth rate was higher than the average for the sample, while the Panamanian inflation rate was much lower than the sample average. Of the fifteen countries included in the sample, Panama had the lowest inflation rate and the third highest GDP growth rate. One thing to keep in mind is that, in 1988, Panamanian GDP fell by 15.6% due to a conflict with the U.S.

Table 5.1: Real GDP Growth in Latin America (1970-1998)

Country	Mean	Std Dev	Min	Max
Antigua and Barbuda	5.10%	3.67%	-4.21%	12.72%
Argentina	2.44%	5.57%	-7.59%	12.67%
Barbados	2.13%	4.18%	-5.01%	9.51%
Belize	5.52%	4.48%	-2.11%	15.17%
Bolivia	2.65%	3.20%	-4.45%	6.68%
Brazil	4.56%	4.75%	-4.39%	13.98%
Chile	4.63%	5.83%	-11.36%	12.28%
Colombia	4.29%	1.99%	0.60%	8.46%
Costa Rica	4.20%	3.54%	-7.29%	8.90%
Cuba				
Dominica	3.67%	6.50%	-18.44%	14.26%
Dominican Republic	5.45%	4.48%	-5.83%	18.23%
Ecuador	4.89%	5.39%	-5.98%	24.03%
El Salvador	2.22%	4.83%	-11.77%	7.55%
Grenada	4.15%	3.22%	-2.64%	11.15%
Guatemala	3.63%	2.82%	-3.53%	7.81%
Guyana	1.16%	5.41%	-13.19%	8.50%
Haiti	1.08%	4.71%	-13.19%	8.55%
Honduras	3.88%	3.30%	-1.39%	10.50%
Jamaica	1.11%	5.03%	-6.46%	16.38%
Mexico	4.04%	3.94%	-6.17%	9.70%
Nicaragua	0.69%	7.20%	-26.48%	14.19%
Panama	3.55%	4.69%	-13.38%	9.74%
Paraguay	4.90%	4.20%	-3.72%	14.82%
Peru	2.66%	6.05%	-12.58%	13.12%
Puerto Rico	3.90%	3.01%	-3.05%	8.69%
St. Kitts and Nevis	5.47%	3.81%	-1.44%	15.08%
St. Lucia	5.50%	8.70%	-10.82%	23.54%
St. Vincent and the Grenadines	4.95%	3.73%	-2.41%	14.61%
Suriname	0.79%	6.30%	-15.44%	11.83%
Trinidad and Tobago	3.01%	6.17%	-11.73%	14.36%
Uruguay	2.32%	4.49%	-10.27%	8.81%
Venezuela, RB	2.32%	4.29%	-8.59%	9.74%

Table 5.2: Inflation in Latin America (1970-1998)

Country	Mean	Std. Dev.	Min	Max
Antigua and Barbuda	5.95%	3.83%	2.18%	14.79%
Argentina	317.01%	660.67%	-2.02%	3057.64%
Barbados	7.76%	7.38%	-1.47%	31.42%
Belize	4.79%	6.00%	-6.81%	21.71%
Bolivia	511.51%	2290.45%	4.37%	12339.30%
Brazil	406.26%	707.76%	3.65%	2509.47%
Chile	80.10%	150.60%	2.67%	665.39%
Colombia	22.27%	5.12%	9.89%	29.17%
Costa Rica	19.50%	14.69%	2.44%	84.17%
Cuba				
Dominica	6.06%	5.10%	-0.45%	20.24%
Dominican Republic	14.79%	15.77%	1.18%	58.21%
Ecuador	27.29%	16.99%	1.20%	70.78%
El Salvador	11.40%	7.16%	0.40%	33.29%
Grenada	5.05%	4.40%	-1.37%	20.17%
Guatemala	12.20%	10.21%	-1.36%	41.46%
Guyana	23.04%	37.95%	-5.78%	162.62%
Haiti	12.24%	9.09%	-3.38%	35.63%
Honduras	10.78%	8.12%	-2.78%	28.89%
Jamaica	20.20%	13.48%	-3.58%	59.54%
Mexico	35.04%	33.12%	2.63%	139.66%
Nicaragua	279.12%	954.47%	-99.99%	4709.25%
Panama	4.71%	6.54%	-1.28%	33.69%
Paraguay	16.99%	9.50%	1.91%	36.28%
Peru	384.32%	1231.15%	5.55%	6134.45%
Puerto Rico	4.82%	2.81%	0.11%	11.52%
St. Kitts and Nevis	5.80%	4.17%	-0.55%	14.88%
St. Lucia	3.49%	2.48%	0.17%	10.24%
St. Vincent and the Grenadines	5.75%	4.45%	0.88%	16.87%
Suriname	43.78%	105.59%	0.65%	474.10%
Trinidad and Tobago	9.41%	12.41%	-13.44%	54.05%
Uruguay	56.51%	35.76%	4.20%	191.56%
Venezuela, RB	26.19%	26.79%	-1.20%	115.68%

What do these simple statistics tell us? First we can obviously see that dollarization, at least in Panama, is not inflationary. An average inflation rate of 3.6% is low. Also, we see that dollarization hasn't led to negative economic growth. Apart from a decrease in GDP in 1983, and in 1987 and 1988 due to the conflict with the U.S., Panama has had a positive

GDP growth rate. In Panama at least, it is not the case that the lack of an independent monetary policy hinders GDP growth. It is possible that Panama would have grown faster over the 28-year sample period had it been under another exchange rate regime, but compared with other Central American and South American countries, its macroeconomic performance appears to be strong. Of course, it is possible that Panama's high growth and low inflation rates are caused by something other than its monetary regime, but we can see that a policy of official dollarization has not caused Panama to perform worse than other countries in its part of the world.

CHAPTER 6

CONCLUSIONS

In Chapter 2, I discussed a hazard model of currency crashes built with a limited number of macroeconomic and financial variables. The hazard model allows for the time-without-crash as an explanatory variable. I found a positive relationship between the time-without-devaluation and the probability of a devaluation, which is inconsistent with the hypothesis that the longer a regime has survived, the greater the government's credibility in maintaining the regime in the future, and the lower the likelihood of a crash. The empirical relationship is different from the predicted relationship, but we do see that the age of the regime does significantly explain currency crashes. I compared the predictive ability of the hazard model to the predictive ability of the models by Frankel and Rose (1996) and Berg and Patillo (1998). Although the number of currency crashes used for testing out-of-sample is small, I presented evidence that the hazard model is able to separate the countries at risk for a devaluation from those countries that aren't, better than the other two models. This is due partly to the smaller number of variables needed for the hazard model, which allows more observations to be used to estimate the model.

The goals of the research in Chapter 3 were to measure the extent of capital flight in developing countries worldwide and to determine whether differences in average capital flight can be explained by the risk of devaluation. Because of the varying definitions of

capital flight and doubts about the accuracy of the IMF's Balance of Payments data, I chose to apply three different methods for estimating capital flight. The three are discussed in World Bank (1985), Morgan Guaranty (1986), and Cuddington (1986). For the risk of devaluation, I used the model-generated probabilities for Chapter 2. It was shown that capital flight, over the last eighteen years is a problem in other countries than just those countries in Latin America and those that are considered low income. Using an instrumental variables econometric procedure, it was shown that the risk of a devaluation does indeed explain differences in capital flight across countries. The hypothesis is that the risk of a devaluation drives capital outflows. But, devaluation probability is dependent on reserves at the central bank, so capital flight will drain reserves at the central bank. Because of the possibility of this relationship biasing the OLS regression estimates, I applied the IV model, which should provide consistent coefficient estimates.

In Chapter 4, I discussed empirical research into the theoretical arguments in Nichols (1974) and White (1999). Their arguments claim that countries that have imposed capital controls should experience greater amounts of seigniorage, as the capital controls artificially increase real demand for domestic monetary balances. These controls limit the amount of available substitutes for domestic currency, which should allow governments to increase the money supply at a greater non-inflationary rate than they would be able to without controls. I found that capital controls do indeed explain differences in seigniorage across countries. Those countries with capital controls in place experience greater amounts of seigniorage as a share of GDP. And in Chapter 5, I discuss monetary and exchange rate alternatives for developing countries. These policies are based on a stringent fixed exchange rate regime,

with a currency board fixing the developing country's exchange rate to an anchor currency or basket of currencies and 100% backing of the monetary base, while under a dollarized system, the developing country officially adopts the currency of another country. Also in this chapter, I discuss a short history of the Argentine currency board system, and a little bit about the Panamanian and Liberian dollarized systems. I argue that the benefits from the credibility of these stringent exchange rate policies exceed the costs due to a more limited domestic monetary policy.

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