Currency Crises

Talk delivered at the
Graduate School of Industrial Administration, Carnegie Mellon University
April 9, 1999

Saurabh Singal
E-mail: saurabh@saurabh.com

Contents

Summary

The focus of the talk is to discuss Currency Crises - the factors leading to currency crises, the models used to explain crises, techniques for identifying contagion and estimating crises probabilities and monetary arrangements for dampening the frequency of crises. We start by taking a quick look at the three main approaches traditionally employed for exchange rate determination. We then move on to Krugman's Canonical Currency Crisis Model, followed by a description of the Second Generation Models. We discuss the factors that may cause crises. Kaminsky, Lizondo and Reinhart's 'Signals Approach' comes next. This is followed by Eichengreen, Rose and Wyplosz's study on Contagion. We round up with a discussion of monetary systems supposedly helpful in reducing the occurrence of currency crisis – common currency and monetary unions, currency boards and finally dollarization.

1. Models Of Exchange Rate Determination

1.1 Introduction

Rudiger Dornbusch (1980) commented “There are basically three views of the exchange rate. The first takes the exchange rate as the relative price of monies (the monetary approach); the second as the relative price of goods (the purchasing power parity approach); and the third, the relative price of bonds (portfolio balance approach)”

We will briefly outline the salient features of the various models of exchange rate determination. It is no surprise that none of them works very well. But there is a rich set of insights that come out of these studies.

1.2 Purchasing Power Parity and Exchange Rates

This is the most widely followed measure by economists to evaluate currency misalignments. Dornbusch and Krugman (1976) said “Under the skin of any international economist lies deep seated belief in some variant of the PPP theory of the exchange rate.” The basic idea follows from the Law of One Price, that identical goods should trade at the same price when valued in terms of a single currency. There are many examples where PPP actually holds- gold, as also stocks and bonds that are traded on a cross border basis. PPP is expected to hold when

i. The commodities under question are tradable
ii. There no barriers to arbitrage
iii. Transaction cost is zero
iv. Goods are homogeneous.

Formally, the equilibrium exchange rate *e*, is related to the domestic and foreign price levels *(P and P_f), respectively as $e = P/P_f$*

However, empirical analysis has shown that departures from PPP are often large and persist for long periods PPP is a very bad model for short term or even the medium term. It is useful for forecasting in the long-term, but as Keynes remarked, “in the long run we are all dead.” Why then is this useful?

As we shall see later, one of the most important indicators of currency crisis is the Real Effective Exchange Rate.
The real effective exchange rate is calculated as

$$REER = \Pi (e_i P_i)^{Wi}/P$$

Where P is the domestic price level,
e_i is the bilateral nominal exchange rate with country i
W_i is the trading weight with country i.

The equilibrium real exchange rate is that rate which results in the simultaneous attainment of internal and external balance. External balance is achieved when the current account is close to balance – else either the central bank is gaining reserves, which it does not want to do indefinitely, or losing reserves. Internal balance is defined as the equilibrium in the market for domestic goods at full employment.

1.2.1 Problems with PPP

PPP derives exchange rates based on relative prices and depending on whether one uses relative GDP deflators, consumer price index, wholesale price indexes wages, or some other relevant price measures, a currency can appear to have different values.

A large number of non-tradable goods and services makes the whole concept wobbly – GDP deflators and the CPI's place heavy weight on non-tradables and are therefore inappropriate. Export indices that are almost totally comprise of traded goods come close to being a tautology.

In making relative PPP calculations, it is assumed that changes in exchange rate changes respond to price level changes relative to same base periods. The choice of the base year can make a currency appear undervalued or overvalued. The commonly used technique to avoid this problem is to use that year as base when both the countries had a zero or near-zero current account balance representing a state of equilibrium. Recent research has focused on whether REER follows a mean reverting process in which case PPP is valid in the long term, or whether it is a random walk, in which case there will be large and persistent departures from PPP.

Frankel (1986) concludes that real exchange rate deviations have a life of 4.6 years.

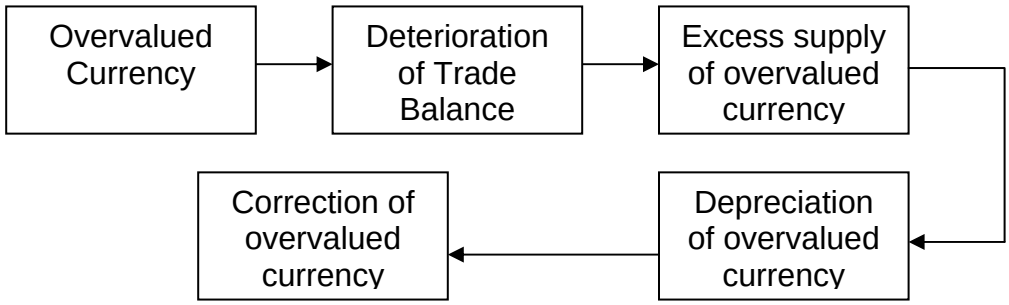

Figure 1. Purchasing Power Parity and Exchange Rate Determination

Comparisons of International Purchasing Power

If a US citizen travels to the different parts of the world, as a tourist he will buy services and non-tradables. If he goes to Africa he will find goods are very cheap. If he goes to eastern Europe, again a similar story. But western Europe is very expensive and so is Tokyo . In 1991, if one bought rubles on the black market at $1 = 100, rubles one could go from Vladivostok to Moscow on Aeroflot for $4. And it would cost about $200 from the airport to downtown Tokyo. Part of the anomaly is explained that even if PPP were to hold, exchange rates be such as would equalize the price of tradables, but price of non-tradables is left as such,

$P_T^{Other} / P_T^{USA} = e$; where P_T^{USA} and P_T^{Other} are the price of tradables in US dollars and a foreign currency, and e is the exchange rate. The price levels will diverge because we will tend to see the price of non-tradables in terms of dollars. Since wages and other non-tradables are low in Africa, when P_N^{Egypt} / e_{Egypt} is low, compared to P_N^{USA}. But P_N^{Japan} / e^{Japan} is higher than P_N^{USA} .For an interesting articles, see Jagdish Bhagwati's article "Why Services are Cheaper in the Poor Countries" in *Economic Journal*, 1984. To illustrate this more concretely assume that PPP holds and that at the start, 1$ = 200¥. Thus a tradable good that cost $1 in USA would cost ¥200 in Japan. Imagine that an increase in productivity causes the price of tradable goods in Japan to fall by half in which case the yen/dollar rate must become $1 = 100 yen. But non-tradables goods in Japan, which cost yen 200 and still cost the same, now appear to have become more expensive at $2. In yen terms, they appear at the same price.

1.3 Monetary Approach to Exchange Rate Determination

The monetary approach based models assume that national monetary policies determine the relative trends in inflation and exchange rates. Real factors affect exchange rates only indirectly by influencing the demand for money. There are several models that have been the monetary approach as their core.

1.3.1. Flexible –Price Monetary Model

The Flexible Price Monetary Model says that

$e = ln (m/m_f) – b_1 ln\ y/y_f + b_2 (i - i_f)$

Where *m*, *y* and *i* are the domestic money supply, income level and interest rate, respectively. Variables subscripted with *f* represent the same quantities for the foreign nation.

The coefficient b_1 and b_2 are the income and interest rate elasticities for the demand for money and are the same for both countries.

This model assumes that both PPP holds and the strict Quantity Theory of Money holds. The Quantity Theory of Money says that increases in money supply will immediately lead to an increase in price level with no real effects.

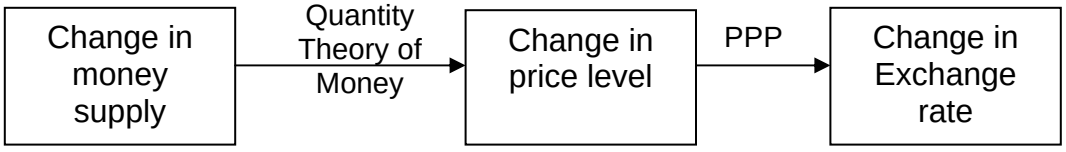

Figure 2. The Flexible Price Monetary Model and Exchange Rate Determination

1.3.2 Dornbusch's Sticky Price Monetary Model

But neither PPP nor the strict Quantity Theory of Money holds continuously. Dornbusch modified the assumption of the flexible price- prices are assumed to be sticky in the short run because goods market adjust more slowly than asset

markets in response to monetary shocks. Since prices are assumed to be sticky in the short run, an increase in money supply will cause interest rates to decline. This will cause capital outflow, causing a currency depreciation. In the short run, the exchange rate overshoots its long-run PPP level.

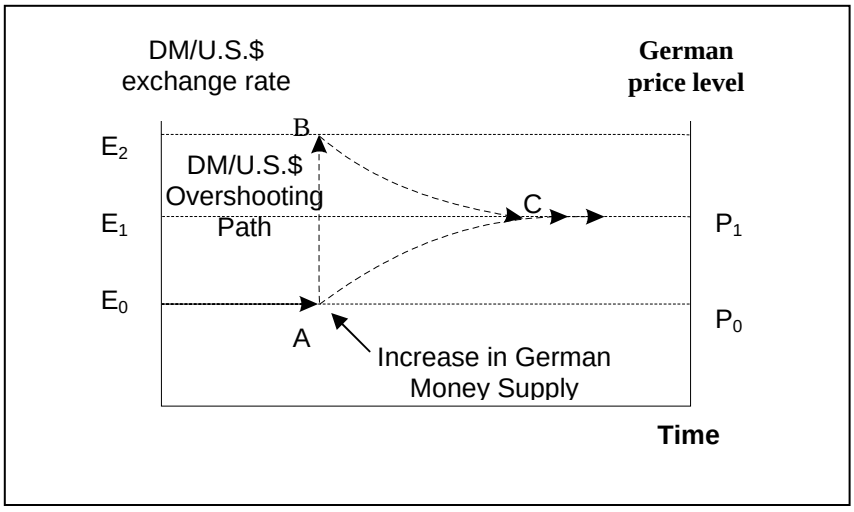

Figure 3. Overshooting of Exchange Rate in Sticky Price Model

The short run exchange rate (determined by uncovered interest rate parity) overshoots the level of the long run exchange rate (determined by PPP). The reason for the overshooting phenomenon is that the adjustment speeds are different in the financial and goods markets. Disequilibrium in the financial markets is immediately eliminated by movements of interest rates and exchange rates. But disequilibrium in the goods markets will be present for a long time because of price rigidities (sticky prices).

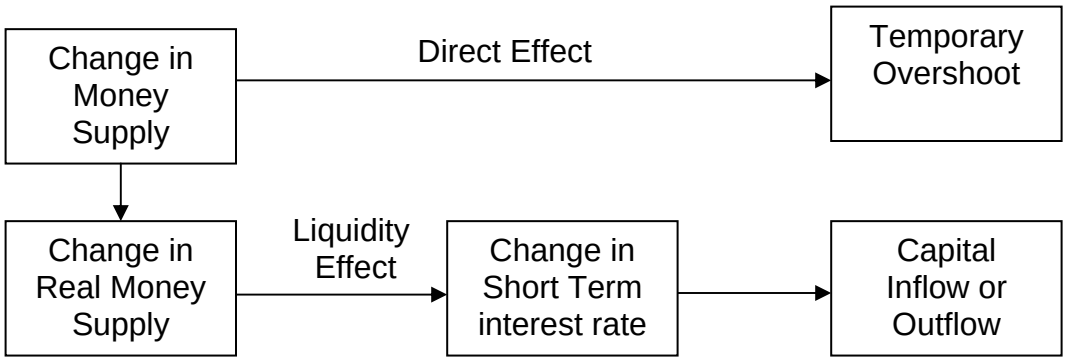

Figure 4.The Direct and Liquidity Effects of Money Supply changes under the Sticky Price Monetary Model of Exchange Rate

1.3.3. Further Refinements to the Monetary Model

Hooper and Morton (1982) modified the monetary model by extending it so that the impact of the changes in external trade balance was included in the model.

Girton and Roper (1977) added a small modification to the monetary model by noting that exchange rates may be heavily influenced by central bank intervention. They defined the sum of rate of change in internal reserves, deflated by the level of monetary bases, plus rate of change of the exchange market pressure. The exchange market pressure is substituted as in place of e, the exchange rate, after expressing the explanatory variables are expressed in terms of rate of change.

1.3.4. Empirical Performance of the Monetary Models

Unfortunately, the monetary models do a poor job of predicting, or even explaining the path exchange rates have taken.

The main culprits are –

i. The failure of PPP to hold in the short and medium term
ii. Assuming a stable demand for money, while in practice major shifts in demand occur
iii. Money supply and level of output are supposed to be determined exogenously, not endogenously.

1.4 The Portfolio Balance Approach to Exchange Rate Determination

1.4.1. Basic Framework in Portfolio Balance Models

In the Portfolio Balance (P-B) models, the net wealth of a country comprises

i. Non-interest earning reserve money of the central bank, M.
ii. Interest bearing domestic bonds,B and
iii. Interest bearing foreign bonds F.

If i and i_f are the domestic and foreign interest rates, e is the exchange rate and E(e) is the expected rate of change of e, then I, i_f, e and E(e) are all determined by the relative supplies and demands of domestic and foreign bonds. Without going into the derivation, we will look at the basic features.

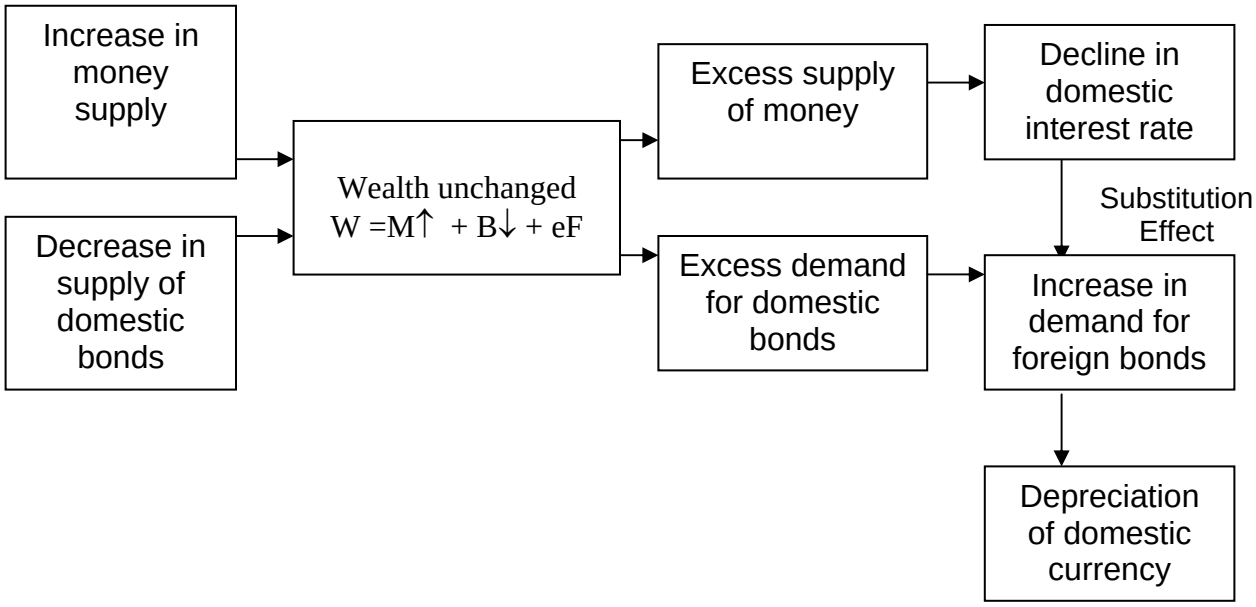

Figure 5. Impact of an Increase in Domestic Money Supply on Interest Rates and the Exchange Rates.

First, consider a central bank engaging in open market purchase of domestic bonds. There is no increase in addition in domestic wealth but reserve money is swapped for bonds domestic residents find themselves with excess supply of money and excess demand for domestic bonds, both of which can be eliminated by a decline in domestic interest rates. The decline in rates causes residents to

switch to foreign bonds. This substitution effect puts downward pressure on domestic currency

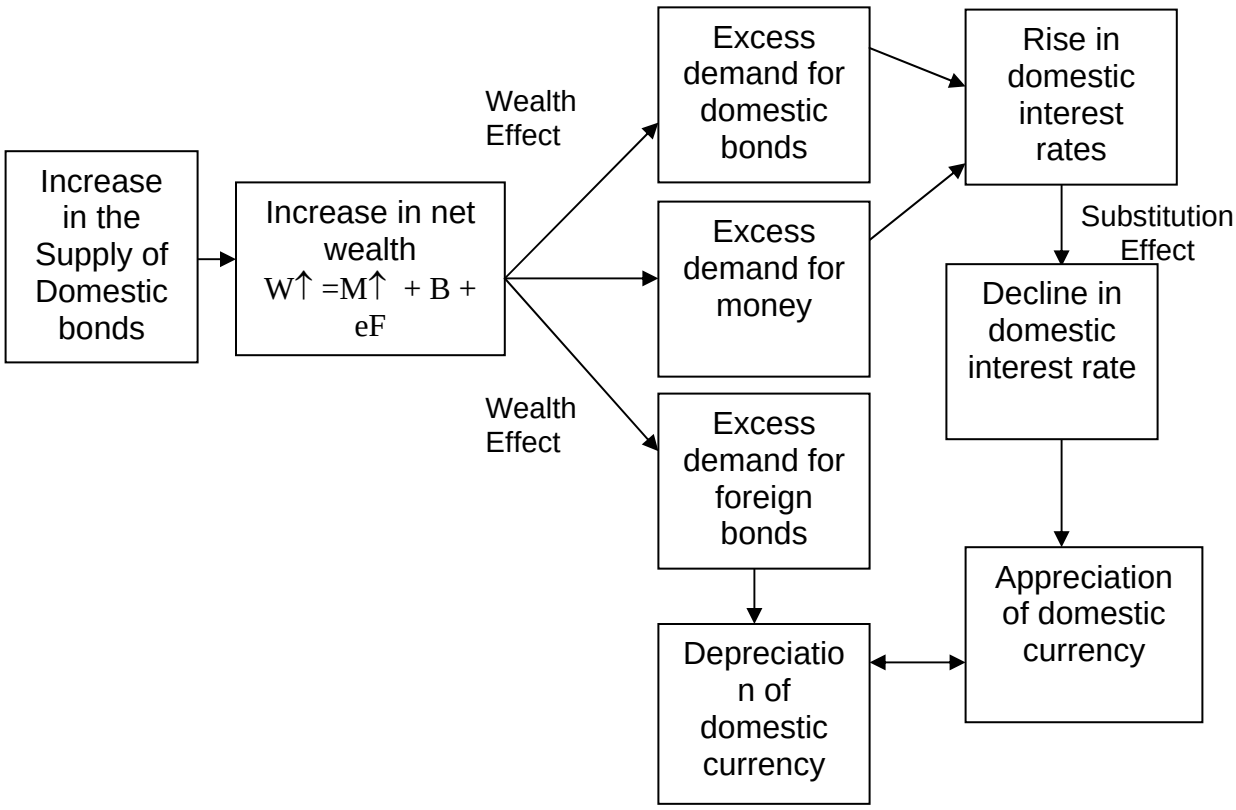

Figure 6. The Impact of an Increase in the Supply of Domestic Bonds on Interest Rates and the Exchange Rate.

Consider now the case where an expansionary fiscal policy leads to increase in the supply of bonds. This leads to an increase in B, and hence in net wealth. Residents find themselves with an excess supply of domestic bonds and an excess demand for reserve money and foreign bonds. The domestic interest rates must rise to eliminate excess demand for money. The excess supply of domestic bonds also raises rates.

The increased supply of bonds exerts two pressures on the exchange rate, each in different directions. The excess demand for foreign bonds causes by the initial rise in net wealth causes tends to place downward pressure on the domestic currency. On the other hand, the rise in domestic rates that is necessary to clear the domestic bonds and money markets tends to induce assets holders to switch from foreign to domestic bonds. Thus switching forces the domestic currency up. Depending on the relative size of the two effects, the domestic currency can go up or down.

1.4.2 Synthesis of Monetary and Portfolio Balance Approaches

Combining the Monetary and Portfolio balance approaches gives the following structural form

$e = ln\ m/m_f - b_1\ ln\ y/y_f + b_2\ [\ E(l) - E(l_f)] - b_3\ (r\text{-}r_f) + b_4\ (b\text{-}f)$

where m, m_f are the domestic and foreign money supply

y and y_f are the domestic and foreign output

l and l_f are the domestic and foreign inflation

r and r_f are the real interest rates

b and f are the share of domestic bonds and foreign bond in net wealth

This integrated model says that the domestic currency will

i. Fall, if domestic money growth exceeds foreign money growth
ii. Rise, if domestic output exceeds foreign output
iii. Fall, if domestic inflation exceeds foreign inflation
iv. Rise, of domestic real rates exceed foreign real rates
v. Fall, if increase in the supply of domestic bonds exceeds the increase in supply of foreign bonds.

Results from empirical testing of the P-B approaches have been dissatisfying. The coefficients are either wrongly signed, or if they have the correct signs they

are statistically insignificant. But this approach does have useful insights. The rise of the US dollar in the 1980's was explained by the large budget deficits. The same was the case for the Deutsche Mark in 1990's.

2. Models of Currency Crisis

2.1 Introduction

A currency crisis may be said to occur when a speculative attack on the exchange value of a currency results in the devaluation or sharp depreciation, or forces the authorities to defend the currency by spending a large part of its international reserves or raising interest rates.

This criterion has the advantage of including those episodes where there was a speculative attack, which did not result in a very large depreciation, but at the cost of depletion of reserves. The case of the Hong Kong dollar in the summer of 1998 is one such example.

A standard approach is to create an index of exchange market pressure. We can use a weighted index of percentage changes in nominal exchange rate (defined as units of domestic per US dollar) and the negative of the change in international reserves. The weights are chosen so that the variance of the two components is equal and the index is not dominated by any one component. A rise in the index level indicates increased pressure on the currency. Periods when the index is higher than its mean by three standard deviations or more are identified as a currency crisis.

2.2 First Generation Models of Currency Crisis

The first systematic attempt to model currency crisis came in 1979 in a now classic paper by Paul Krugman (1979). Krugman drew on a paper published by Steve Salant and Dale Henderson (1978). Salant, a federal reserve economist, was studying the efficacy of commodity price stabilization by the authorities.

Salant argued that such a scheme would invite attacks by speculators. The point of departure was the insight that a speculator will hold an exhaustible resource if and only if he expects its price to rise rapidly enough to offer them a rate of return (risk adjusted) equivalent to that on other assets. This derives from the well known Hotelling lemma (1931) of exhaustible resource pricing; the price of such a resource should rise over time at the rate of interest, with the level of the price path determined by the requirement that the resource should be just finished by the time the price has risen to the choke point (where there is no more demand). In this setting, if an official price stabilization board declares its support in favour a target price level, then as long as this target is above the shadow price (the "Shadow Price" is the price that would have prevailed in the absence of the price stabilization scheme), speculators will sell off their holdings. They will act this way for they cannot expect any more gains. Thus the board will find itself with a large stock of the resource. Eventually the shadow price will rise above the target and then the resource will become a desirable asset and the stocks held by the board will be soon exhausted. Salant considered a gold price stabilization scheme. Then others, led by Krugman analyzed a pegged currency regime in an analogous way, mimicking the commodity board story.

The upward trend in the shadow price was supplied by assuming the government issues money to finance budget deficits, but the central bank stands ready to defend the exchange rate using international reserves.

Krugman’s analysis stressed upon the inconsistency between an overly expansionary monetary policy and the maintenance of a fixed rate peg. If a central bank is forced to monetise a large and persistent budget deficit or inject massive sums of liquidity to support a trouble bank system, then the fixed rate peg is doomed. Assume that changes in a currency’s value are inversely related to the changes in monetary base, M

$\dot{e} = -\dot{M}$

The monetary base consists of D the domestic credit issued by the central bank and R, the international reserves.

M = D + R

If the central bank attempts to monetise a large budget deficit by expanding domestic credit, D, that will increase the base M unless the reserves are run down by a corresponding amount. For the nominal exchange to stay fixed,

$\dot{e} = 0, \dot{M} = 0,$ and a rise in D must be offset by a fall in R

Since the reserves are finite, R cannot support a rising D indefinitely. At the point where the central bank's reserves fall to zero, the monetary base will start expanding at the same rate as domestic credit.

$\text{if } R = 0, \text{ then } \dot{M} = \dot{D}$

The speculators are forward looking. Once they realize the inevitability of collapse at T_1, they would attempt to make profits and launch an attack well before resources are exhausted. Hence the day of reckoning is brought forward to T_0 (see figure 7).

The weakness of this model lies in the unrealistic description of the way the central bank is supposed to act in abandoning the peg. The policymakers are assumed to be passive, sticking with currently mutual inconsistent policies and abandoning the fixed rate when the minimum critical level is reached. They neither take an aggressive role in defending the current exchange rate policy, nor do they adjust their commonly known policy objectives in the light of external economic and political developments.

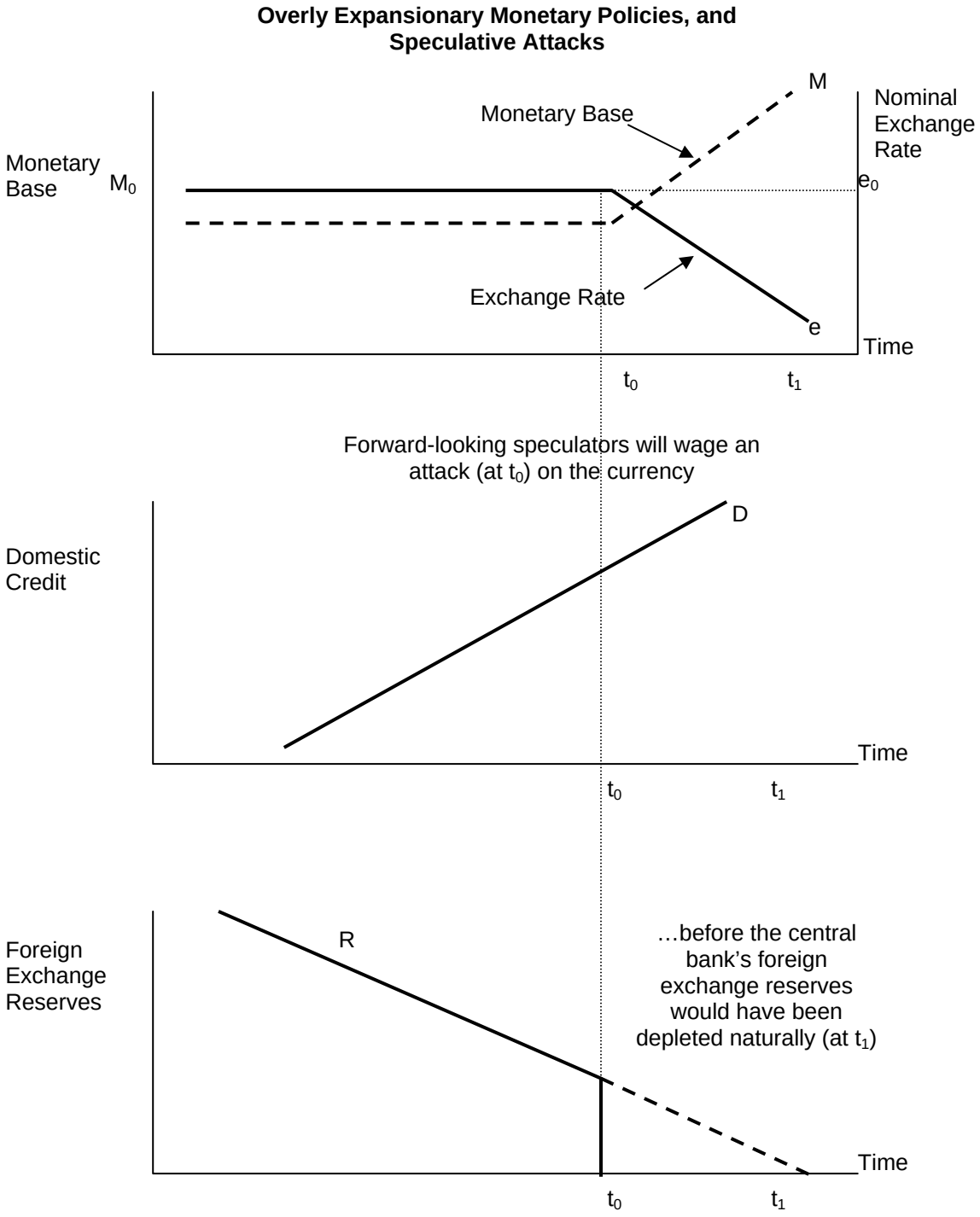

Figure 7. Canonical Model for Currency Crisis

A more accurate characterization of the policy is that the decision whether to devalue or not reflects counterbalancing objectives. Deteriorating fundamentals are an important part of the story, but the decision to devalue is taken not because it is literally unavoidable, but because of the importance of other objectives given external developments. Policy makers may choose to devalue even though it may be technically feasible to maintain the peg. They might devalue if it is no longer optimal in the face of political or other costs associated with it.

2.3 Second Generation Models of Currency Crisis

The second-generation models emanated from an array of models published in Obstfeld (1994 - 1995). These models had two features. First, they were designed to produce multiple equilibria - it was possible to have two or more outcomes for the survival of the fixed exchange rate system, depending entirely on how speculators acted. Self-fulfilling crisis can be modeled in this class of Models. Second, this modeling strategy explicitly showed what the government's choice parameters were, and they put the government in the role of an optimizing agent. The government controlled its environment, and it selected exactly whether and when it wanted to devalue based on balancing the various costs that it faced.

Second-generation models focussed on potential important non-linearities in government behavior. They studied what happens when government policy reacts to changes in private behavior or when the government faces an explicit trade-off between the fixed exchange-rate policy and other objectives. Some of the newer models show that even when policies are consistent with the fixed exchange rate, attack-conditional policy changes can *pull* the economy into an attack. In contrast, First generation models generate an attack by having inconsistent policies before the attack *push* the economy into a crisis. Other models show that a shift in market expectations can alter the government's trade-

offs and bring about self-fulfilling crisis. The newer models admit the possibility that an economy can be at a no-attack equilibrium where speculators see but do not pursue available profit opportunities. In such a situation, anything that serves to coordinate the expectations and actions of speculators can suddenly cause an attack

2.3.1 Examples of Second Generation Models

In Ozkan and Sutherland (1995) the authorities objective function depends positively on certain benefits derived from keeping a fixed peg - such as enhanced credibility in the efforts to reduce inflation, and negatively on the deviation of output from a desirable level. Under a fixed exchange rate, increases in foreign interest rates led to higher domestic interest rates and lower levels of outputs. This makes it more expensive to maintain the peg. Once foreign interest rates exceed a critical level, the cost of maintaining the peg exceeds the benefits. At this point authorities may abandon the peg

The second generation or newer models have examined the fact that crisis may develop without any noticeable change in economic fundamentals. Economic policies might not be pre-determined but respond to changes in the economy and economic agents take this relationship into account while forming expectations. The expectations and actions of economic agents effect some variables to which economic policies respond. This circular or feedback arrangement creates the possibility of multiple equilibria, and the economy may move from one equilibrium to another without a change in fundamentals.

In Obstfeld (1994) the expectation of a collapse will lead to higher wage levels and lower employment. This might lead to an abandonment of the peg out of concern for the output.
Obstfeld also consider the effect of rising interest rates increasing the probability of a banking crisis and the associated fiscal cost of a bailout.

3. Early Warning Systems and Estimating Currency Crisis Probabilities

3.1. Introduction

There have been a very large number of studies where sets of macroeconomic and political indicators have been used to characterize the periods preceding crisis and to measure the probabilities of crisis.

Kaminsky, Lizondo and Reinhart (1998) have listed 25 different papers out of a much larger set. We will just illustrate the approach followed by KRL, which the authors have termed as the *Signals Approach*.

The most commonly used methodology is to estimate the one-step (or k-step) ahead probability of devaluation in the context of a probit model

3.2. Factors used to Explain Crisis

We would like to first list, and then elaborate upon some of the factors influencing currency crisis, before proceeding ahead. We have broken them into twelve categories.

1. Output and Inflation

- GDP growth
- Industrial production
- Consumer price inflation

2. Money and Credit

- Growth in M1 balances
- Money multiplier
- Reserves/M2
- Credit to the Private sector/nominal GDP

- M2 in real terms
- Credits to the private sector

3. Fiscal Factors

- Budget balance as a percentage of GDP
- Budget balance: deviation from trend
- Structural Budget Balance

4. Domestic Financial Markets

- Real deposit rate
- Domestic interest rate spread
- Discount or other policy Rate
- International Interest Rate Differential
- Change in interest rate
- Change in equity prices

5. Trade and Current Account

- Growth in imports and exports
- Trade balance
- Current Account balance

6. Capital Flows and Debt

- Foreign Direct Investment flows
- Portfolio investments flows
- Total, short term and private debt
- Debt service ratio

7. International Reserves, Terms of Trade and the REER

- International Reserves
- Term of Trade

- Real Effective Exchange Rate deviation from trend

8. Policy Environment

- Economic policy Environment
- Political Stability

9. Global Output, Inflation, Liquidity

- Change in US Industrial Production
- Change in G5 Industrial Production
- US Inflation Rate
- Change in G5 inflation
- Change in global liquidity

10. Global Finance Markets

- G3 10 Year bond yields
- US yield Curve
- G3 equity prices
- G3 exchange rates

11. International Commodity Prices

- Change in Non fuel commodity prices
- Change in international oil Gold Prices

12. Discontinuous Variables

- Capital Account Liberalization
- Contagion

Let us discuss these factors briefly

1. Output and Inflation Factors

The key measures of economic activity are GDP and Industrial production. If growth exceeds underlying potential there can be initial buoyancy in domestic capital markets, which attracts capital inflows. This can in turn induce inflationary pressure. If growth is too low, there can be pressure on the government to ease financial policy, including a depreciation in order to stimulate growth. Hence both overheating (Mexico, 1994) and slowing growth (ASEAN countries, 1997) can lead to currency depreciation. Inflation is one of the most important indicators that an economy is overheating. Additionally, inflation has considerably bearing on resource allocation and competitiveness. In case of an exchange rate peg, inflation higher than that of the nominal anchor trade can lead to an overvalued real exchange rate. Some researchers have looked at the volatility of inflation but empirical studies have shown that levels of inflation tend to at the same that volatility of inflation is high. Inflation in both Russia and Brazil had come down significantly so there can be limited usefulness of inflation as a predicator.

2. Monetary Factors

The role of excessive growth in monetary and credits aggregates in exacerbating internal and external imbalances is quite important. In a period of relatively loose monetary policy, the banking sector often extends credit without due regard to risk and quality of loans. This makes the economy more vulnerable to a slowdown. High growths in monetary aggregates are difficult to sustain in the long run. The experience of the ASEAN economies shows that lag times might be several years. Two more factors in the role of excessive credit expansion have been identified in the context of the ASEAN crisis- 1) Weakness in the regulatory regimes, which led to lax lending standards. 2) The pegged exchange rate regimes, which because their credibility was high, attracted capital flows on favourable terms. The result was a sharp growth in domestic credit.

3. Fiscal Balances

The budgetary deficit reflects the imbalances between revenue and expenditure. If this imbalance is large, growing and is monetized, then it will lead to

macroeconomic instability. However financing deficits by issuing debts is not without problems, since higher deficits will cause the government debt to be seen as being more risky. The problem worsens when the borrowings are of short maturity or in foreign currency. This is common to both Mexican and Indonesian crises. The government then does not have the option of rolling out the printing press.

If the issuance is in domestic currency then increases in domestic taxes might be required and a vicious cycle might ensue where increasing shares of revenue must be allocated simply to service the debt. However lower levels of debt will not guarantee stability as Korean example will show.

4. Domestic Financial Markets

Domestic deposit and lending rates reflect a variety of factors, including domestic monetary conditions, risk premia, public and private sector net savings rate. Higher interest rates are a double-edged sword they will attract portfolio flows but at the same time dampen economy activity and raise the cost of servicing domestic debt. Sharply rising stock markets may indicate the building up of speculative bubbles. Land prices also may spurt along with construction and government regulations again pointing to a possible crisis

5. Trade and Current Account Balances

The balance of payment is one of the most important macroeconomic indicators, providing a strong signal of an impending currency crises. A sharp slowdown in export growth is an important feature in currency crises. The Asian currency crisis is one example. Trade and current account balance- for emerging markets, the current account is largely influenced by the trade balance. The way the trade or current account deficit is financed is crucial. A deficit caused by increasing domestic consumption and financed by short-term inflows is more likely to cause a crisis than that caused by investment. And were significant deterioration in

trade balances prior to Latin American and Asian crises. The current account gives a broader picture of the external balance of the economy. If investment exceeds savings there is a current account imbalance which is financed by capital inflows. Once again, if there inflows are used for augmenting productive capacity it might lead to beneficial effects albeit with a lag. The net imports being used for consumptive purposes are unhealthy. An example is that of Thailand where initially the current account deficits were funded initially by foreign direct investment and longer term debt. But deficit continued to be large and the debt maturity shifted to the shorter side leading to the crises. Also note that the current account deficit as a percentage of the GDP is the relevant number, and not just the level. And the case of the US and Japan in this issue is totally unrepresentative.

6. Capital Flows and External Debts

There has been considerable questioning of capital account liberalisation and the extent to which increase transactions costs may alter the composition of flows and reduce the vulnerability resulting from sudden outflows. There is some evidence that the differences in the type of flows may be an important contributor to this vulnerability. For instance, portfolios inflows including flows into the domestic equity and debt markets, while clearly beneficial, can be easily reversible. They can be highly sensitive to any changes in the international financial environment as well as to change in investor sentiment. A country relying on them may be perceived to be more vulnerable than a country which borrows long term by issuing debt in the international market or relies on foreign direct investment flows including flows resulting from the privatisation process. If the underlying fundamentals are sound, both portfolio and direct investment flows can be highly beneficial and provide support for the currency, but they can also magnify weaknesses.

The characteristics of debt are as important as the level of debt and debt servicing. For a given level of debt, the higher the share of short to long-term

debt, the greater is the vulnerability to debt servicing difficulties as well as currency crisis. It is also important to consider the source of debt, for instance, the extent to which the debt is owed to official rather than to private sources

7. International Reserves, Terms of trade and REER

The level of international reserves is a key indicator of the sustainability of an exchange rate regime. The higher the level of reserves relative to imports, the more unlikely is a speculative attack against that currency. As shown by Krugman, the level of reserves need not fall to zero before an attack is launched, but speculators are going to wait only till reserves fall to a certain critical level. If expectations are bearish, there may be speculative pressures. Another useful indicator is the ratio of broad money, M2, to international reserves. The REER or Real Effective Exchange Rate. depends upon bilateral exchange rates vis-a-vis trading partners, trading weights, and inflation relative to trading partners. It is one of the most useful indicators of the competitiveness of an economy. An increase in the REER makes an economy uncompetitive and the currency overvalued.

8. Policy environment

Economic policy and more importantly, the way economic policy implementation is viewed by international players is extremely important. Recent examples are Brazil it was commonly suggested that Cardoso would not let the Real go before the 1998 elections. As soon as Fraga was appointed to the head of the central bank, the real rallied. What happens in Argentina depends on the elections, outcome. War in emerging markets can worsen the outlook for obvious reasons. George Soros said to have anticipated UK policy makers' dilemma before launching the most spectacular coup in history.

9. Global Output, Inflation and Liquidity

The US economy is the consumer of last resort. Developing economics in a slowdown look to the US economy. Japan was blamed in large part for the Asian crisis. The problems caused by a liquidity crunch are so well highlighted by the assorted crises of 1998 that we will, once again, move on to other things.

10. Global Financial Markets

Rise in yields in G7 countries, seems to herald emerging markets currency crisis though there seems to be an 18-month lag. It is now widely acknowledged that the when the US Federal Reserve started to tighten monetary policy with interest rates hike in 1994, this significantly worsened the pressure on the Mexican peso. The sharp depreciation of the yen vis-à-vis the dollar from mid-95 onwards is considered to have adversely affected the competitiveness, of Asian currencies, which were implicitly pegged to the dollar.

11. International Commodity Prices

Trading in primary commodities is highly significant for several emerging models. Coffee and cocoa for Brazil, oil for OPEC countries, are examples as obvious that no further elaboration is needed.

Even amongst G7 countries, the pound sometimes moves up and down with crude oil. The Australian dollar is a commodity-based currency. Falling commodity prices often hit the primary commodity exports badly.

12. Discontinuous Variables

Contagion and herding are important factors but we have discussed them else where in greater detail.

China still does not allow capital account convertibility-partly this has led it to be a rock of stability.

3.3. Early Warning Indicators: The Approach of Kaminsky, Lizondo and Reinhart

Kaminsky, Lizondo and Reinhart (1998) examined 77 currency crisis episodes from a sample of 20 nations between 1970-95. They compute the probability of a crisis conditional upon a signal from that indicator.

An indicator is said to issue a *signal* when it deports from its mean beyond a *threshold level.* Threshold levels are chosen so as to strike a balance between the risk of having too many false signals (too aggressive) and missing to issue true signals true signals (too aggressive)

Signaling horizon is a period within which indicators would be expected to have ability for anticipating crises. Kaminsky and Reinhart define this period arbitrarily as 24 months.

It would be useful to consider the following matrix-

	Crisis (within 24 months)	No crises (within 24 months)
Signal issued	A	B
Signal not issued	C	D

In this matrix, A is the number of months in which the indicator issued a good signal, B is the number of months in which the indicator issued a bad signal, C is

the number of months in which the indicator refrained from issuing a good signal and D is the number of months in which the indicator refrained from issuing a bad signal.

A perfect indicator would produce signals only in the northwest and southeast cells, it predicts every crises and does not produce any false signals – A>0, D>0 and B=C=0. In practice we will never find any perfect indicators. But this matrix will be a useful reference to assess how far or close is each indicator from that profile.

3.3.1. Statistics Analyzed by Kaminsky, Lizondo and Reinhart

1. The number of crisis correctly called, defined as the number of crisis for which the indicator issued at least one signal in the previous 24 months expressed as a percentage of the total crises episodes.

2. A measure of the tendency of an indicator to issue good signals A/(A+C). Obtaining 100% in the first measure would require that the indicator issues at least 1 signal within 24 months prior to each crises, and a 100% in second measure would require a signal to be issued every month within the 24 month period preceding the crises. The REER is the indicator issuing the highest percentage of possible good signals in the second measure.

3. The measure of sending bad signals, or B/(B+D), other things being equal, the lower this number, the better the signal. REER is the best performer and ratio of lending to deposit interest rates is the worst.

4. A noise to signal ratio [B/(B+D)]/[A/(A+C)]; This is just a ratio of bad signals to good signals expressed as percentages. Other things being equal the lower this number; the better is the indicator. The REER is the best performer. The noise to signal ratio is used as a criterion for deciding which indicator to drop from the list

of potential indicator. An indicator that issues signals at random times and has no predictive power will attain a noise to signal ratio of one greater than one is just adding excessive noise to the model.

An equivalent way of categorizing this information is to compare the probability of crises conditional upon the signal, to the unconditional probability of crises, i.e., to compare (A/A+B) to (A+C/A+B+C+D). If an indicator is useful, the conditional probability should increase compare to the unconditional exception.

Table 1 shows how these indicators performed.

3.3.2 The Lead Time of Indicators

For the policy maker who wants to implement pre-emptive measures, a signal must come in sufficient time before a crisis. If one gets a signal only at the eleventh hour, then it is too late for a pre-emptive strike.

Table 2 looks at the average number of months in advance of crises that an indicator first issues a signal. The longest lead-time is for the REER but the significant feature is that an average the lead times tend to be between one and one and a half years. Hence these indicators are leading indicators rather than co-incident, and can be useful in creating early warning systems.

3.3.3 Persistence of Signals:

Persistence of a signal from the time issued to the onset of crisis is another useful feature. In a way this is just another way of looking at the noise to signal ratio.

	%age of	Good .Signals as Percentage	Bad Signals as	Noise/Signal	P(Crisis/Signal)	P(Crisis/Signal) -P(Crisis)

	Crisis Called	of possible Good Signals	Percentage of Possible Bad Signals			
In terms of the matrix in the text		A/(A+C)	B/(B+D)	[B/(B+D)]/[A/(A+C)]	A/(A+B)	
Real Exchange Rate	57	25	5	0.19	67	39
Exports	85	17	7	0.42	49	20
Import prices	64	17	8	0.47	49	18
International reserves	80	21	10	0.48	46	17
	77	16	8	0.52	49	16
Excess Ml balances	61	16	8	0.52	43	15
M2/International reserves	75	22	12	0.55	41	13
Money multiplier (M2)	73	20	12	0.61	40	11
Domestic credit/GDP	56	14	9	0.62	39	11
Real interest rate	89	15	11	0.77	34	6
Terms of trade	79	19	15	0.77	36	6
Real interest differential	86	11	11	0.99	29	0
Imports	54	9	11	1.16	26	-3
Bank deposits	49	16	19	1.20	25	-4
Lending rate/deposit rate	67	13	22	1.69	18	-9

Table 1. Signals Approach, Performance of Indicators (from Kaminsky, Lizondo and Reinhart, 1996)

Indicator	Number of Months in Advance of the Crisis When First Signal Occurs
Real exchange rate	17
Real exchange rate	17
Imports	16
M2 multiplier	16
Output	16
Bank deposits	15
“Excess” M1 balances	15
Exports	15
Terms of trade	15
International reserves	15
Stock prices	14
Real interest differential	14
M2/international reserves	13
Lending rate/deposit rate	13
Domestic credit/GDP	12

Table 2. Average Lead Time (from Kaminsky, Lizondo and Reinhart, 1998)

Indicator	Persistence During Crisis relative to Tranquil Times
Real exchange rate	5.14
Exports	2.37
Stock prices	2.15
M2/international reserves	2.07
Output	1.93
“Excess” M1 balances	1.92
International reserves	1.82
M2 multiplier	1.64
Domestic credit/GDP	1.62
Real interest rate	1.30
Term of trade	1.29
Real interest differential	1.01
Imports	0.86
Bank deposits	0.84
Lending rate/deposit rate	0.59

Table 3. Persistence of Signals (from Kaminsky, Lizondo and Reinhart, 1998)

3.4. IMF's May 1998 World Economic Outlook Report:

The IMF in its May 1998 World Economic Outlook report constructed on early warning index for 10 emerging market countries, four in Latin America and the other six in Asia. This index is a weighted average of
(1) The deviation of the REER from it is three-year mean level
(2) The deviation in domestic credit growth from its three year average and
(3) The deviation of M2/Reserve ratio from its three year average. The index is designed to signal heightened vulnerability to a possible currency crisis.

These three indicator were chosen because of their favourable track record in preceding past crisis with sufficiently long lead times. Additionally timely data for these three are available IMF is careful to warn that this index is supposed to be a tool for identifying weakness, not for predicting timings of speculative attacks.

Some other conclusions reached by the IMF in its May 1998 World Economic Outlook report-
1) In the period leading to the crisis, the REER is higher than its mean level during tranquil periods.
2) Export performance deteriorates.
3) Trade balance did not show significant changes.
4) Sharp fall in international reserves prior to the crisis.
5) There is deterioration in the terms of trade.
6) Inflation was higher in pre crisis periods than tranquil periods. But there were crisis not preceded by inflation episodes that did not lead to crisis.
7) The ratio of M2/Reserves tended to rise in the period leading to crisis and then fell sharply the immediately prior to crisis.
8) Money supply growth tends to rise.
9) Growth in domestic credit rises sharply prior to a crisis.
10) Both real estate and stock markets tend to boom prior to a crisis.
11) Output in real terms fell sharply after a crisis.

4. Contagion in Currency Crises

4.1 Introduction

A notable feature of recent currency crisis has been the clustering of crises in different countries. A speculative in one country has spelled over contagiously to countries with sound with economic fundamentals as well. More formally,

if P (Crisis in country A | there is a crisis in country B)> P (Crisis in country A)

then we say that contagion effects exist. Some people, notably Masson (1998) have gone further, saying that 'contagion' is a term which should be used only where a crisis in another country for reasons unexplained by macro economic fundamentals, common shocks or trade links.

4.2 Reasons Behind Contagion

There are three main sets of reasons, which have been put forth as explanations

1 There may be a common cause driving the crises. Major shifts in industrial countries economic policies and currencies can cause emergency market crises. This is exemplified by the weakening of the yen against the dollar, which was a contributing factor to the Asian crisis in 1997. The Asian currencies were pegged to the dollar, which led to a significant real appreciation in these currencies.

2 Trade and capital market linkages: A devaluation in one country will make other countries uncompetitive. Illiquidity in one market may force people to liquidate positions in another country.

3 Flight to quality, sometimes called pure contagion, herding or psychology can be an important reason.

Asymmetric incentives faced by fund managers are also a contributing factor. South Korea was not really too heavily intertwined with the south east Asian troubled economies, but a fund manager who did not reduce exposure in South Korea and got caught in the devaluation of the won would be blamed for lack of due diligence.

Allan Drazen (1996) has talked of pure political contagion models

Several crises cannot be explained well on grounds of discrepancy between economic policy and exchange rate targets, or bad fundamentals. The most glaring examples were in the EMS currency crisis of 1992-93. It was argued that the French franc and the Irish punt came under attack as a result of earlier crisis experienced by the British pound and Italian lira. French fundamentals actually resembled those of Germany and not Britain. The French authorities were incensed that they should be a target of speculative pressure in spite of being fundamentally sound.

Sweden came under pressure when Finland devalued in 1992 because they exported to the same set of countries. Spain's depreciation in that crisis led to attacks on Portugal since they are trade partners – even though Portugal had sound fundamentals.

4.3 The Study by Eichengreen, Rose and Wyplosz.

One of the most widely quoted studies on contagion in currency crisis has been that of Eichengreen, Rose and Wyplosz (1996) They have done a wide range of sensitivity analyses and tests to suggest that even after controlling for economic and political factors, a crisis elsewhere increases the probability of crisis by eight percent.

Using a panel of quarterly macroeconomic and political data covering twenty industrialized countries from 1959 to 1993, they examine if the incidence of

currency crisis in a particular country at a given point in time correlated with the incidence of a currency crisis in another country at the same time even after controlling for current and lagged macroeconomic and political influences. The crisis observations are not randomly distributed but appear in clusters. They find a strong partial correlation, which is consistent with the hypothesis of contagion. They warn that this is not sufficient proof because the finding may not reflect contagion, but a common shock not captured by the choice of variables. They create a Market Pressure Index consisting of exchange rate depreciation, fall in reserves and rise in interest rates with the weights being chosen to equalize the variances of the three components, and define

$crisis_{i,t} = 1, \text{ if } MPI_{it} > 1.5\,\sigma + \mu$

$= 0, \text{ otherwise}$

where μ & σ^2 are the mean and variance of the Market Pressure Index (MPI)

The macroeconomic variables they used are-

1. Total international reserves
2. Interest rates
3. Export and import rates
4. Current account measured as a percentage of GDP
5. Long term bond yields
6. Stock market index
7. Growth in domestic credit
8. Measures of money supply, M1 and M2
9. CPI
10. GDP growth
11. REER
12. Unemployment
13. Wage growth

They also tried to control for political factors using dummy variables for the following:

1) Government victory
2) Government loss
3) Capital controls

Trade links are an important channel of contagion – when one country devalues and its currency becomes more competitive, other countries feel the pressure to devalue or face a slow down in exports. But linkages other than those of trade can also be important. When Mexico devalued in 1994, Argentina and Brazil came under attack due to trade links but Hong Kong, Malaysia and Thailand also came under pressure. At that time similarity of macroeconomic fundamentals was touted as an explanation. It was argued that once a country with a certain set of macroeconomic fundamentals and policies is subjected to successful attack speculators would look for attacks on other similar currencies. They will also gauge the government response to the speculative pressure and revise expectations of another government behavior.

To test the importance of the above two links, they fitted three models

- A naive model of contagion
- A model of contagion where crises in different countries have different weights, the weights depending on the bilateral importance of trade
- A model of contagion where crisis are weighted by similarity of macroeconomic policy.

The result suggested that trade links are more important as a channel of contagion than macroeconomic fundamentals. However both the weighted crisis models outperform the naive model of contagion.

4.4 The Naïve Contagion Model

Eichengreen, Rose and Wyplosz used lagged, contemporaneous and moving averages to estimate a binary probit model of the form.

$Crisis_{i,t} \sim \omega D\,(Crisis_{i,t}) + \lambda I\,(<)z, t + \varepsilon_{i,t}$

where $D\,(Crisis_{j,t}) = 1$, if $crisis_{j,t} = 1$ for $i \neq j$

$= 0$, otherwise

and $I(J)_{j,t}$ is an information set of contemporaneous and/or lagged variables, and ε is normally distributed noise.

The test the null H_o: $\omega = 0$. Evidence of the null is inconsistent with a contagion effect.

They find evidence in favour of a contagion effect and that speculative attack elsewhere in the world increases the probability of crises by eight percent.

Following the above testing for contagion, they test whether trade linkage or macroeconomic similarities are more important as channels of transmission. The naïve model is transformed slightly and it now becomes

$Crisis_{i,t} \sim \omega W_{ij,t}\,(Crisis_{j,t}) + yI\,(L)_i, t + \varepsilon_{it}$

$W_{ij,t}$ is a weight which relevance at time *t* of country *j* for country *i*.

4.5 The Trade Weighted Contagion Model

The trade weighting scheme is $W_{ij,t} = EER_{ij}$ for i = j where EER_{ij} is the weight for country *j* in country in IMF multilateral effective exchange rate measure (MERM).

4.6 The Macroeconomic Weighted Contagion Model

The second scheme is designed to capture macroeconomic similarity. They use seven variables to measure similarity – domestic credit growth, money growth, inflation, output growth, unemployment rate current account balance and budget

deficit. The variables are standardized by the standard deviation. Two different standardization are performed – a country specific approach in which a country is compared to its time series data and a time specific approach where an observation at one point for a country is compared to observations at the point in time across all the time across all the countries.

The macro weights according to this two schemes are-

$W_{ij,\,t} = \sum_j (1-\{\phi [(x_{jt} - \mu_i)/\sigma_i] - \phi [(x_{it} - \mu_i)/\sigma_i]\})$ *for any* $j \neq i$

and $W_{ij,\,t} = \sum_j (1-\{\phi [(x_{jt} - \mu_t)/\sigma_t] - \phi [(x_{it} - \mu_t)/\sigma_t]\})$ for any $j \neq i$

where $\phi(.)$ is the cumulative normal distribution
μ_i (μ_t) is the country-specific (time-specific) sample average of x_i and
σ_i (σ_t) is the country specific (time-specific) standard deviation of x_j.

This specification implies that if country *j* is attacked at time *t* and *j* is similar to country *i* in the sense of having similar macroeconomic variables then it receives a high weight on the contagion variable. If *j* and *i* have identical standardized value for a variable then the weight is unity. The more dissimilar the values the lower is the weight. If *i*'s value is at the extreme lower end of the cumulative distribution while *j*'s is at its upper end, the weight is zero.

The trade-weighted model improves the fit of the model. The coefficients in the macroeconomic weighted contagion model are generally insignificant when considered individually.

The conclusion is that trade links are a channel for contagion but not macroeconomic similarity. But the unweighted measure of contagion is significant even when the trade weighted and macro-weighted measures are included simultaneously. This suggests that contagion may spread through channels other than trade links and macroeconomic similarity.

5 Alternative Monetary Systems for Prevention of Currency Crisis

5.1 Introduction

A debate currently rages on designing a New Financial Architecture. Regulations want more disclosure by hedge funds. Capital controls, Tobin tax, a return to the gold standards and McKinnon's 'Fixed but Adjustable rates', the gold standards without gold have all been bandied about. We believe that there is no substitute for fiscal and monetary discipline. If the government embarks upon irresponsible spending behaviour, currency crisis is an accident waiting to occur.

Three major monetary arrangements have attracted a lot of attention recently. We will now discuss them in turns

5.2 Monetary Unions and Common Currency Arrangements

Monetary unions or common currency arrangements are supposed to reduce exchange rate volatility. A reference to the theory of Optimum Currency Areas, due to pioneering works by Mundell (1961) and Mckinnon (1963) might be in order. The focus is on

i. Asymmetric shocks to the member economies
ii. Labour mobility and behavior of real wages.
iii. Trade links.
iv. Transaction value of a single currency.

It is commonplace to conclude that neither Europe nor the USA are optimum currency areas - it is quite often that people advocate the case for a Californian dollar or a mid-West dollar. It has also been suggested that Germany and the USA will never find it economically beneficial to be a part of any monetary union.

The cost of entering into a common currency arrangement is the loss of independent macroeconomic policy:

5.2.1 South East Asia as an Optimum Currency Area

Even before the Asian crisis struck, Eichengreen and Bayoumi (1996) examined if the Asian countries - China, Hong Kong, Singapore, Taiwan, Korea, Malaysia, Indonesia, Thailand, and the Philippines - constituted an optimum currency area. They analyzed if these countries would benefit from having a common peg to a basket. The implicit baskets against which these currencies were pegged were essentially dollar based with the yen being a small component. Hong-Kong was a currency board and China currency was non-convertible. They suggested that the Asian countries should reduce the weight of dollar in their implicit pegs.
Eichengreen and Bayoumi created an (OCA) Optimal Currency Area index as follows:

$$SD\ (ln(e_{ij})) = \alpha + \beta_1\ SD\ (ln\ (y_i/y_j)) + \beta_2\ DISSIM_{ij} + \beta_3\ TRADE_{ij} + \beta_4\ SIZE_{ij}$$

where e_{ij} = bilateral exchange rate for countries *i* and *j*

SD (x) = standard deviation of *x*

y_i = real out put of country *i*

$DISSIM_{ij}$ = sum of absolute differences in the shares of agricultural, mineral and manufacturing trade in total merchandize trade

$TRADE_{ij}$ = mean of the ratio of bilateral exports to domestic GDP for the two countries and

$SIZE_{ij}$ = mean of the logarithm of the GDP of the two, measured in US dollars.

The coefficients above are estimated using data for Japan and 18 of its trading partners. These estimated coefficients are then used to compute the OCA index for the Asian countries.

This OCA index is computed separately for European nations. The value of the OCA index for some of the Asian nations approached the European levels - reinforcing the argument for a common peg. These country pairs were- Singapore-Malaysia, Singapore-Thailand, Singapore-Taiwan, and Hong Kong-Taiwan.

However, political considerations tend to override economic ones It has taken almost seven hundred years for a common European currency- the idea of a common federation of European princes was floated in 1306, and William Penn, Rousseau, Victor Hugo - all spoke of European integration at different times. Will post-crisis Asia ever look to integrate?

5.3. Currency Boards

Currency Boards are all the rage nowadays. One of the main proponents of currency boards is Steve Hanke, professor of Economics at Yale, but more notably a columnist for Forbes magazine. One of the most vociferous opponents is Nouriel Roubini of the NYU's Stern School of Business.

It is being suggested that Indonesia as well as Mexico would benefit from adopting currency boards. On the other hand Lithuania and Estonia are trying to abandon their currency boards which they adopted in the early 90's.

5.3.1. What is a Currency Board?

A Currency Board is a monetary authority that issues notes and coins convertible into a foreign currency at a truly fixed rate and on demand. As reserves, a currency board holds low risk, interest bearing bonds denominated in the anchor currency, A Currency Board usually must hold reserves equal to 100% or more of its currency notes and coins. A Currency Board generates profits from the

difference between the interest earned on its liabilities (the notes and coins in circulation). A Currency Board has no discretion in monetary place and cannot change the money supply.

5.3.2. Some Currency Boards

Historically, currency boards started in British colonies and the first one was established in Mauritius (1849). The oldest one still around is that of Djibouti, in existence since 1949. The most notables ones are those of Hong Kong (since1983) and Argentina (1991). The most recent ones are those of Bosnia (1997) and Bulgaria (1997). The Caribbean Island of Antigua and Barbuda, Dominica, Grenada, St. Kitts and Nevis, St. Lucia and St. Vincent and the Grenadines all have a common currency under a currency board with a peg to the US dollar. Lithuania and Estonia also have currency boards, although they are planing to abolish them.

5.3.3. What Currency Boards Can Achieve

An IMF paper by Ghosh, Gulde and Wolf (1998) shows that average inflation does decline under currency boards. In a currency board, there is no independent central bank and no independent monetary policy. The monetary discipline, and the credibility it wins for the government policies is helpful in preventing speculative attacks.

5.3.4. What Currency Boards Cannot Achieve

- Critics of currency boards argue that ultimately it is the soundness of policies followed that determines the fate of a currency, noting that speculative attacks can occur in a currency board inspite of backing of currency with reserves. Hong Kong’s is probably the most credible currency board but it came under attack in 1997 and again in 1998. Similarly for Argentina in 1995 following the Mexican crisis. In Hong Kong, the 6-month forward had an implied carry of around 300

bps in 1998 implying significant expectations for a change in peg. The HKMA had to raise rates to stave off the attack, which led to an economic slowdown. Taiwan and Singapore in contrast, were not under currency boards and devalued quickly, not only avoiding the hike in rates with all the associated costs, but also gained competitiveness.

- Banking systems can become more fragile under currency boards since a currency boards rules out the possibility that monetary base can be raised or credit increased. Under speculative attack, the lender of last resort does not exist and banks may be forced to call in loans.

- Currency boards can be dangerous for countries which are substantial exporters of primary commodities, particularly oil; the prices of these are not affected by devaluation. The total loss of monetary flexibility can cause problems when commodity price falls fall. Some people have likened this to Texas, which effectively has a monetary union with the rest of the USA. When oil prices collapsed in the 1980's the state went into a deep recession. If Texas had its own Texas dollar, a depreciation of the currency would have mitigated the fall in oil prices. In fact for a primary commodity-exporting nation, a fall in prices causes a real appreciation of the currency inviting a speculative attack. The large fluctuations in monetary base (since sterilization is not possible) will cause destabilization. At least in case of Texas, it satisfies the conditions for an optimum currency area with the rest of the US. Labor and capital being mobile, these migrated to other states, dampening the shock. Where can people of Hong Kong go?

- Currency Boards cannot avoid capital flow volatility. Larger capital inflows in optimistic periods and outflows under troubled times will occur even under currency boards. Argentina and Hong Kong are examples. Since sterilization is not possible, monetary base cannot be adjusted and all the related problems can ensue.

- Currency boards cannot prevent real appreciation and loss of competitiveness. The Hong Kong dollar appreciated in real terms along with the US dollar. Between 1990 and 1997 it had a real appreciation of about 30%.

- Currency boards can collapse even though the monetary base is backed by reserves. If an attack occurs, holders of domestic assets will try to sell off domestics and buy foreign assets. This will run down the reserves the important point is that the domestic financial assets are a large multiple of the monetary base. If one uses a broader measure like M1/FX reserves or M2/Fx reserves rather than one sees how difficult it is for an attack to be staved off these ratios were between 3 to 8 for most currency boards in 1998.

- Currency boards may improve monetary discipline but do nothing to impose fiscal discipline.

5.4 Dollarization and a Comment on Argentina's Proposal

Currency substitution occurs when a currency other than the domestic currency is used for fulfilling a substantial part of the transaction demand for money. Panama has the US dollar as its currency. The Argentinean Peso follows a currency board in a 1:1 peg. The US dollar accounts for 60% of the transactions volume.

The Argentinean Currency Board has US $15 billion in reserves and $15 billion peso in circulation. Assuming that reserves earn 5% annually, the Currency Board earns $750 million a tear.

5.4.1 Argentina's Plan

i. Sell the UST-bills held as reserves for dollar cash and use that to buy back the entire stock of pesos.

ii. Negotiate with the US so that part of the lost revenue is paid to Argentina in the form of a transfer. If this amount is US 600 million. Then, US fiscal revenue increases by US $150 million annually.

iii. Using the US $600 million as collateral, Argentina can borrow at rates only slightly higher than the T-bill rates. Using this as collateral, Argentina can borrow in excess of $10 billion.

5.4.2 Advantages to Argentina

i. The biggest advantage is that the threat of a currency crisis is gone.

ii. As things stand, the central bank can generate additional liquidity by 30% of monetary base, which is $4.5 billion. Thus dollarization increases that by a factor of more than two.

5.4.3 Advantages to the USA

- The US is fiscally better off.

References

Dornbusch, Rudiger (1980), “Exchange Rate Economics Where Do We Stand?” *Brooking Papers on Economic Activity*

Dornbusch, Rudiger and Paul R. Krugman (1976), “Flexible Exchange rates in the Short Run” *Brooking papers on Economic Activity 3*

Drazen, Allan (1998), “Political Contagion in Currency Crises”, *Draft Manuscript*

Eichengreen, Barry, Andrew Rose and Charles Wyplosz (1996), “Contagious Currency Crisis”, *NBER Working Paper No. 5681*

Eichengreen, Barry and Tamim Bayoumi (1996),. “Is Asia an Optimum Currency Area? Can it Become One? Regional, Global and Historical Perspectives on Asian Monetary Relations.” *International Monetary Fund*

Frankel, Jeffrey (1986), “International Capital Mobility and Crowding Out in the US Economy.” in *How Open is the US Economy?* Ed. R. Hofer. Lexington Books

Ghosh, Atish R, Anne-Marie Gulde and Holger C. Wolf (1998), “Currency Boards: the Ultimate Fix?” *International Monetary Fund.*

Girton, Lance and Dan Roper (1977),. "A Monetary Model of exchange Market pressure Applied to Post-War Canadian Experience." *American Economic Review.*

Hooper, Morton and John Morton (1982), "Fluctuations in the Dollar: A model of Nominal and Real Exchange Rate determination." *Journal of International Monetary and Finance.*

Hotelling, Harold, (1931), "The Economics of Exhaustible Resources", *Journal of Political Economy, 39.*

Kaminsky, Graciela, Saul Lizondo and Carmen Reinhart (1998), “Leading Indicators of Currency Crises”, *IMF Staff Papers*.

Krugman, Paul (1979), “A Model of Balance of Payments Crises”, *Journal of Money,Credit and Banking*, *11*

McKinnon, Ronald (1963), "Optimum Currency Areas", *American Economic Review 53*

Mundell, Robert A (1961), " A Theory of Optimum Currency Areas”, *American Economic Review, 51*

Masson, Paul R. (1998), "Contagion: Monsoonal Effects, Spillovers and Jumps between Multiple Equilibria", *International Monetary Fund*.

Obstfeld, Maurice (1994), “The Logic of Currency Crises”, *NBER Working Paper, No.4640.*

Obstfeld, Maurice and Kenneth Rogoff (1995), “The Mirage of Fixed Exchange Rates”,*NBER Working Paper, No. 5191.*

Obstfeld, Maurice (1996), “Models of Currency Crises with Self-Fulfilling Features”, *CEPR Discussion Paper Series, No. 1315.*

Ozkan , F. and Alan Sutherland (1995), “Policy Measures to Avoid a Currency Crisis”, *The Economic Journal, 105*

Salant, Stephen and Dale Henderson (1978), "Market Anticipation of Government Policy and the Price of Gold", *Journal of Political Economy 86*

Appendix 1. A Note on Generalized Linear Models

Consider $E(Y) = \mu = \sum_{k=1}^{K} \beta_k x_k$

This is the ordinary linear model, used in linear regression model. To create a more generalized model, we introduce the variable, η, which links the function $\sum_k b_k x_k$ to μ, although not necessarily in a *linear* fashion.
In general, we specify η as a linear predictor produced by $x_1, x_2, \ldots, x_k$.
Regardless of the type of model, the set of explanatory variables always linearly produce η, which is a predictor of *Y*. The relation between η and the x variables is given by

$$\eta = \sum_{K=1}^{k} \beta_k x_k$$

The function of the relation between η and μ distinguishes one member of a generalized linear models from another.

(1) Linear: $\eta = \mu$
The links in classic linear models is identity.

(2) Logit: $\eta = \log[\mu /(1-\mu)]$
This will specify a logit model that takes a binary outcome variable.

(3) Probit: $\eta = \phi^{-1}(\mu)$,
where ϕ^{-1} is the inverse of the standard normal cumulative distribution function. Similarly, this link function specifies the probit model that examines a binary outcome variable.

(4) Logarithm: $\eta = \log \mu$.
This results in a Poisson regression model
The choice of the link function used depends on the distribution of the data. The distribution of the random component in *Y* determines the link functions and the generalized linear model. In generalized linear models, the distribution of the random component comes from an exponential family, to which the normal, the binomial, and the Poisson distribution all.belong. When this distribution is normal, the linear link function arises.
The link functions (2) and (3) are both based on the binomial distribution, while (4) follows the Poisson distribution.