

To Float, to Peg, or to Hide?—
Deciphering *de facto* Exchange Rate Regimes in South Asia

by

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Chapter 1 - Introduction

Recent literature has confirmed the gap between *de jure* and *de facto* exchange rate policies in several countries. Many countries suggest that they float their exchange rate, when in reality they heavily intervene in the exchange rate market (Calvo and Reinhart, 2002). Similarly, many countries that argue that they fix their exchange rate, in fact, devalue their currency in the face of crises (Rogoff and Obstfeld, 1995). Finally, countries that claim to target a basket of currencies shift the weights on the currencies in the basket when they desire to do so (Frankel et al., 2001).

Given that mismanagement of exchange rate policy has been attributed as a direct or indirect cause of many crises, such as the Asian Financial Crisis, and that exchange rate stability is considered important for trade and economic integration, knowledge about the actual exchange rate regime of a country is crucial for currency traders, portfolio managers, trade negotiators and macroeconomists (Shah et al., 2005). Because the *de jure* and *de facto* exchange rate policies differ, the relevant stakeholders cannot rely on a country's announced exchange rate policy. This has led economists to develop various techniques to analyze the *de facto* exchange rate regime of a country.

One stream of literature has focused on inferring a currency's flexibility by comparing exchange rate variability to foreign exchange reserve variability (Calvo and Reinhart, 2002; Levy-Yeyati and Sturzenegger, 2003). A second stream of

literature has focused on estimating implicit basket weights by regressing changes in the home currency value against changes in the values of potential anchor currencies (Frankel and Wei, 1994; Ohno, 1999). More recently, a third stream of literature has combined the virtues of both of the aforementioned techniques by creating a synthesis technique that allows one to infer both weights flexibility (Frankel and Wei, 2008).

While the synthesis technique has addressed most of the pitfalls of the earlier two techniques, there are many econometric and methodological issues with the way the technique has been applied recently. Therefore, the first goal of this thesis is to contribute to the literature on exchange rate regime analysis by critiquing and building upon existing methodologies.

Furthermore, these techniques of exchange rate regime analysis have seldom been used to analyze the exchange rate regimes of countries in South Asia. South Asia is home to over one-fifth of the world's population, and is the most populous and most densely populated geographical region of the world.¹ While some researchers have included India's exchange rate regime in their analysis, their research methods fail to account for various econometric and methodological issues. Furthermore, including only a single South Asian country in a primarily non-South-Asian analysis does not allow for a comparative analysis of the South Asian exchange rate regimes.² The omission of South Asia in such analyses in the literature is understandable to a certain extent as South Asia is considered as one of the poorest regions of the world. However, with the rising geopolitical importance of the region,

¹ Cavoli (2010) analyzes exchange regimes of some South Asian countries but his method suffers from serious methodological problems, some of which will be discussed in Chapter 3.

² For examples of such papers, see Frankel and Wei (2008) and Patnaik (2007)

the expedited economic liberalization of South Asian countries and the emergence of these countries, particularly India, as significant players in the world economy, it is becoming increasingly important to analyze the exchange rate regimes of South Asian countries. Thus, the second goal of this thesis is to analyze and understand the *de facto* exchange rate policies of South Asian countries.

Part of the literature on exchange rate regimes has focused on analyzing the effect of the Asian Financial Crisis on the exchange rate policies of East Asian countries (Cavoli and Rajan, 2005; Taguchi, 2004; McKinnon, 2001). However, the effect of the global financial crisis on exchange rate regimes has not been thoroughly analyzed as yet. Given that the impact of the global financial crisis was not limited to a specific location, as it was in the Asian financial crisis, the effect of the global financial crisis on exchange rate regimes can be examined using South Asian exchange rate data. Therefore, as a third goal, this thesis will analyze the effect of the Global Financial Crisis on the exchange rate policies of South Asian countries.

As members of the South Asian Association for Regional Cooperation (SAARC), South Asian countries have indicated their interest in pursuing economic integration. A key component of economic integration is to maintain intra-regional exchange rate stability (Kawai, 2008). For that to happen, some convergence of exchange rate regimes is necessary. Mori et al. (2002) and Castell et al. (2007) have similar prescriptions. First, each country should adopt an individual currency basket system based on the direction of its trade. In the second step, each country should harmonize its exchange rate regime and the weights in its currency basket; this harmonization leads to implicit exchange rate coordination, where each individual

country's individual currency basket is similar to every other country's individual currency basket. After implicit exchange rate coordination, it becomes easier to initiate explicit exchange rate cooperation, in the form of common currency basket, or even a common currency, which is seen as an integral step towards economic integration. Thus, convergence of exchange rate regimes and harmonization of currency basket weights could potentially take place. As a fourth goal, this thesis will analyze whether such convergence and harmonization of exchange rate regimes has been taking place. Since there is no explicit policy of exchange rate coordination, the analysis will check to see if implicit exchange rate coordination has already been occurring. Moreover, this analysis will indicate the level of difficulty involved in shifting the South Asian exchange rate regimes to a policy of explicit coordination.

The thesis's analysis of these issues starts off with Chapter 2 giving a literature review of exchange rate regime analysis, and Chapter 3 discussing contentious issues in the literature. Chapter 4 describes the data and methodology used. Chapter 5 provides the results of the analysis. Chapter 6 contains a summation, some cautions and some recommendations.

Chapter 2 - Literature Review

Background on exchange rate regimes

As a precursor to the discussion on exchange rate regime analysis, it is worthwhile to discuss the background and classifications of exchange rate regimes. Broadly, exchange rate regimes can be categorized into three categories: fixed exchange rate regimes, intermediate exchange rate regimes and floating exchange rate regimes (Frankel and Wei, 2008). While further sub-categories of exchange rate regimes can be drawn, for the purpose of simplicity, I will restrict the discussion to the three aforementioned exchange rate regimes.

Perhaps the most commonly used regime in history, the fixed exchange rate regime, is defined as a regime in which countries peg their exchange rates to an anchor currency or to the currencies of a group of countries. This regime provides countries with a nominal anchor for monetary policy, which helps them fight inflation. Furthermore, such regimes are associated with low nominal volatility, which in turn encourages trade and investment. In fact, some economists argue that fixed exchange rate regimes preclude competitive depreciation as fixing helps trade competitors and partners achieve a cooperative solution (Frankel, 2004). However, on the other hand, Fischer (1999) and Krueger (1999) argue that fixed exchange rate regimes lack credibility and, in unfavorable circumstances, invite speculation against the ability of the authorities to maintain a fixed exchange rate. In some cases, the

costs associated with the speculation that accompanies fixed exchange rates could outweigh any benefits that come from lower exchange rate variability.

At times, countries may want to minimize the volatility of their currency against major reserve currencies, in which case they pursue basket pegs. Basket pegs are considered as a type of fixed exchange rate, where a country pegs to multiple currencies as opposed to a single currency. Basket pegs do help in sheltering a country's exchange rate against cross-rate fluctuations; however, basket pegs could forego the benefits of maintaining one constant bilateral exchange rate for relevant comparisons and economic transactions. Moreover, a failure to disclose weights could lead to speculative attacks such as with single-currency fixed rates (Khan, 2009).

On the other end of the spectrum, floating exchange rate regimes are preferred by countries that opt for an independent monetary policy (Castell et al., 2007). Some economists argue that these regimes are less susceptible to and have a faster and smoother adjustment to speculative attacks and financial crises than fixed regimes (Ghosh et al., 2010). Retaining the lender-of-last-resort capability, authorities under a floating regime can create the necessary money to bail out banks and other institutions in times of crisis (Frankel, 2004). However, several researchers have argued that floating exchange rates often exhibit such high volatility that it negatively impacts international trade (Bénassy-Quéré and Lahrèche-Révil, 2003).

Meanwhile, somewhere between floating and fixed exchange rate regimes, lies the intermediate exchange rate regime. In the intermediate case, the authorities maintain a degree of flexibility by allowing the exchange rate to deviate from a

reference basket, but they tend to intervene when the deviation from the reference basket reaches a critical point (as defined by the authorities) (Frankel, 2009). Under this approach, countries potentially combine the benefits and avoid the costs of the fixed and flexible exchange rate regimes: low exchange rate volatility with a competitive level of the real exchange rate, avoiding overvaluation. This extra degree of freedom in policy making allows countries to use monetary policy to make balance-of-payments adjustments when faced by asymmetrical shocks. Furthermore, like fixed regimes, the intermediate regime reaps the benefits of deeper trade integration through stable exchange rates (Ghosh et al, 2010).

Critics of the intermediate regime idea argue that these regimes are more likely to face crises than the fixed or flexible exchange rate regimes; according to them, this is because the appearance of a peg, when the authorities are not necessarily following a peg, invites speculation against the currency since market participants cannot verify intermediate regimes until a few months elapse (Frankel et al., 2001). Other studies cast a negatively light on intermediate regimes by associating poor growth with these regimes (Levy-Yeyati et al., 2003). However, yet other studies argue that intermediate regimes are indeed viable for many countries that fulfill the relevant criteria of relatively high capital mobility and sufficiently high economic development (Mussa et al., 2000). This disagreement among academic economists on the value of intermediate regimes, leads us to a discussion of the “Two-Corner hypothesis,” which has been the subject of debate and controversy in recent times.

Two-Corner hypothesis

The “Impossible Trinity Theory” argues that countries cannot maintain exchange rate stability, capital mobility and monetary autonomy simultaneously.

Naturally, some analysts argue that if countries cannot make use of independent monetary policy, they should sacrifice it in favor of maintaining exchange rate stability. With intermediate exchange regimes, the case is less clear-cut. In an intermediate regime, where authorities follow a managed floating policy, this potentially allows them to maintain some exchange rate stability, some monetary autonomy and some capital mobility all at the same time. In essence, from the lens of the “Impossible Trinity Theory,” a little bit of everything is given up, but in exchange all three can occur at the same time (Berdiev et al., 2011). However, proponents of the corner hypothesis, or the bipolar view, such as Eichengreen (1994) and Fischer (2001), argue that intermediate regimes’ goal of simultaneously maintaining stable exchange rates and smooth cyclical output fluctuations is unattainable. In short, the “Two-Corner hypothesis” argues that intermediate regimes are not sustainable and thus cannot be a solution to the trinity problem. Proponents of the “Two-Corner hypothesis” encourage countries to pursue a corner solution with either a freely floating exchange rate or a fixed exchange rate (Frankel, 1999).

However, several economists have opposed the “Two-Corner hypothesis,” by proposing the intermediate exchange rate regime for countries in East Asia to help them stabilize their effective exchange rates. Williamson (2000a) further questions the ability of the freely floating exchange rate to provide a long-term solution given

that freely floating rates suffer from excess volatility, which could lead to long-run misalignments. On a similar note, the “Fear of Floating hypothesis” counters the corner solution by arguing that even in the best of times, when countries may have voluntary access to international capital markets, a fear that exchange rate instability will be taken as a sign of economic mismanagement leads to frequent intervention by the authorities. Despite the official “floating” label, these countries stabilize their exchange rate more than they have announced; a common way to stabilize the exchange rate is to measure deviations with reference to a currency basket, which is precisely what an intermediate exchange rate regime does (Calvo and Reinhart, 2002). On the other hand, as compared to pegged exchange rate regimes, the intermediate regime offers an extra degree of flexibility, which is particularly useful in the face of crises (Williamson, 2000a). Thus it stands to reason that there is a valid place for the intermediate exchange rate regime in a policymaker’s toolbox.

As I discuss in the next section, the choice of exchange rate regime is not necessarily restricted to the corner solution; instead, it will depend on the conditions of a country and the particular economic challenges that it faces.

Which regime works best?

The exchange rate regime debate has historically been framed in terms of a trade-off between credibility and flexibility. Ghosh, Gulde and Wolf (2003) argue that hard pegs work best, Levy-Yeyati and Sturzenegger (2003) claim that floats work best while Reinhart and Rogoff (2004) insist that limited flexibility works best. However, to be fair, as Frankel (1999) convincingly argues, there is no universally

right regime. Individual countries should choose the exchange rate regime best suited to address its particular economic challenges, and to provide it macroeconomic and financial stability. External and internal stability, international competitiveness, low transaction costs and credibility of monetary policy are all key factors that countries should keep in mind when they choose exchange rate regimes (Khan 2009).

A series of hypotheses have developed over time regarding the likelihood of a country to adopt a specific exchange rate regime. A consensus has not developed regarding any of these hypotheses. Instead, contradictory arguments have been presented by various economists. A comparative analysis of the different views is out of the scope of this thesis. However, some of these hypotheses are worth discussing as they may be particularly relevant to the discussion of South Asian exchange rate regimes.

According to some economists, left wing governments, democratic institutions, central bank independence and financial development all increase the likelihood of a developing country to choose a flexible exchange rate regime. However, contrary to the argument that financial development in developing countries leads to more flexible exchange rate regimes, other economists argue that more globalized countries and developing countries with higher level of economic development are more likely to choose a fixed regime (Berdiev et al., 2011). On a similar note, countries that have signed Preferential Trade agreements with trade partners are more likely to prefer flexibility in their exchange rate regime so as to retain the ability to use monetary autonomy to improve domestic producers' competitiveness. Ironically, in this case, countries follow the letter of law in the

Preferential Trade agreements but violate the spirit of the international agreement by often resorting to exchange rate protection (Copelovitch and Pevehouse, 2010). While they are all interesting arguments, none of them have been conclusive, which is understandable given the difficulty of isolating the effect of one factor, out of many, on the choice of exchange rate regimes.

Perhaps the most heated debate has been over the effect that an exchange rate regime has on the likelihood of currency crises. Previously, various exchange rate regimes have been blamed for increasing the odds of currency crises. However, more recently researchers have argued that countries can pursue any of the exchange rate regimes without being worried that one of the regimes will increase the likelihood of currency crises. Both Stiglitz (2002) and Haile and Pozo (2006) convincingly argue that the *de facto* exchange rate regime plays no role in determining currency crises, and that indeed no exchange rate regime can be consistently blamed for such crises.

Instead of basing the choice of exchange rate regime on highly generalized ad-hoc measures such as the likelihood of an exchange rate regime causing currency crises or the likelihood of an exchange rate regime in promoting growth, a country should focus more on the fundamental, specific factors underlying the exchange rate regimes. Some economists have made broad assertions, such as, that (Frankel, 1999):

- Floating is desirable for large economies
- Fixing is desirable for very small open economies and for economies that suffer from hyperinflation, where independent monetary policy is no longer useful

- Intermediate regimes are desirable for some developing countries for whom large-scale capital flows are not a concern.

Even beneath these broad categories, there are further factors that need to be analyzed to get a more detailed understanding of when each of the exchange rate regimes would be useful. A fuller comparison is contained below in Table 1.1 (Frankel, 2011a). The focus is on pegged and floating regimes for the sake of this analysis, but the benefits of intermediate regimes can be easily deduced from this.

Table 1.1

<u>Factor</u>	<u>Why the factor matters</u>
Size and Openness	For countries with small size and high openness, measured as the ratio of tradable goods to GDP, a fixed exchange rate could facilitate trade (McKinnon, 1963). Therefore, if a country has small size and high openness, the benefits of fixing, such as facilitation of trade, tend to be larger and advantages of floating, such as discretionary monetary policy, tend to be smaller.
Existence of major-currency partner in trade and investment	If a major-currency partner exists with whom bilateral trade and investment is high or could be high in the future, then a peg to this dominant partner will be useful, simple and credible. If a diversified, but stable, trade pattern exists then the country can peg to a basket of foreign currencies.

Symmetry of shocks	Pegging to a country with which the domestic country has highly correlated cyclical fluctuations is useful because if the domestic country gives up its ability to follow its own monetary policy, it is better if the interest rates chosen by the larger partner are close to what the domestic currency would have chosen anyway (Bayoumi and Eichengreen, 1994).
Labor Mobility	Labor mobility is very important for countries that do not have the ability to use monetary policy to respond to asymmetric shocks. For countries considering pegging and giving up monetary autonomy, it is useful to have labor mobility as one of the core mechanisms of adjustment to the shocks (Mundell, 1961).
Countercyclical Remittances	Remittances from emigrants often represent a large share of foreign exchange earnings. Furthermore these remittances are variable and countercyclical. Frankel (2011b) argues, that they seem to respond to the difference between cyclical positions of the country sending them and the country receiving them. This makes it more likely for the domestic country to give up the option of setting its monetary policy differently than say, the United States, because remittances will achieve some of the necessary smoothing.

Level of Financial Development	<p>The literature argues that countries seldom float their exchange rates without having developed financial markets.</p> <p>The representative argument comes from Husain, Mody and Rogoff (2005), who argue that if financial markets are thin, then the advantages of using exchange rate flexibility to accommodate real shocks are outweighed by the costs of financial shocks. Therefore, fixed rates might be a better option for countries with low levels of financial development.</p>
Origins of Shocks	<p>Fixed rates work best if shocks are mostly internal demand shocks, especially monetary shocks, while floating rates work best if shocks tend to be supply shocks or real shocks, especially external trade shocks (Edwards, 2011).</p>

From the lens of a central bank

The central bank of a country has three options:

- a. Floating the exchange rate and not intervening.
- b. Pegging to an anchor currency or basket of currencies by putting weights on their values.
- c. Following an intermediate regime, in which case the authorities use a certain basket of currencies as a reference point against which it measures deviations.

In this case, one allows the currency to fluctuate around the basket of

currencies (reference point) to accommodate macroeconomic and economic shocks. For example, a 0.5 weight on U.S. dollar and Euro could be used to calculate a predicted exchange rate and the actual exchange rate would be kept within a band of that predicted exchange rate (so, for example if the exchange rate from the weighted basket turns out to be 1.05, one would keep it within 1.05 plus/minus 5 percent) The idea is to have a reference point, but allow deviations around it.

So for countries, the options are analytically very simple. In the floating case, the authorities do not do anything. In the peg case, they decide the weights on anchor currencies based on some criteria (discussed below) and then basically observe changes in the anchor currencies to maintain the peg.

In intermediate exchange rate regimes, Bands, Baskets and Crawls (BBCs) are becoming more and more popular. The idea behind BBC is to follow a basket of currencies, monitor movement around the basket within a band and allow the exchange rate to crawl over time. Crawling in this context refers to an increasing or decreasing trend in the exchange rate over time (Williamson, 2000b). The authorities decide on what currencies they want to use for the reference point, the weights they will put on them and then, they use those weights to calculate a reference exchange rate and allow their actual exchange rate to float around that reference exchange rate in the form of a specified band. As the deviation becomes too large, the authorities intervene in the foreign exchange market to bring it within the bands. If a country increases the band, it allows the exchange rate to deviate more from the reference exchange rate calculated using the basket weights. Sincere there are potentially large

benefits to maintaining exchange rate stability via a peg or basket of currencies in the intermediate case, a country would not want to give it up unless forced to due to a lack of reserves or decides to do so due to a policy shift (the case where a structural change occurs is discussed later).

Why do countries not follow their announced policies?

This whole exercise of analyzing *de facto* exchange rate regimes would be unnecessary if countries followed their announced exchange rate policies. However, that is hardly the case, as the recent literature on *de facto* exchange rate regimes testifies. A country's *de facto* exchange rate regime has been distinguished from its *de jure* regime by many economists. Alternate classifications, placing countries into their "true" categories, have cropped up in recent times (Ghosh et al., 2003; Reinhart and Rogoff, 2004). Even the IMF has started distinguishing between the *de facto* and *de jure* exchange rate classifications, and has offered its own classification system since 1999. If these alternate classifications were consistent and accurate, one could have arguably used these as an indication of a country's exchange rate regime.

Unfortunately, these alternate classifications differ from each other as much as they differ from the *de jure* classification (Frankel and Wei, 2008). A more detailed critique of these classification techniques will follow later in this chapter; for now it must be pointed out that the differences in the alternate classifications indicate incoherence in the methodology being used to classify exchange rate regimes.

While differences exist in alternate classification schemes, the distinction between *de jure* and *de facto* exchange rate regimes has become well-established. The

reasons behind a country's inability or unwillingness to follow an announced exchange rate policy depend on the announced policy itself. Countries that commit to maintaining a pegged exchange rate, often devalue their currencies in the face of crises. This "fear of pegging," not keeping to an announced peg, is partially attributed to poor economic institutions as these poor institutions lead to poor economic management (Alesina and Wagner, 2003).

Meanwhile some countries target a basket of major world currencies, but often keep the weights in the currency basket secret as it allows the government to change the weights or devalue their currency secretly when the need arises. However, this approach has been criticized by some economists who argue that secret weights reduce the credibility of the government to commit to low-inflation monetary policy (Frankel and Wei, 1994).

On the other end of the spectrum, countries with *de jure* floating exchange rate regimes display a "fear of floating," meaning they float less than announced and in fact try to reduce exchange rate volatility. In essence their exchange rate management looks close to a managed exchange rate arrangement despite their official policy of a freely floating exchange rate (Calvo and Reinhart, 2002). Given the fact that many of these countries have good institutions, their "fear of floating" cannot be blamed on economic mismanagement. Ironically, the authorities in these countries are concerned that the wide exchange rate fluctuations that may occur in a floating exchange rate regime could be taken as a sign of economic mismanagement; therefore, the authorities intervene to reduce exchange rate volatility.

Rationales behind choosing anchor currencies

Now that the distinction between *de jure* and *de facto* exchange rates has been established, it is pertinent to discuss the techniques used for inferring *de facto* exchange rate regimes. But as a first step in that discussion, it is important to scrutinize the philosophy and rationale behind the various technical nuts and bolts of the exchange rate regimes.

The case of the freely floating exchange rate is perhaps the simplest of them all. In the freely floating exchange rate, a country's central bank and authorities do not intervene in the exchange rate market and leave it up to the market to decide the actual exchange rate. On the other hand, the intermediate regime and fixed exchange rate regime deserve much more attention in this section, especially because in these regimes the countries make a conscious choice of pegging to or putting weight on a currency or basket of currencies. The rationale behind choosing the relevant anchor currencies or basket of currencies may seem country-specific at first, but in reality there are certain trends and factors that dictate that choice. The discussion that follows will focus on anchor currencies or currency baskets, without differentiating between pegs and intermediate regimes, in the interest of space. The major difference in the case of fixed exchange rate regimes and intermediate regimes will be that in the case of the former the domestic currency will peg to an anchor currency or basket of currencies while in the case of the latter, the domestic currency will put weight on an anchor currency or basket of currencies while maintaining some degree of freedom.

In the 1950s, there were half a dozen anchor currencies. By now, the list of anchor currencies has mostly shrunk to the U.S. dollar and the Euro, with varying degrees of interest in the Japanese Yen and the British Pound (Meissner and Oomes, 2009). This is not a surprise as 97.8 percent of the world's reserves have been held in these four currencies since 2000 (Patnaik et al., 2011). In terms of what has dictated the choice of anchor currencies, there are several theories. In sum, economists argue that foreign trade, external debts, foreign direct investments, foreign assets, remittances, major world currencies, currencies of former colonial powers and the currencies in which trade and reserves are denominated in are important factors in determining anchor currencies or exchange rate weights in a basket (Freitag, 2010). The most relevant of these will be discussed in further detail, as these factors will be important in the next section as I choose anchor currencies for empirical testing.

Perhaps one of the most important factors in determining anchor currencies is foreign trade. Empirical literature has revealed a modestly negative relationship between exchange rate variability and trade with notable heterogeneity (Coric and Pugh, 2010). Some economists argue that the goal of the basket peg is to stabilize foreign trade by cushioning the domestic currency's vulnerability to fluctuations in the currencies of its major economic partners and by reducing volatility of its effective exchange rate currencies vis-à-vis its economic partners. This helps a country maintain export competitiveness and stabilize import cost. Therefore, the "Optimal Peg theory" argues that the composition of currency baskets should exactly mirror the directions of trade of a country (Freitag, 2010). If foreign trade was the only important factor in deciding anchor currencies, then finding the optimal and *de*

facto exchange rate regimes would have been a matter of simple mathematical calculations. However, the optimal peg theory ignores numerous other factors that affect the choice of anchor currencies, which is why the overly simplistic explanation of the Optimal Peg theory should not be taken at face-value.

Another important factor in the choice of anchor currencies is consideration of network externalities and strategic complementarities. When pegging to a currency, one of the motivations of the domestic country is to minimize the transaction costs associated with that pegging. To put it in the words of Meissner and Oomes, it is “optimal for a country to adopt the anchor currency that minimizes the sum of bilateral exchange rate volatilities weighted by the relative importance of each trade partner” (“6,” 2009). As the Optimal Currency Area theory argues, the savings in transaction costs associated with using a particular currency increases as more and more transactions are carried out in the currency. Thus, there is a snowball effect where the benefit of using a particular anchor currency increases when other countries peg to the same currency. So, one reason why some countries may peg to a specific anchor currency, besides from trade considerations with the anchor currency, is to benefit from the network externality, where the use of a common currency anchors facilitates trade between countries. It is entirely possible that once a few strategically and economically important countries let go of a common currency anchor, their trade partners will follow and the currency bloc will unravel.

Potentially even more important than trade itself is the currency in which the trade is denominated. For example, in the case of certain East Asian countries, their trade with the U.S. is roughly equivalent to their trade with Japan. Thus, their use of

the U.S. dollar as an anchor currency may surprise many, but that follows naturally from the fact that the dollar is used as the invoice currency for most of their trade. If invoicing of trade is done in a specific currency, then there is less exchange rate risk to peg to that currency, as has happened in many cases (McKinnon and Schnabl, 2003). In a conversation with an official from the State Bank of Pakistan, the official emphasized the importance of the currency in which trade is invoiced. For instance, Pakistan trades regularly with Saudi Arabia, but since the trade is invoiced in U.S. dollars, it incentivizes the State Bank of Pakistan to maintain stability with the dollar.

Additional considerations include credibility and remittances. For a country suffering from hyperinflation or economic instability, using an anchor that is associated with macroeconomic stability signals an intention to stabilize inflation and helps the country regain credibility and bring inflation down. Similarly, there are valid reasons for a country to peg its currency to that of a country, say country S, from where major remittances are coming in. Since remittances are correlated with the differentials in growth and employment between the domestic country and country S, a way to stabilize the domestic country's currency account is by pegging the domestic currency to country S's currency (Frankel 2011b).

Given the important role of the U.S. dollar as an anchor currency for many countries around the world, it is worthwhile exploring the reasons behind this. As evident from earlier arguments in this section, foreign trade, trade denomination in the dollar, network externalities, remittances and credibility play an important role in incentivizing countries to peg to the U.S. dollar. In addition, the U.S. dollar is the dominant inter-bank currency used for clearing international payments, denominating

short-term capital flows and denominating international financial transactions; it is also the primary intervention and reserve currency for most governments (McKinnon and Schnabl, 2004b).

Clearly, there are several reasons why a country may choose to peg its currency to the U.S. dollar. However, the trend indicates that countries are loosening their peg to the U.S. dollar. The motives behind this are unclear, but can be hypothesized based on available information. First, the high volatility of the yen-dollar and the euro-dollar exchange rates has meant that countries pegging to the U.S. dollar do not get exchange rate stability with the euro and the yen. This is particularly troublesome for countries that have grown diverse economic relationships through trade, foreign direct investment and capital flows. For them, the high volatility with regards to the other currencies caused by the dollar peg means that they cannot reap the benefits of exchange rate stability with their major economic partners. Second, the desire to keep competitiveness with other countries around the region has led to a greater interest in the intermediate exchange rate regimes, where countries retain an extra degree of flexibility. Finally, the recent volatile behavior of the U.S. dollar, especially in the last decade, has shown that it may not be the ideal anchor currency in the long run (Kawai 2008). This hypothesis will be more formally tested later in this thesis in relation to South Asian countries.

Inferring degree of flexibility

The literature is filled with numerous attempts to infer a country's degree of flexibility. Traditionally, economists used the variability of a country's exchange rate alone to infer the degree of flexibility. However, this technique ignores the fact that some countries experience greater shocks than others. For example, the Australian dollar has been known to have higher exchange rate variability than the Japanese Yen but that is not necessarily because it floats more but rather because it experienced larger shocks. Furthermore, countries that specialize in mineral products, or even agricultural products, tend to have larger shocks due to volatility in terms of trade. This demonstrates the folly of judging a country's degree of flexibility based solely on exchange rate variability (Frankel and Wei, 2008).

Building on this argument, a new stream of literature has started focusing on creating a flexibility parameter by comparing exchange rate variability to foreign exchange reserve variability as a way to judge the degree of flexibility (Levy-Yeyati and Sturzenegger, 2003; Ghosh, Gulde and Wolf, 2003). The rationale behind this approach is that exchange rate stabilization is not observed only through movements (or lack of them) in the nominal exchange rate, but rather through monetary policy actions, especially intervention in the foreign exchange market, that are meant to moderate movements in the exchange rate. This flexibility parameter, representing shocks in demand for the currency, gives us the propensity of the central bank to let these shocks show up in the price of the currency (floating exchange rate regimes) or the quantity of the currency (fixed exchange rate regimes) or somewhere in between

(intermediate exchange rate regimes). The idea behind this is that when a shock in international demand for a currency occurs, a country's authorities will allow it to show up either as an appreciation or as an increase in foreign currency reserves (or both if the authorities allow some appreciation and some increase in foreign exchange reserves) (Girardin, 2011).

This approach can be operationalized by defining it as a variable, Exchange Market Pressure (EMP), which is the sum of the percentage change in the exchange rate and the change in foreign exchange reserves (scaled by Monetary Base or by M1 Money Supply). The theoretical foundations of EMP come from a monetary model incorporating the demand for money, its supply and relative purchasing power parity (Cavoli and Rajan, 2009). From these foundations, the following index is developed:

$$EMP = \Delta e_{it} + \left(\frac{R_{t+1} - R_t}{M1_t} \right)$$

In the index, R_t refers to Foreign Reserves at time "t," e_{it} refers to domestic currency's exchange rate at time "t" and $M1_t$ refers to M1 money supply at time "t." In the literature, an *a priori* constraint is imposed that a one percentage increase in the foreign exchange value of the currency and a one percentage increase in the supply of the currency (change in reserves as a share of monetary base or money supply, M1) have equal weights in reflecting demand for the currency (Frankel and Wei, 2008).

A glance at the various *de facto* exchange rate classifications, as mentioned earlier in Chapter 1, that used the exchange market pressure approach shows how much they disagree with each other. This reflects the lack of objectivity in this

approach in deciphering the *de facto* exchange rate regimes. So, while this exchange market pressure approach improves upon the earlier techniques of measuring flexibility from exchange rate variability, it is still not an accurate measure of inferring *de facto* flexibility of countries for several reasons.

First, this technique imposes a choice of a major currency around which the domestic country defines its value. Thus, we must make an arbitrary judgment regarding what major currency to choose. However, instead of arbitrarily deciding upon a single major currency *a priori*, it would be better to use the data to estimate endogenously what the anchor currency or basket of currencies is. So, this technique could be valid if the major anchor currency is known.

However, further analysis of this technique reveals other problems with using it alone as a measure of flexibility. For instance, countries that float, such as Canada, often use reserves in substantial magnitudes. On the other hand, countries with very firm pegs, such as Hong Kong, can have very low variability of reserves because of low variability of shocks. If we were using EMP as an indicator of *de facto* flexibility, we might reach the incorrect conclusion. Some have proposed to compare the EMP values of countries under investigation against those of “clean floaters” but that comparison will be unreasonable as it rests on the underlying assumption that all countries face uniform shocks over time. Therefore, this approach needs to be supplemented by an approach that allows us to infer implicit basket weights as well, if there are any. Thus, in the situation where the EMP indicates a strong peg, yet we can’t find significant basket weights on any potential anchor currencies, we should be very careful in drawing conclusions (Frankel and Wei, 2008).

Inferring implicit basket weights

A second stream of literature has specifically focused on inferring the anchor currencies and estimating the implicit basket weights in a country's currency basket. A technique, used at least since Haldane and Hall (1991), and popularized by Frankel and Wei (1994), has been designed for the purpose of estimating the currencies in the basket with their respective weights. The idea is to run a regression of the percentage changes in the value of the domestic currency against the percentage changes in the values of the major currencies that are potential candidates for the anchor currency or basket of currencies. Generally, the currencies are measured against an independent numeraire, which is not correlated with the values of the other currencies in the equation. Common numeraires include the Swiss franc, the Special Drawing Rights and the Australian dollar. The equation, commonly called the Frankel-Wei (FW) equation, can be represented as:

$$\Delta e_j = c + \sum_{i=1}^n a_i \Delta e_i$$

In this FW equation, “ e_j ” is the exchange rate of the domestic country, “ e_i ” is the exchange rate of potential anchor currencies and “ a_i ” is the basket weight on currency “ e_i .”

In the special case where the country that we are investigating follows a perfect basket peg, this technique is an especially effective use of the OLS regression. In this case, the fit would be perfect, the standard error of the regression would be zero, the R-squared would be 100%, accurate estimates of the weights would be

recovered and the weights would be highly significant. This can be seen in the case of pegged exchange rate regimes, such as Hong Kong's.

In the case of an intermediate exchange rate regime, the analysis is more complicated because the model does not completely predict how the domestic exchange rate will behave. However, theoretically, in an intermediate regime, the authorities monitor an index, which is often an anchor currency or basket of currencies reflecting their major economic partners, against which they allow deviations depending on macroeconomic considerations or speculative sentiments. As long as the local deviations – the error term – are uncorrelated with the values of the major currencies that are included in the equation as potential anchors, we can estimate the coefficients in the equation without any bias (Frankel and Wei, 1994). An analytical position that justifies this assumption of no correlation is based on the distance and size of economy, especially in the case of this thesis where South Asian countries are being analyzed. First, the distance between South Asia and the U.S., U.K., Europe, Japan and other countries with potential anchor currencies is significant which means that any domestic shocks or crises that affect the local country's exchange rate would be unlikely to pass on the economies of the aforementioned countries due to a lack of proximity. Secondly, a comparison of the economies of the U.S., U.K., Europe, Japan and most other major currencies that could be potential anchors, will most certainly reflect that South Asian countries have

much smaller economies whose effects are unlikely to affect the potential anchor countries.³

Thus, in the intermediate case, the weights in the basket would not reflect a basket peg, but rather would indicate the index, or reference basket, that the authorities follow closely to keep deviations to a minimum level. However, as McCauley (2001) argued that a high estimated weight on a currency, such as the U.S. dollar, does not necessarily imply that the local currency was following the U.S. dollar really closely. Instead, we must also focus on the standard errors and significance on the estimated weight to get an idea of whether the local currency was consciously following the U.S. dollar or the weights were merely market-driven correlations, as they are in the case of freely floating currencies such as the Canadian Dollar. The R-squared in this case can be taken as an indication of flexibility, where high R-squared values reflect lower flexibility and vice versa.

However, this approach to inferring implicit basket weights has its own downsides, especially in the case of intermediate regimes. While we can certainly estimate implicit basket weights in the intermediate case using the standard technique, it is hard to justify the accuracy of the basket weights obtained given that the authorities were maintaining some flexibility. As compared to the basket peg case, where the OLS estimation is remarkably apt, there will be a higher level of inaccuracy when analyzing intermediate exchange rate regimes. In the case of substantial flexibility, as often occurs in intermediate regimes, there is no theorem

³ The only exception could be India due to the size of its economy. In the case of India, the size of their economy is comparable to that of the U.K. but one could argue that the lack of proximity ensures that local shocks do not affect U.K.'s exchange rate.

that proves that the FW equation will be correctly specified, the weights accurately estimated or the R-squared an accurate and appropriate measure of the flexibility of the exchange rate regime. In particular, it is entirely possible that the R-squared value could fall because of an increase in external shocks to the economy as opposed to an increase in flexibility of the exchange rate regime (Frankel 2009). Therefore, it is difficult to maintain much faith in the results of our analysis using the FW equation in the intermediate case, which is becoming more and more popular with countries in recent times.

Synthesis Frankel-Wei Technique

Interestingly, the limitation of the implicit basket weights approach is the same as the virtue of the flexibility-parameter estimation approach and vice versa. The implicit basket weights approach is well-specified only if there is no flexibility while the flexibility-parameter estimation approach is well-specified to estimate the degree of flexibility only if the anchor currency is known. Frankel and Wei (2008) synthesize both techniques to produce an equation that is suitable to infer *de facto* regimes across a spectrum of flexibility and across a variety of potential anchor currencies. In the synthesis equation, Frankel and Wei add the EMP variable on the right-hand side of the original FW equation to produce the following:

$$\Delta e_j = c + \sum_{i=1}^n a_i \Delta e_i + EMP$$

The change in reserves is calculated as a percentage of a monetary aggregate, such as the monetary base or the money supply (M1), instead of as a percentage of

the level of reserves itself. This is because a small change in reserves, in absolute terms, for a country that holds a relatively small level of reserves could seem very large in percentage terms if we use the percentage of the level of reserves; this could mislead us into believing that a large intervention happened in the foreign exchange market. Calculating the change in reserves as a percentage of a monetary aggregate prevents this from happening. The EMP variable is constructed in a manner that a coefficient of 0 on the EMP from the regression will signify a fixed exchange rate, a coefficient of 1 on the EMP will signify a freely floating exchange rate and a coefficient in between 0 and 1 will indicate an intermediate regime. If we find the EMP variable to be insignificant then we cannot conclusively say much about the flexibility of the country. Insignificance of the EMP should not be confused with a lack of flexibility because in many specifications below, especially 2SLS, the EMP is not significant even if there is no statistically significant weight on the anchor currencies.

Since this synthesis equation allows us both to infer flexibility and to uncover the basket weights at the same time, it will be the focus of this thesis. However, results from the original FW technique will be provided in some cases for comparison.

Chapter 3 - Contentious Issues

The synthesis technique developed by Frankel and Wei is perhaps the most appropriate and relevant technique to analyze *de facto* exchange rate regimes. However, there are numerous parts of this technique that have been the subject of contention in the literature. In this chapter, the most relevant of these issues will be discussed and analyzed; this discussion will build up to the methodology that I will use in this thesis.

Data

In most cases, as long as the data is collected on a regular basis and uniformly within each source, using various sources for the data might not be a problem. However, for this thesis, the use of a common source for data of a single variable, especially exchange rate data, is of the utmost importance. As shown earlier in the FW equation and the synthesis equation, in order to analyze *de facto* exchange rate regimes, the percentage changes in the local currency are regressed against the percentage changes in the potential anchor currencies. Since exchange rates are continuously changing and are collected according to different criteria (bid, ask, middle), it is absolutely necessary that all exchange rates used in the data analysis are collected from the same data source, and that the exchange rates are collected at the same time periods, for example end of day, and using the same criteria. Otherwise, the results may be tainted by a lack of consistency in the compilation of data. Unfortunately, most economists in the literature are unclear about the source of their

data, which could perhaps be the reason why two economists using the same synthesis technique on the same data often get different results.⁴ It is entirely possible that two different data sources will provide different results, especially if we are using daily exchange rate data. This is an issue that has not been adequately addressed in the literature and it would be useful to develop some best practices for collecting exchange rate data.

In terms of best practices, there are three suggestions. First, for internal consistency of the analysis, all exchange rate data must be collected from the same source, which uses the same criteria for collecting the exchange rates. Unless there is strong reason to believe that two sources provide consistent exchange rate data, one should avoid mixing and matching exchange rate sources. If we use half the exchange rate data from the IMF and the other half from OANDA historical exchange rates, we could get inconsistent results. Even with the same source, for instance using OANDA historical exchange rates, we must make sure that we are collecting exchange rate data using the same criteria, for example bid rates. Second, for external consistency and comparability of the analysis, economists should agree upon the standard exchange rates data to use. Since exchange rate data varies by every minute and can differ largely depending on whether we are looking for bid rates or ask rates or some midpoint value, it is important to agree upon standard criteria that can be used across the literature. Otherwise, it is difficult to compare an analysis done using bid exchange rates collected at noon with an analysis done using ask exchange rates collected at the end of the day. Third, using weekly exchange rate data might be

⁴ See Frankel and Wei (2008) and Patnaik and Shah (2009)

preferable to using daily exchange rate data as the daily fluctuations, many of which may not signal movement that cause monetary authorities to intervene, are averaged out when weekly exchange rate data is used. However, one should still be cautious when using weekly exchange rate data because different sources have different methodologies of calculating weekly exchange rate data; some sources average out exchange rates for the preceding week while others average out exchange rates for three days on either side of the date. So, even though weekly exchange rate data may be an improvement upon daily exchange rate data, they are still not perfect in terms of consistency across different sources and techniques. Ideally, we should try to ensure consistency of source across all variables; however, in practice this is difficult due to the unavailability of data across sources for specific variables.

Asides from the data consistency issue, there are other arguments in favor of using weekly exchange rates. First, daily exchange rate data is known to be inconsistent across the day because of the wide fluctuations in the exchange rate throughout any one given day. Thus, depending on the period of the day from which daily exchange rate data is obtained, the results of the analysis could differ widely (Chow, 2011). Fukuda and Ohno (2006) conduct exchange rate regime analysis using exchange rate data from different times of the day and obtain results that are different enough to signal problems in making inferences from daily exchange rate data. Moreover, analysis done using daily exchange rate data reflects exchange rate policy in the very short run, where we can only infer micro-structural relationships and ad-hoc interventions to minimize volatilities as opposed to degrees of influence of anchor currencies. Second, analysis done using lower frequency data, such as

monthly data, can be misleading because exchange rates tend to drift more at lower frequencies and the limited degrees of freedom lead to higher standard errors of the coefficients, preventing much useful analysis (McKinnon, 2001). Therefore, using weekly exchange rate data seems to be the best option, given that weekly exchange rate data does not suffer from the same problems as daily or monthly exchange rate data and reflects the middle-ground between them.

Taking the aforementioned factors into account, this thesis will use weekly exchange rate data from OANDA Historical Exchange Rates to conduct all relevant analyses. One additional reason for skipping analysis using daily exchange rate data is the difficulty in obtaining reserves and monetary aggregate data on a daily basis; the data are in fact available on a monthly basis and it is only through interpolation that weekly data will be obtained. Therefore, interpolating to obtain daily data would give very inaccurate results. This is discussed further in the “Exchange Market Pressure” section below.

The primary reason for using OANDA Historical Exchange Rates is its ability to provide consistent and high-quality exchange rate data on a daily, weekly and monthly basis with different numeraires. Therefore, results using various frequencies of exchange rate data will be consistent. Other options for data sources included the IMF and the European Central Bank. However, IMF only provides monthly exchange rate data for all countries; for some countries it does provide weekly and daily exchange rate data, however, that does not cover the South Asian countries. Similarly, the European Central Bank provides daily exchange rate data for many countries but the data extends back to only 2000, thus limiting our sample size, and the data is

expressed with the Euro as the numeraire. Merely multiplying different exchange rates to get different numeraires will be inconsistent as each bilateral exchange rate is calculated in a specific way that does not allow for direct interchangeability using simple cross-multiplication.

Since one goal of this thesis is to analyze the impact of the Global Financial Crisis on the exchange rate policies of South Asian countries, the data range will be from January 1999 to January 2012. The primary reason for choosing January 1999 as the starting point is because the Euro would have been introduced by then and any effects of the Asian financial crisis on the regional currencies would have waned out. The crisis periods themselves have not been precisely defined by the literature and different economists use various time periods. I will use the dates for the crisis periods that have been used most often in the literature.

Levels or first differences?

Since the exchange rate data follows a non-stationary process, the literature recommends a clean way to solve that problem by using differenced exchange rate data. Using differenced data also allows one to account for trend appreciation or depreciation, which has been common for countries in Latin America and China, by simply including a constant term in the regression analysis (Frankel and Wei, 2008).

On the other hand, there has been opposition to this approach by those who argue that actual policy is likely to consider the level of exchange rate as opposed to first differences. To substantiate that claim, Moosa (2009) argues that the U.S. Dollar to Special Drawing Rights (SDR) exchange rate is written in levels by the IMF and

the Central Bank of Kuwait also uses levels to calculate its basket peg. However, these examples are unconvincing. The IMF's approach to calculating the U.S. Dollar to SDR exchange rate is hardly representative of the approach of most central banks as the SDR is a special currency constructed by the IMF. Therefore, it is hard to generalize from the example of the SDR. Furthermore, the Central Bank of Kuwait is an isolated example out of hundreds of countries. So it is possible that the Central Bank of Kuwait may be an outlier than the representative example. In fact, in an interview with an official from the State Bank of Pakistan, I learned that the State Bank of Pakistan uses differences in calculating its basket peg. Until a complete and thorough analysis is done of the policy that central banks apply, in terms of using levels or differences, it will be hard to reach any conclusions on this subject and any hypothesis will likely be merely a conjecture. With that said, since authorities are likely to judge deviations, it is just as reasonable to argue that they are using first differences as opposed to levels in judging those deviations.

In any case, if the data are in levels, the non-stationary problem must still be dealt with. A solution proposed is to use fully-modified OLS; however, the fully-modified OLS technique does not allow us to deal with the serial correlation that arises. So, aside from the loose theoretical underpinnings of the argument for using levels, the use of levels is most likely going to lead to inaccurate results due to the inability of the fully-modified OLS to deal with serial correlation and a lack of other available techniques to deal with the problem of non-stationary processes. Therefore, this thesis will stick with the convention and use differenced data in the analysis

because the argument for differenced data is based on sound theory and fulfills the practical need to get rid of non-stationary processes.

Numeraire

Perhaps the most debated issue in the context of using the FW technique and the synthesis technique has been the question of defining the numeraire against which the exchange rates are expressed. In a perfect basket peg, the choice of numeraire does not matter. However, for intermediate regimes and freely floating exchange rates, the choice of numeraire can have a significant impact. Past studies have used a variety of numeraires, including the U.S. Consumer Price Index (CPI), SDR, Swiss franc, U.S. dollar and Australian dollar (Frankel and Wei, 1994).

More recently, the debate has narrowed down into two viewpoints. The first argues that a remote currency like the Swiss franc or the Australian dollar should be used as a numeraire as it is not linked with most of the potential anchor currencies in any basket and has a low correlation with them. Critics of the Swiss franc idea argue that it is linked with the Euro and U.S. Dollar (Fidrmuc, 2010). This means that the U.S. Dollar and the Euro would have low variance in the equation and could be confused with the constant term. A simple correlation test, using a remote numeraire like the Canadian Dollar, shows us that while the correlation between the Swiss franc and the Euro is high, the correlation of the Australian dollar with anchor currencies is low. These results are more fully expressed in the results section.

The second view, promoted recently by Frankel and Wei (2008), claims that a weighted average of major world currencies, such as the SDR, should be used as the

numeraire. Their argument rests upon the background that in the intermediate case, authorities measure deviations against a reference point or weighted average in order to constitute what a large deviation is that warrants intervention in the foreign reserves market. So, authorities are less likely to use the Swiss franc or Australian dollar in thinking about deviations and are more likely to use a weighted average of major currencies. If we use a similar measure as a numeraire as the authorities do, then we will be able to minimize the correlations between the error term and the numeraire. However, there are several problems with this argument. First, as Benassy-Quere and Coeure (2000) showed in their seminal paper on *de facto* exchange rate analysis, using a basket of currencies in the numeraire could be highly problematic because if the potential anchor currencies are prominent in the numeraire, the right-hand side of the equation can be insignificant even when the local currency is not pegged to the numeraire. Furthermore, the SDR would naturally have a higher correlation with most of the major currencies, which are coincidentally the potential anchor currencies in most cases too as will be shown later; this could lead to inaccurate results as compared to results obtained using the Australian dollar as a numeraire because the Australian dollar is shown to have a lower correlation with the potential anchor currencies. Second, Frankel makes the assumption that authorities are more likely to follow a weighted average of major currencies. While the argument is reasonable, no evidence is cited for it. Perhaps, this assumption may be true for some authorities but not for others. It is equally reasonable to assume that some countries measure deviations against a remote international currency such as the

Australian dollar because it is easier to measure and monitor than a weighted average of major currencies.

Furthermore, even if we do acknowledge the fact that the countries are measuring deviations against a weighted basket of currencies, it is difficult to recognize what the weighted basket of currencies is. For countries in East Asia, the weighted basket might include the Yen, the U.S. Dollar, Euro and Chinese Yuan but might not include the British Pound, while for countries in Africa, the weighted basket might include the U.S. Dollar, Euro, British Pound but might not include the Japanese Yen or Chinese Yuan. Third, exchange rate data against SDR are available from the IMF on a monthly basis for most countries, and on a weekly basis for only a few countries, which does not include most South Asian countries. This will be problematic for the analysis as it means that exchange rate data for other currencies must be compiled using different data sources. As mentioned in the earlier section on Data, there are severe problems with this approach.

Keeping the aforementioned arguments in mind, I use the Australian dollar as the numeraire in this analysis. In any case, Frankel has demonstrated that the results of the *de facto* exchange rate regime analysis are generally robust to changes in numeraire.

Choosing anchor currencies – discussion of vector

autoregression (VAR)

Building on the discussion on the rationale behind the choice of anchor currencies, this section will discuss the potential anchor currencies chosen in the literature on the *de facto* regime analysis. Using a similar argument as Kawai and Takagi (2001), much of the literature includes the G3 currencies as potential anchor currencies: U.S. Dollar, Euro and Japanese Yen. Such a currency basket system is known to provide the relevant flexibility and stability needed to promote international trade and foreign direct investment. There is a general, implicit consensus that the G3 currencies should be included as anchor currencies in any *de facto* regime analysis.

Given that 97.8% of the world's reserves have been held in the U.S. Dollar, Euro, Yen and British Pound since 2000, some authors have included the British Pound as a potential anchor currency in addition to the G3 currencies (Patnaik et al., 2011). Other major trade partners could be potential anchor currencies as well, but if the trade is denominated in dollars or another major currency, as it is mostly, then in that case the trade partner might not be a potential anchor as the home currency benefits from stabilizing its exchange rate against the currency in which the trade is denominated.

In addition, the literature on *de facto* regimes in East Asia shows a trend among East Asian countries to put weight on the currencies of regional countries (Frankel, 2009). Due to high levels of intra-regional trade and export competition, the countries have an incentive to maintain low bilateral exchange rate volatility amongst

each other. This could be the case for South Asian countries too, so we must analyze whether regional currencies play an important role in the currency baskets of South Asian currencies. In the literature, most attempts to analyze the weights on regional currencies have focused on including the regional currencies' exchange rates on the right hand side of the FW Synthesis equation (Frankel, 2009). For instance:

$$\Delta e_j = c + \sum_{i=1}^n a_i \Delta e_i + EMP + RC_i$$

In this equation, RC_i refers to regional currency "i."

However, such an approach leads to biased results because there is naturally going to be a correlation between the error terms, which represent shocks in demand for currency, and the regional currency because shocks in demand for local currency could pass on to other regional currencies as well. To avoid this problem, this thesis will use Vector Auto-Regression (VAR) analysis to analyze whether regional currencies have an effect on each other's exchange rate policy.

Exchange Market Pressure

As mention earlier, the Exchange Market Pressure (EMP) variable has been constructed as a measure of flexibility in the FW synthesis equation. Due to the nature of the variable, there have been several concerns raised about its validity.

The first critique of the EMP is its exclusion of interest rates, which could possibly be a policy variable used by the authorities when they intervene. However, there are two strong reasons for its exclusion. First, market interest rates for most

countries are unavailable. Second, as Bayoumi and Eichengreen (1998) argue, it is difficult to tell whether interest rate variations are being driven by the market or by policy intervention. Therefore, interest rates are excluded from the EMP variable in the analysis. In any case, Frankel and Wei (2008) have shown that the results are robust to the inclusion of interest rates in the EMP variable for several countries, which can be taken as further reassurance.

In terms of the EMP variable, it is suggested to use the monetary base or another monetary aggregate to scale the change in reserves. Due to the unavailability of monetary base data for all South Asian countries, I will use M1 money supply as the monetary aggregate to scale the change in reserves. A caveat to this is the fact that reserves and money supply data are available only on a monthly basis from 1999 forward. This has an important implication. When conducting the analysis, the weekly reserves and money supply data will need to be obtained from a straight-line interpolation in between months. This suggests that there could be inaccuracies due to the interpolation of the EMP variable.

Since we are primarily interested in the management of the volatility of the exchange rate as opposed to the management of the value of the exchange rate, the effects of possible reserve accumulation by central banks that do not affect the daily management of the volatility of exchange rate need to be removed. Such reserve accumulation is happening in several Asian countries, including Korea (Cavoli and Rajan, 2005). We can account for this reserve accumulation by adjusting for the trend using a Hodrick-Prescott (HP) filter technique. This thesis accounts for the HP filtered trend, but we find largely similar results using the simple reserve measure and

the HP-filtered reserve measure. Therefore, in the thesis, only results for the analysis conducted using the normal reserve measure will be reported.

Perhaps the biggest concern with the use of the EMP variable is the possible endogeneity of the EMP variable. Through our current EMP variable, we are capturing changes in the international demand for the local currency from both endogenous and exogenous shocks; however, our goal is to capture only those changes in the international demand for the local currency that originate in exogenous shocks. This can be done through instrumental variable analysis for countries that specialize in the production of mineral or agricultural products. The world price of the mineral or agricultural product is a ready-made instrumental variable, assuming that the local country is too small to affect the world price, which appears true in most cases in my sample (Frankel and Wei, 2008). Thus, as part of the analysis, Instrumental-Variable analysis will also be done through Two Stage Least Squares to give us further insight into the *de facto* exchange rate regimes of South Asian countries.

A final limitation of using the EMP that should be kept in mind is the difficulty in separating the reserve changes due to policy intervention and the reserve changes due to changes in currency valuation. Ideally, we should exclude the effects of currency fluctuations before the analysis; unfortunately, this is not possible because countries do not report data on the currency composition of reserves (Cavoli and Rajan, 2006). Therefore, this could impact the precision of results in some cases.

Endogeneity of coefficient weights

Notice that in our case the potential anchor currencies are exogenous variables, but we are concerned that the coefficient on the U.S. dollar is endogenous because it is possible that the authorities might use the changes in reserves as a way to infer whether they should change the coefficient weights or not. For instance, in the situation where there is a reserves crisis, the authorities might shift the basket weights. Similarly, constant pressure on the reserves may cause authorities to change the weights with the realization that their previous basket weight choice was incorrect. This means that the basket weights could be a direct function of the exchange market pressure, which implies that the basket weights are endogenous.

There are two solutions for this. First, we could account for structural breaks endogenously using the Bai-Perron Structural Breaks method. This would mean that any shifts in exchange rate regimes or policies would be captured by the Structural Breaks method and it would be reasonable to assume relative consistency of the basket weights in the time periods between structural breaks. Therefore, if basket weights are relatively consistent within the time periods, there is no reason to be concerned about endogeneity of the basket weights. The other solution, if we do not account for structural breaks is to use interaction terms in the regression. Here is the reasoning behind this assertion.

Assume that the coefficient on one of the anchor currencies is endogenous and determined by the EMP variable (in other words, it is a function of the EMP variable). For a FW regression:

$$\Delta e_j = c + a_u \Delta e_u + b(EMP) \text{-----} \textbf{(Equation 1)}$$

For a linear relationship, an equation to represent the weight on an anchor currency is:

$$a_u = k + m(EMP) \text{-----} \textbf{(Equation 2)}$$

This means that the coefficient on the anchor currency is dependent upon the EMP. Substitute Equation 2 into Equation 1.⁵

$$\Delta e_j = c + (k + m(EMP))\Delta e_u + b(EMP)$$

$$\Delta e_j = c + k\Delta e_u + m(EMP)\Delta e_u + b(EMP)$$

The simple solution to this problem where the coefficient on the U.S. dollar may be dependent on another independent variable is to use interaction terms in the regression analysis. Thus, this thesis will use interaction terms to account for potentially endogenous coefficients.

⁵ Please refer to Wooldridge (“238,” 2006) for further discussion on this.

Time-varying parameters or structural breaks?

A limitation of the FW Synthesis technique is that countries often switch weights in their currency baskets and even their currency regimes every few years. The clearest example of that is that of Chile, which changed parameters 18 times from September 1989 to September 1999. Since parameters can change randomly and frequently, there needs to be a way to capture the change in parameters. Many existing studies have responded to this challenge by estimating time-varying weights using sub-samples and rolling regressions (Frankel and Wei, 2008). Such a technique allows us to test the volatility of a coefficient over time and gives us greater insight into the behavior of the authorities and central bank. A smooth coefficient over time with little volatility indicates conscious effort and intervention on the part of the central bank to maintain the degree of influence of the anchor currency. On the other hand, a high coefficient that is highly volatile over time indicates that any strong correlation between the home currency and anchor currency could be the result of purely market conditions, trader behavior and noise. With that said, the rolling regression technique is subject to a number of criticisms. First, it suffers from information inefficiency due to short samples and biased estimates due to the uncertainty in subsample division. For instance, if a regime switches from fixity to flexibility, a smoothed change and abrupt break can happen in the process so that the constant coefficient model becomes a biased estimator. Since structural changes are artificially smoothed, this approach can result in higher and correlated errors from the regression (Fang et al., 2012).

More recently, the use of Recursive Least Squares and the Kalman filter has become more popular, as these processes are not prone to the same problems as rolling regression analysis. The Kalman Filter is a technique where coefficients are estimated as time-varying parameter processes following a random walk.

The recursive least squares approach is a special case of the Kalman filter. However, if we account for structural breaks in the equation, then we can assume that the parameters are not varying every other week, which the Kalman filter implies. So, as long as we divide the sample into sub-samples based on the structural breaks, the weights on the anchor currencies will be stable and using a Kalman filter with a random walk, as Fidrmuc (2010) does, could lead to inaccurate results.

While recursive least squares regression and the general Kalman Filter allow us to understand how parameters change but they do not provide us with inference on determining the dates of the structural changes in the regimes or parameters. Not accounting for the structural changes could actually lead to autocorrelation of residuals, a serious problem in any analysis. If the date of structural change of the exchange rate regime is available, a Chow test would be sufficient; however, in most cases the date of the structural change is unavailable and it must be determined endogenously. In such cases, the Bai-Perron structural breaks analysis technique is very useful as it determines the dates for structural changes in exchange rate regimes endogenously. For robustness, the dates obtained from the Bai-Perron analysis are cross-checked with a number of other structural break techniques, including the Chow Test and the Quandt-Breakpoint Test.

Do the coefficients add up to 1?

In terms of a country's currency basket, Frankel and Wei (2008) make the case that the weights on the anchor currencies should add up to one; they argue that the authorities are likely to view the weights as fractions that collectively add up to one, for easy reference. Thus, they propose subtraction of the British pound returns from currency returns on both sides of the equation to ensure the coefficients sum to one. However, instead of imposing the constraint, the validity of this constraint, that coefficients add up to one, must be assessed through the Wald Coefficient Restriction Test before the constraint is imposed. In certain cases the Wald Coefficient Restriction Test rejects the constraint, which means that we should not *a priori* impose a constraint. This is because imposing the constraint may lead to results that are significantly different from those obtained without imposing the constraint. Supporters of the theory that the coefficients must add up to one argue that if the constraint is rejected, it is probably because the FW regression missed out on some important potential anchor currency. Even if that is the case, since we do not know what that potential anchor currency is, we should not impose the constraint.

Moreover, two further problems are associated with imposing the constraint. First, on a theoretical level, it is hard to understand why the authorities would choose the coefficients to add up to one, as opposed to 0.5, 2 or 10. There does not seem to be a convincing argument behind it, other than that suggestion that 1 is an easy reference point. Second, if we assume *a priori* that the coefficient weights add up to 1, but in reality the *de facto* exchange rate regime is floating, in that case the

constraint is meaningless and could actually bias the results. Therefore, in this thesis, before any constraint is imposed, its validity is checked for theoretically and empirically. Seeing no basis for the restriction, the analysis in this thesis does not impose any constraints on the coefficients.

Serial Correlation

As Wooldridge (“428,” 2006) discusses, in the presence of serial correlation the OLS is inefficient, causing its standard errors and t-statistics to be misleading (however, OLS may still be unbiased or at least consistent). Assuming that the model is correctly specified, there are two approaches that we can take here, each with different virtues:

- The Feasible Generalized Least Squares (FGLS) technique can account for serial correlation in the equation and is generally more efficient than OLS if serial correlation is present. However, if any of the explanatory variables are not strictly exogenous (e.g EMP) then FGLS is not consistent, let alone efficient. Therefore, FGLS offers no advantage over OLS in the case where any of the explanatory variables may not be strictly exogenous. Also, in FGLS, we assume that the errors follow an AR(1) model, which may not be true in all cases.
- Heteroskedastic-Autocorrelation-Consistent (HAC) standard errors provide efficient standard errors robust to serial correlation even in the presence of potentially endogenous variables or higher order serial correlation processes.

Thus, in this case it seems like FGLS will not even be consistent due to the endogeneity of the explanatory variables (EMP), so we might be better off using HAC-standard errors.

If we assume that our model is incorrectly specified, then the question is a little more difficult to answer because then OLS may be biased in itself (but it could still be consistent). Regardless, FGLS will not be consistent or efficient because of the endogenous explanatory variable. So there are reasons to prefer OLS here as well (with or without HAC is another question), but this case is less conclusive.

In general, we have reason to believe our model is well-specified as mentioned above, so we will use OLS with HAC standard errors.

Further considerations

As discussed earlier, while the adjusted R-square value is not necessarily a measure of flexibility in the original FW regression, let alone with the inclusion of the EMP in the synthesis equation, the adjusted R-squared is the traditional measure of the goodness-of-fit. But in two special cases, it is difficult to make any inferences from the adjusted R-squared value: first, in the case of Feasible Generalized Least Squares (FGLS), which is used to correct for serial correlation, and second, in the case of an Instrumental Variable Regression.⁶ Unfortunately, the literature has continued to use the adjusted R-squared from such regressions to make inferences. This practice should be discontinued. In this thesis, the adjusted R-squared will not be used as a measure of goodness of fit for Instrumental Variable regression because

⁶ Refer to Wooldridge ("417" and "516," 2006)

under Instrumental Variable regression, the adjusted R-squared has no natural interpretation as will be discussed in the Chapter 5.

Moreover, a lingering problem in the literature has been that of serial correlation in the FW regressions. Many authors have not accounted for the serial correlation, as is evident from the Durbin Watson statistics reported in their papers, while others do not mention such statistics at all, which leaves it ambiguous as to whether the problem of serial correlation has been addressed or not.⁷ In this thesis, serial correlation will be addressed by using HAC errors. OLS-HAC is preferred over FGLS because EMP is potentially endogenous and we are unsure of the type of serial correlation present. Thus, if used, FGLS may be inconsistent and inefficient. Using OLS with HAC will provide greater efficiency for all kinds of autocorrelation even in the presence of a potentially endogenous variable.

Finally, one of the purposes of this analysis is to put the results in the context of a country's actual situation. Thus, a conscious effort will be made throughout this thesis to relate the results obtained from the *de facto* regime analysis to the geopolitical and economic situation of the home country.

⁷ See Frankel and Wei (2008) and Cavoli and Rajan (2010)

Commodity Prices as instruments for South Asian countries

Considering the potential endogeneity of the EMP variable in the FW synthesis equation, as discussed in the last chapter, it is important to identify agricultural or mineral commodities whose production each South Asian country specializes in, so that their world prices could be used as instrumental variables in the various country-specific regressions. Assuming that a country is too small to affect the world prices of the commodity, which is a fair assumption in most cases except perhaps the case of Saudi Arabia and oil, changes in the world prices will produce exogenous shocks in demand for the local currency. Therefore, commodity prices are natural instruments for EMP.

To find relevant commodities for South Asian countries, I analyzed the export structure of each country and chose to use the commodity price of each country's major export. In case, a country has multiple major export commodities, any one of them could be reasonably used as an instrument. Table 3.1 shows the commodities that reflect major exports of each country.

Table 3.1

Country	Commodity
Afghanistan	Cotton
Bangladesh	Fish Products
Bhutan	Wood pulp
India	Iron and Steel
Pakistan	Cotton
Maldives	Fish Products
Nepal	Tea
Sri Lanka	Tea

Source: U.S. Department of State – Background Notes

In this chapter, I have provided a comprehensive overview of the various contentious issues in the literature, and my own analysis on those issues. Keeping the conclusions that were drawn on each contentious issue in mind, I will now proceed to discuss the data and empirical strategy for the exchange rate regime analysis.

Chapter 4 - Data and Methodology

Data

The data used in this thesis are described in Table 4.1 below:

Table 4.1

Name	Time Period and Frequency	Unit	Source
Exchange Rate Data	January 1 st 1999 – February 28 th 2012 (Weekly Exchange Rates)	Various numeraires including Swiss franc, Australian dollar, and Canadian Dollar.	OANDA Historical Exchange Rates
Foreign Exchange Reserves	October 1999 – January 2012 (Monthly)	Swiss franc and Australian dollar	IMF
Money Supply (M1)	October 1999 – January 2012 (Monthly)	Swiss franc and Australian dollar	IMF
Commodity Prices	October 1999 – January 2012 (Monthly)	Swiss franc and Australian dollar	World Bank

As mentioned in Chapter 3, Exchange Rate Data is obtained from OANDA Historical Exchange Rates as it provides consistent, high-quality and multiple-frequency exchange rate data against various numeraires for extended time periods. The start date is imposed due to the unavailability of the Euro prior to that and to ensure that any effects of the Asian financial crisis had waned out. Exchange Rate data is collected on a weekly basis. The weekly exchange rate will be used in most of

the analysis in the next section. Furthermore, the exchange rate is collected against various numeraires for multiple purposes:

- a. Exchange Rate data with the Australian dollar as numeraire will be used in main analysis.
- b. Exchange Rate data with the Canadian dollar as numeraire will be used to check for the correlation of the Swiss franc and Australian dollar with South Asian currencies and potential anchor currencies in their currency basket.

For the Foreign Exchange Reserves and Money Supply, data are collected from October 1999 due to the unavailability of data before that. Since monetary base data is unavailable, I use M1 Money Supply as the monetary aggregate to scale the changes in reserves. The IMF is used as the data source due to the high reliability of IMF Data. Unfortunately, both Foreign Exchange Reserves and Money Supply data are only available on a monthly basis, therefore it is interpolated to obtain weekly data.

Commodity Prices data are available for a surprisingly longer period of time, but the start date is naturally matched with the foreign exchange reserves and money supply data as the commodity prices will act as instruments for them. As with before, the commodity prices are only available on a monthly basis from our source, the World Bank, which is used for its reliable data; therefore the prices are interpolated to obtain weekly data.

Despite the discussion on the best practices in choosing data in the last chapter, I have collected data for each variable from a different source. This doesn't contradict

the earlier argument about consistency in choosing data. First, the major argument was that there should be consistency in collecting data for a specific variable. This is to ensure that the method and timing of calculation remains consistent across our sample, which would not be the case if we collect half the data for a variable from one source and the other half from another source. Such consistency is ensured in this thesis. Second, in an ideal scenario, all variables should come from one source but due to the unavailability of data across sources for specific variables, this becomes difficult to ensure.

Bhutan will not be included in the analysis because the Bhutanese ngultrum does not exchange independently with other countries' currencies but is interchangeable with and equal in value to the Indian rupee. Thus, conducting any regime analysis in Bhutan's case will be redundant.

Time Period

The time range for the data is from January 1st 1999 – February 28th 2012. There are two distinct approaches that will be taken to the time period: (each approach is labeled from 1 to 2)

1. The overall time period will be divided into multiple sub-samples to represent the global financial crisis periods:
 - a. Pre-Global Financial Crisis (1999-2007)
 - b. Global Financial Crisis (2007-2008)
 - c. Post-Global Financial Crisis (2009-2012)

This will enable us to isolate the effects that the Global Financial Crisis had on the *de facto* exchange rate regimes of South Asian countries.

2. The structural break analysis techniques will allow us to identify the dates of shifts in parameters and exchange rate regimes of each South Asian country. Using the date of each shift, we can divide the overall time-period into sub-samples; this will ensure that each sub-sample will represent a single exchange rate regime without any shifts in parameters or regimes, and will allow us to estimate consistent results in each smaller time period.

However, the VAR will be run on the entire sample for reasons discussed later.

Numeraire

When choosing the numeraire, the rationale is to choose a numeraire that has the lowest correlation with the currencies being used in the regression analysis. A high correlation between the numeraire and a potential anchor currency could lead to limited variation in the potential anchor currency, leading to inaccurate results.

Therefore, before any other analysis, I will check for the correlation of both the Australian dollar and the Swiss franc with other currencies relevant for our analysis, using the Canadian dollar as the numeraire.

Methodology – VAR

One of the findings in the literature on East Asian exchange rate regimes suggests that countries in a region have a substantial effect on each other's exchange rate choices. For instance, as Frankel (2009) shows, Malaysia features prominently in the basket of currencies of countries such as China. Therefore, before moving on to the FW Regression Analysis, it is important to analyze the effects of regional currencies on each other's exchange rate regimes.

One approach to analyze this is to use VAR analysis to see how changes in one currency's exchange rate are related to other regional countries' currencies. For the VAR, I will run the following regression:

$$y_t = A_1(y_{t-1}) + A_2(y_{t-2}) + \dots + A_p(y_{t-p}) + \beta(x_t) + \varepsilon$$

In the VAR, “ y_t ” represents a matrix comprising of domestic exchange rates regressed on its lagged values and on “ x_t ” which represents a matrix comprising of exogenous exchange rates. The VAR will be run on the entire sample to give us a general idea of the relationship between different currencies. Dividing the VAR sample by crisis periods will be an ad-hoc approach, because there is no reason to believe that the interdependence of regional currencies changed in times of crisis. Meanwhile, since the VAR is the pre-cursor to the FW regression, it does not make sense to use structural breaks to identify different time periods because the structural breaks depend on the FW regression. Thus, the VAR will be run on the entire sample.

In the VAR, through a combination of Impulse Response functions and Variance Decomposition results, we can deduce the effect of regional currencies on each other's exchange rate choices.

De facto regime analysis

For each country, three types of analysis will be run:

- a. Original FW regression – labeled as OLS (1)
- b. Synthesis FW regression – labeled as OLS (2)
- c. Synthesis FW Instrumental Variable Regression – labeled as IV

Each of these techniques is discussed in detail below.

Original FW Regression

For each country, we will run the original FW regression of changes in local currency against changes in the currencies of potential anchors. Given the prominence of the U.S. Dollar, British Pound, Euro and Japanese Yen as global reserve currencies, they will be included in every regression analysis. In addition, countries identified by the VAR technique will be also included in the relevant currency basket.

The regression will be:

$$\Delta e_j = c + \sum_{i=1}^n a_i \Delta e_i$$

Synthesis FW Regression

The synthesis FW regression technique allows us to infer flexibility and *de facto* basket weights simultaneously. As with the original FW regression, this will be

run on currencies of potential anchors and the exchange market pressure of the local currency. The regression will be:

$$\Delta e_j = c + \sum_{i=1}^n a_i \Delta e_i + EMP$$

However, as discussed previously, there is a possibility that the basket weights (coefficients) can be endogenous with the exchange market pressure. Due to the possible endogeneity of the exchange market pressure variable, we have to deal with this issue. In the time periods using structural breaks, there is reason to believe that the weights will be consistent between the breaks. Thus, it does not pose a problem in that case, because in that case the FW synthesis equation is a locally useful solution. But, in the case where we use time periods divided by crisis, we need to resolve this issue because it is possible that the weights may be a function of the exchange market pressure. An easy way to resolve this, as mentioned earlier, is to add interaction terms of the basket currencies and the exchange market pressure. Therefore, in addition to running the simple synthesis FW regression mentioned above, the following regression will be run:

Synthesis FW Regression (Instrumental Variable)

Given the endogeneity of the exchange market pressure variable, there is a need to use two stage least square (2SLS) analysis to instrument for it. As mentioned earlier, for countries that specialize in the production of an agricultural or mineral commodity, a natural instrumental variable is the world commodity price for the specific commodity the country specializes in. Using this insight, I will use 2SLS

regression. If we account for the endogeneity of the exchange market pressure, then we do not need to add interaction terms, so we will build this upon the simple FW Synthesis Regression technique. In the first stage, the instruments will be checked for significance and in the second stage, IV estimation results will be obtained.

For each of the regressions, tests will be performed to check for serial correlation and heteroskedasticity. If both are found, or even if only serial correlation is present, I will account for it by using HAC errors in the regression. Finally, in order to check if we need the instrumental variable regression, the regressor endogeneity test will be performed on the EMP variable.

Chapter 5 - Results

Initial Results

The augmented Dickey Fuller (ADF) test performed on the initial series confirms the presence of unit root in the levels exchange rate. However, we can reject the null hypothesis of a presence of unit root at the 1% level for exchange rates in first differences. Therefore, as hypothesized earlier, we will proceed to use logged-first differences for the exchange rate data. Detailed results for the ADF test are in the appendix.

As mentioned earlier, it would be best to use a numeraire that is not highly correlated with the exchange rates being used in the analysis. Two potential numeraires are the Australian dollar and the Swiss franc. Some authors have recently argued that the Swiss franc has in fact become relatively stable vis-à-vis the Euro. A correlation test of all exchange rates in the series with the Australian dollar and the Swiss franc, using the Canadian dollar as the numeraire, confirms this. The results are compiled in Table 5.1. From Table 5.1, it is clear that the Swiss franc is highly correlated with three of the four potential anchor currencies, as indicated by the shaded cells in Table 5.1. In contrast the Australia dollar is not highly correlated with any of the currencies in the analysis. Therefore, I will proceed to use the Australian dollar as the numeraire for the purposes of this thesis.

Table 5.1

	AFG	BAN	EUR	GBP	IND	JAP	MAL	NEP	PAK	SRI	USD
AUSD	0.05	0.02	0.39	0.32	0.17	0.02	-0.02	0.12	0.05	-0.01	-0.01
CHF	0.01	0.44	0.86	0.64	0.39	0.56	0.39	0.42	0.41	0.43	0.49

Key:

AFG – Afghanistan **BAN** – Bangladesh **EUR** – Euro **GBP** – Great Britain Pound

IND – Indian Rupee **JAP** – Japanese Yen **MAL** - Maldivian Rufiyaa

NEP - Nepalese rupee **PAK** – Pakistani Rupee **SRI** – Sri Lankan Rupee

USD – United States Dollar **AUSD** – Australian Dollar **CHF** – Swiss Franc

VAR

As a first step, vector auto-regression analysis is performed to understand intra-regional exchange rate dependency in South Asia. All regional currencies are used as endogenous variables to identify any possible relationships between them.

Lag values are chosen based on Akaike and SIC criteria. The LM Residual Serial Correlation test confirms the absence of serial correlation. In terms of the analysis, the focus is on the variance decomposition results and the impulse response functions.

Starting off with the variance decomposition results, they show us that the forecast error variance for Nepal can be predicted by shocks in the Indian exchange rate. This suggests that the Indian Rupee is a potential anchor currency for the Nepalese Rupee, and thus, the Indian Rupee will be included in the regression analysis involving the Nepalese Rupee. For all other currencies, there seems to be no relationship between error forecast variance of one country and shocks in the

exchange rate of another regional country. Detailed results of the variance decomposition are attached in Table 5.2.

Table 5.2

	Time Period	IND	PAK	AFG	BAN	SRI	MAL	NEP
AFG	1	0.05	0.06	99.89	0.00	0.00	0.00	0.00
	5	0.07	0.24	99.20	0.00	0.01	0.35	0.04
	10	0.07	0.24	99.20	0.00	0.01	0.35	0.04
BAN	1	0.27	0.68	0.00	99.05	0.00	0.00	0.00
	5	0.31	0.69	0.06	97.41	0.78	0.35	0.29
	10	0.31	0.69	0.06	97.41	0.78	0.35	0.29
IND	1	100.00	0.00	0.00	0.00	0.00	0.00	0.00
	5	96.43	0.82	0.04	0.69	1.71	0.03	0.02
	10	96.42	0.82	0.04	0.69	1.71	0.03	0.02
MAL	1	0.00	2.74	0.01	0.03	0.14	97.06	0.00
	5	0.07	2.93	0.13	0.08	0.36	95.59	0.28
	10	0.07	2.93	0.13	0.08	0.36	95.58	0.28
NEP	1	38.26	0.01	0.01	0.76	0.03	0.06	60.86
	5	39.97	0.52	0.06	1.86	1.08	0.27	55.96
	10	39.97	0.52	0.06	1.86	1.08	0.27	55.96
PAK	1	1.12	98.88	0.00	0.00	0.00	0.00	0.00
	5	1.70	95.70	0.11	0.86	0.66	0.29	0.54
	10	1.70	95.70	0.11	0.86	0.66	0.29	0.54
SRI	1	0.66	0.56	0.00	0.00	98.78	0.00	0.00
	5	0.77	0.58	0.01	3.09	94.85	0.53	0.13
	10	0.77	0.58	0.01	3.09	94.85	0.53	0.13

In most cases, we only do not see signs of interdependency in the regional currencies, except in the case of Nepal. Furthermore, the impulse response functions show how a currency responds to shocks in other regional currencies. Our earlier hypothesis on the relationship between the Indian rupee and Nepalese rupee is confirmed by the impulse response functions, as the currency respond actively to shocks in the Indian rupee. The impulse response function of Nepal is attached below. For comparison the impulse response function of Sri Lanka is attached as well. All other impulse response functions are added in the appendix.

Approach to analyze results

In the approach to the results of the regression analysis, a structured approach will be used to interpret the results. The approach will be different for the crisis-based samples and the structural breaks-based samples.

For the crisis-based samples, the following approach will be used:

- a. For each country, analysis will be performed using:
 - i. Original FW Regression labeled OLS (1)
 - ii. Synthesis FW Regression labeled OLS (2)
 - iii. Synthesis FW Regression with interaction terms labeled OLS (3)
 - iv. IV Regression labeled IV
- b. The Original FW OLS is included for reference but will not be discussed as the Synthesis FW is superior to it. Due to a lack of space to present results, and prioritizing the other regressions, the results for OLS (1) are not reported for the regressions by crisis.
- c. OLS (2) and OLS (3) will be compared. If the results are consistent, then OLS (2) will be used as it would mean that adding interaction terms did not affect results. However, if both OLS (2) and OLS (3) give different results then further discussion will take place.
- d. OLS (2) and OLS (3) will also be compared with the IV results. If the IV results are different, again there will be further discussion.
- e. The effect of the Global Financial Crisis on South Asian exchange rate regimes will be analyzed using earlier discussion.

- f. A broader interpretation of the effects of the Global Financial Crisis on South Asia will be developed.

For the structural breaks-based samples, the following approach will be used:

- a. For each country, analysis will be performed using:
 - i. Original FW Regression labeled OLS (1)
 - ii. Synthesis FW Regression labeled OLS (2)
 - iii. IV Regression labeled IV
- b. The Original FW OLS is included for reference but will not be discussed as the Synthesis FW is superior to it.
- c. OLS (2) and OLS (3) will be compared. If the results are consistent, then OLS (2) will be used as it would mean that adding interaction terms did not affect results. However, if both OLS (2) and OLS (3) give different results then further discussion will take place.
- d. OLS (2) and OLS (3) will also be compared with the IV results. If the IV results are different, again we will need further discussion.
- e. Using the regression results and coefficient weights, I will check the size of the band around the basket-predicted exchange rate, within which the central bank authorities allow the actual exchange rate to float.
- f. A general understanding of the exchange rate regimes of South Asian countries will be developed using earlier analysis.
- g. The exchange rate regime of each South Asian country will be compared to each other, so that we can see if implicit exchange rate coordination is occurring.

Notes:

- 1) When the Regressor Endogeneity test shows that we can treat the EMP as an exogenous variable, 2SLS results will not be reported.
- 2) For the Crisis-based sample, Synthesis FW along with interaction terms will be used to override any potential endogeneity of coefficients.
- 3) There will be special cases for some countries which will be discussed on a case-by-case basis.
- 4) In most cases, results that are significant at the 10% level will not be discussed.
- 5) In most cases, changes on basket weights of less than 0.05 will not be taken as significant changes in basket weights, and shall be assumed as no change for purposes of discussion.

For 2SLS, the first stage results are reported in Table 5.3. Instruments for each country are based on Table 3.1. The results show that in all cases, with the exception of Afghanistan and Maldives, the first stage results demonstrate a significant relationship between the instrument and the EMP variable. This further validates our choice of instruments and we can now apply 2SLS for IV estimation of exchange regime analysis.

Table 5.3 - First stage results for two stage least squares using commodity prices

IV	AFG EMP	BAN EMP	BHU EMP	IND EMP	MAL EMP	NEP EMP	PAK EMP	SRI EMP
Cotton	0.21 (1.51)	0.25*** (2.80)					0.17*** (2.81)	
Fish			0.32* (1.80)	0.28*** (3.30)	0.11 (1.16)	0.28*** (3.04)		
Tea								0.48** (2.34)

Key: X*EMP where X refers to country as described in earlier key and EMP refers to Exchange Market Pressure

Regression Results –by crisis period

Pre-Global Financial Crisis - 01/01/99 to 08/03/08

Crisis-Period – 08/10/08 to 12/27/09

Post-Crisis – 01/03/10 to 02/28/12

For each individual country, the sample size may vary depending upon the availability of reserve and M1 money supply data. Moreover, a Regressor Endogeneity test is performed on IV regressions for each sub-sample. The test checks whether we can reject the null hypothesis that EMP is exogenous. In most cases, as demonstrated in table 5.4, we fail to reject the null hypothesis. Therefore, for these

time periods, we do not need IV estimation because OLS will be unbiased. The specific time period where the null is rejected varies from country to country.

Table 5.4 - Regressor Endogeneity Test for IV Regression

	AFG	BAN	BHU	IND	MAL	NEP	PAK	SRI
Pre-Crisis	R	NR	NR	NR	NR	R	R	NR
Crisis	NR	NR	NR	R	NR	NR	NR	NR
Post-Crisis	-	NR	NR	R	NR	NR	NR	NR

Null Hypothesis: Treat Exchange Market Pressure as exogenous variable

NR – Not Rejected

R – Rejected

India

IV regression results are reported for the crisis and post-crisis periods. Results of OLS (2) and OLS (3) are highly comparable, so can assume that adding interaction terms do not affect the results substantially. Thus, OLS (2) will be used for discussion.

In comparing OLS (2) results and IV results, we noticed stark differences. First, the exchange market pressure variable is insignificant in the IV results. Second, while the Euro is significant at the 5% level in the post-crisis period for OLS (2), there is no significance in the IV results. Moreover, for the crisis period, the weight on the U.S. dollar is large and has high significance in the IV results as compared to the OLS (2) results. Notice that the adjusted R-squared for the post-crisis IV results is negative. However, this should not be problematic because the adjusted R-squared from IV estimation can be negative because sum of squared IV residuals (SSR) for IV

can be larger than the total sum of squares (SST). Therefore, the R-squared has no natural interpretation. Furthermore, the IV methods are supposed to provide us with better estimates of the ceteris paribus effect of our independent variable on our dependent variable when an independent variable is potentially endogenous; goodness of fit is not considered as a factor (Wooldridge “516-517,” 2006). Therefore, while the adjusted R-squared values are reported, goodness of fit should not be a factor in analyzing the efficacy of the IV estimation.

For the pre-crisis period, we can use the OLS (2) results but for other two periods, given the endogeneity of EMP, we will have to use the IV results to infer changes in the Indian regime over the crisis. Using OLS (2) and IV together, we realize that weight on the U.S. dollar is significant and large in both pre-crisis and crisis periods but it drops to insignificance after the crisis. We observe low flexibility for the Indian exchange rate in the pre-crisis period, but in the crisis-period and post-crisis period, we cannot say much about the exchange rate’s flexibility given that the exchange market pressure variable is insignificant in the IV regression.

Comparing the pre-crisis to the post-crisis period, we notice that the weight on the U.S. dollar and the coefficient on the EMP both become insignificant.

Table 5.5

India - Coefficients	Time Period	OLS(2)	OLS (3)	IV
C	Pre-Crisis	-0.00***(-3.23)	-0.00*** (-2.87)	-
	Crisis	0.00 (1.32)	0.00 (0.42)	0.00 (0.59)
	Post-Crisis	0.00 (0.25)	0.00 (0.09)	0.00 (1.02)
USD	Pre-Crisis	0.60*** (9.39)	0.60*** (9.45)	-
	Crisis	0.16(1.60)	0.11(0.67)	0.65** (2.43)
	Post-Crisis	0.17 (1.63)	0.09 (0.93)	1.57 (1.36)
EUR	Pre-Crisis	0.02 (0.60)	0.01 (0.23)	-
	Crisis	-0.00 (-0.05)	0.04 (0.60)	-0.06 (-0.39)
	Post-Crisis	0.13**(2.39)	0.11** (2.10)	-0.18 (-0.58)
JAP	Pre-Crisis	0.02 (1.00)	0.02 (1.15)	-
	Crisis	0.06 (0.74)	0.0 (0.71)	0.03 (0.16)
	Post-Crisis	-0.03 (-0.57)	0.02 (0.30)	-0.27 (-1.02)
GBP	Pre-Crisis	0.02 (0.66)	0.02 (0.75)	-
	Crisis	-0.03 (-0.28)	-0.06 (-0.51)	0.05 (0.34)
	Post-Crisis	-0.03 (-0.37)	0.01 (0.07)	0.14 (0.47)
INDEMP	Pre-Crisis	0.29*** (4.89)	0.29*** (5.01)	-
	Crisis	0.52*** (3.48)	0.62*** (5.02)	-0.09 (-0.46)
	Post-Crisis	0.70*** (8.10)	0.72*** (9.32)	-1.51 (-0.86)
USD*INDEMP	Pre-Crisis		-0.86 (-0.49)	-
	Crisis		4.61 (0.83)	
	Post-Crisis		13.73** (2.32)	
EUR*INDEMP	Pre-Crisis		2.78* (1.65)	-
	Crisis		-10.6* (-1.72)	
	Post-Crisis		12.4 (1.60)	
JAP*INDEMP	Pre-Crisis		-0.67 (-0.43)	-
	Crisis		4.56 (0.91)	
	Post-Crisis		-9.2** (-1.99)	
GBP*INDEMP	Pre-Crisis		-0.45 (-0.16)	-
	Crisis		-4.01 (-1.24)	
	Post-Crisis		-14.5 (-1.61)	
Observations	Pre-Crisis	500	500	-
	Crisis	73	73	73
	Post-Crisis	109	109	109
Adjusted R-squared	Pre-Crisis	0.90	0.90	-
	Crisis	0.81	0.83	0.57
	Post-Crisis	0.82	0.82	-1.99

Table 5.6

Indian Regime	Changes	Pre-Crisis to Crisis	Crisis to Post-Crisis
U.S. Dollar	Weights	Unchanged	-
	Significance	Unchanged	5% to insignificant
Exchange Market Pressure	Coefficient	-	-
	Significance	Decreases (1% to insignificant)	Unchanged

Table 5.7

Indian Regime	Changes	Pre-Crisis to Post-Crisis
U.S. Dollar	Weights	-
	Significance	Decreases (1% to insignificant)
Exchange Market Pressure	Coefficient	-
	Significance	Decreases (1% to insignificant)

In cases where the variable has become insignificant or becomes significant from insignificance, the changes in weights are not reported as they are not useful for inference. Furthermore all variables that are significant at the 5% level at some time period in the regression analysis is included in the table.

Pakistan

IV Regression results are reported for the pre-crisis period. A comparison of OLS (2) and OLS (3) reveals very similar coefficients. However, there is one difference. While, the coefficient on the Exchange Market Pressure is the same for both OLS (2) and (3) in the pre-crisis period and post-crisis period, it differs by 0.09 in the crisis period.

The Two-stage-least-square regression for the pre-crisis period gives insignificant coefficients on all variables, presenting a different picture from OLS (2) and (3). The IV regression is preferred over OLS due to the endogeneity of exchange market pressure. However, the regressor endogeneity test tells us that we can assume exogeneity for the exchange market pressure for crisis and post-crisis periods. So, we can use OLS (2) and OLS (3) to reliably estimate the regressions in the crisis and post-crisis period.

Using the IV and OLS (2) and (3) in conjunction, we observe that the weight on the U.S. dollar became significant in the crisis period and remained significant in the post-crisis period, although the weight did become smaller in the post-crisis period. The exchange market pressure becomes significant in the crisis period with a moderate degree of flexibility and it remains significant in the post-crisis period but OLS (2) and (3) give different results for the direction in which the weight on the exchange market pressure (EMP) moved. Thus, we can't deduce the effect on the EMP as we shifted from crisis to post-crisis period.

Comparing the pre-crisis and post-crisis periods, we notice that the weight on the U.S. dollar decreases while the coefficient on the EMP increases, thus reflecting greater flexibility

Table 5.8

Pak	Time Period	OLS(2)	OLS (3)	IV
C	Pre-Crisis	-0.00 (-1.41)	-0.00 (-0.70)	0.00 (0.81)
	Crisis	0.00 (0.59)	0.00 (0.72)	-
	Post-Crisis	-0.00 (-0.67)	-0.00 (-1.07)	-
USD	Pre-Crisis	0.41*** (4.73)	0.41*** (4.74)	2.26 (1.13)
	Crisis	0.34** (2.23)	0.37** (2.47)	-
	Post-Crisis	0.31*** (3.44)	0.31*** (3.49)	-
EUR	Pre-Crisis	-0.01 (-0.38)	-0.02 (-0.51)	-0.01 (-0.59)
	Crisis	-0.04 (-0.91)	0.05 (0.77)	-
	Post-Crisis	0.03 (1.27)	0.04 (1.36)	-
JAP	Pre-Crisis	-0.013 (-0.48)	-0.01 (-0.55)	0.03 (0.26)
	Crisis	0.02 (0.40)	0.01 (0.22)	-
	Post-Crisis	0.02 (0.62)	9.02 (0.87)	-
GBP	Pre-Crisis	0.01 (0.19)	0.02 (0.57)	-0.10 (-0.42)
	Crisis	-0.07 (-1.20)	-0.10* (-1.61)	-
	Post-Crisis	0.04 (0.75)	0.03 (0.72)	-
PAKEMP	Pre-Crisis	0.57*** (6.75)	0.57*** (6.75)	-1.34 (-0.65)
	Crisis	0.63*** (6.91)	0.54*** (6.16)	-
	Post-Crisis	0.62*** (7.88)	0.62*** (8.36)	-
USD*PAKEMP	Pre-Crisis		-1.41 (-0.89)	
	Crisis		9.45*** (3.03)	-
	Post-Crisis		2.52 (0.90)	-
EUR*PAKEMP	Pre-Crisis		1.30 (0.45)	
	Crisis		1.23 (0.42)	-
	Post-Crisis		2.97 *(1.61)	-
JAP*PAKEMP	Pre-Crisis		0.92 (0.69)	
	Crisis		-9.45** (-2.25)	-
	Post-Crisis		-0.22 (-0.07)	-
GBP*PAKEMP	Pre-Crisis		-2.09 (-0.59)	
	Crisis		1.75 (0.87)	-
	Post-Crisis		-4.58 (-1.37)	-
Observations	Pre-Crisis	422	422	365
	Crisis	73	73	-
	Post-Crisis	104	104	-
Adjusted R-squared	Pre-Crisis	0.88	0.88	-0.58
	Crisis	0.95	0.96	-
	Post-Crisis	0.97	0.97	-

Table 5.9

Pakistan Regime	Changes	Pre-Crisis to Crisis	Crisis to Post-Crisis
U.S. Dollar	Weights	-	Decreases
	Significance	Increases (Insignificant to 5%)	Unchanged
Exchange Market Pressure	Coefficient	-	Ambiguous
	Significance	Increases (Insignificant to 1%)	Unchanged

Table 5.10

Pakistan Regime	Changes	Pre-Crisis to Post-Crisis
U.S. Dollar	Weights	Decreases
	Significance	Unchanged
Exchange	Coefficient	Increases
Market Pressure	Significance	Unchanged

Afghanistan

The data for Afghanistan's EMP is only available from 2006-2009, which means that OLS (1), (2), (3) and IV will cover only that period. The following additional regression will be performed to get an alternate perspective on the Afghan regime by utilizing a large sample than what the EMP allows:

- a. OLS (D) refers to Simple FW regression using entire sample. The results for this are reported in the appendix

IV Results are reported for the pre-crisis period. It is hard to get a clear idea of how the exchange rate regime of Afghanistan changed after the crisis due to the unavailability of exchange market pressure data for a wider sample size.

The results of OLS (2) and OLS (3) are remarkably similar, implying that adding interaction terms did not affect the results. So, we can use OLS (2) as a valid estimate of the actual results. A comparison of OLS (2) with the IV reveals qualitatively similar results with a large coefficient and high significance on the U.S. dollar. The only difference is the insignificance on the Afghanistan Exchange Market Pressure variable in the IV regression. In this case, we cannot prefer the IV over OLS because the first stage regression results indicate that the instrument used for Afghanistan, prices of cotton, is not highly correlated with it. .

Therefore, we cannot make any valid inference about the pre-crisis period. We can observe though that the weight on the U.S. dollar becomes significant at the 1% level and the Afghan EMP becomes significant in the crisis period reflecting a moderate-low degree of flexibility during the crisis period.

Table 5.11

AFG	Time Period	OLS(2)	OLS (3)	IV
C	Pre-Crisis	-0.00 (-0.51)	-0.00	0.00 (0.18)
	Crisis	-0.00 (-0.90)	-0.00 (-0.52)	-
	Post-Crisis	-	-	-
USD	Pre-Crisis	0.75*** (7.33)	0.77*** (8.27)	1.24*** (4.90)
	Crisis	0.74*** (4.68)	0.74*** (4.16)	-
	Post-Crisis	-	-	-
EUR	Pre-Crisis	-0.11* (-1.84)	-0.10* (-1.67)	-0.15* (-1.74)
	Crisis	0.07 (1.62)	0.06 (0.78)	-
	Post-Crisis	-	-	-
JAP	Pre-Crisis	0.06* (1.85)	0.05 (1.57)	0.06 (1.63)
	Crisis	-0.13 (-3.2)	-0.14*** (-3.63)	-
	Post-Crisis	-	-	-
GBP	Pre-Crisis	0.02 (0.47)	-0.02 (-0.77)	0.03 (0.61)
	Crisis	-0.01 (-0.16)	-0.00 (-0.17)	-
	Post-Crisis	-	-	-
AFGEMP	Pre-Crisis	0.23** (2.53)	0.23** (2.56)	-0.24 (-0.97)
	Crisis	0.37** (2.15)	0.37** (2.09)	-
	Post-Crisis	-	-	-
USD* AFGEMP	Pre-Crisis		-2.96 (-0.92)	
	Crisis		3.09 (0.93)	-
	Post-Crisis		-	-
EUR* AFGEMP	Pre-Crisis		-4.21 (-1.57)	
	Crisis		3.41** (2.18)	-
	Post-Crisis		-	-
JAP* AFGEMP	Pre-Crisis		0.98 (0.47)	
	Crisis		-4.40 (-1.49)	-
	Post-Crisis		-	-
GBP* AFGEMP	Pre-Crisis		7.26 (1.60)	
	Crisis		0.13 (0.08)	-
	Post-Crisis		-	-
Observations	Pre-Crisis	87	87	87
	Crisis	56	56	-
	Post-Crisis	-	-	-
Adjusted R-squared	Pre-Crisis	0.98	0.98	0.94
	Crisis	0.97	0.97	-
	Post-Crisis	-	-	-

Table 5.12

AFG Regime	Changes	Pre-Crisis to Crisis
U.S. Dollar	Weights	Ambiguous
	Significance	Unchanged
Japanese Yen	Weights	-
	Significance	Increases (Insignificant to 1%)
Exchange Market Pressure	Coefficient	Ambiguous
	Significance	Ambiguous

Bangladesh

IV results not reported as we can assume EMP as an exogenous variable. The results of OLS (2) and OLS (3) are virtually identical, suggesting that adding the interaction terms did not affect the results. So we can use OLS (2) results with confidence. OLS (2) suggests that the weight on the U.S. dollar remained relatively consistent from the pre-crisis period to the crisis but rose substantially after the crisis. Meanwhile, the weight on the Japanese yen increased as we shifted from the pre-crisis period to the crisis period but it lost significance after the crisis. Finally, the flexibility of the Bangladeshi exchange rate regime decreased during the crisis, but as the exchange market pressure variable lost significance in the post-crisis period, it is hard to compare that to the post-crisis period.

Comparing the pre-crisis and post-crisis periods, we see the weight on the U.S. dollar increases, the weight on the Yen becomes insignificant and the coefficient on the Bangladeshi EMP becomes insignificant as well.

Table 5.13

BAN Coefficients	Time Period	OLS(2)	OLS(3)
C	Pre-Crisis	0.00** (2.10)	0.00** (2.53)
	Crisis	-0.00 (-0.68)	-0.00 (-0.43)
	Post-Crisis	0.00*** (2.73)	0.00** (2.15)
USD	Pre-Crisis	0.84 *** (16.2)	0.84*** (16.1)
	Crisis	0.85*** (18.0)	0.83*** (13.2)
	Post-Crisis	0.93*** (16.3)	0.92*** (13.0)
EUR	Pre-Crisis	0.00 (0.04)	-0.02 (-0.81)
	Crisis	-0.04 (-1.01)	-0.02 (-0.57)
	Post-Crisis	0.08* (1.74)	0.08* (1.80)
JAP	Pre-Crisis	-0.04** (-2.10)	-0.03** (-2.16)
	Crisis	0.06** (2.26)	0.08** (2.63)
	Post-Crisis	-0.04 (-0.96)	-0.05 (-1.43)
GBP	Pre-Crisis	0.02 (0.49)	0.03 (0.91)
	Crisis	0.05 (1.52)	0.04 (1.53)
	Post-Crisis	0.08 (0.15)	0.04 (0.70)
BANEMP	Pre-Crisis	0.14*** (3.65)	0.15*** (3.96)
	Crisis	0.05** (2.19)	0.06** (2.19)
	Post-Crisis	0.07 (1.60)	0.07 (1.52)
USD* BANEMP	Pre-Crisis		-2.24 (-1.13)
	Crisis		-2.00 (-0.89)
	Post-Crisis		0.05 (0.02)
EUR* BANEMP	Pre-Crisis		3.53 (1.32)
	Crisis		-2.56 (-1.02)
	Post-Crisis		2.28 (0.51)
JAP* BANEMP	Pre-Crisis		-3.23 (-1.57)
	Crisis		1.96 (1.18)
	Post-Crisis		-3.39 (-1.39)
GBP* BANEMP	Pre-Crisis		0.59 (0.20)
	Crisis		1.84 (1.07)
	Post-Crisis		3.30 (1.01)
Observations	Pre-Crisis	500	500
	Crisis	73	73
	Post-Crisis	105	105
Adjusted R- squared	Pre-Crisis	0.84	0.84
	Crisis	0.99	0.99
	Post-Crisis	0.91	0.91

Table 5.14

Bangladeshi Regime	Changes	Pre-Crisis to Crisis	Crisis to Post-Crisis
U.S. Dollar	Weights	Unchanged	Increases
	Significance	Unchanged	Unchanged
Japanese Yen	Weights	Increases	-
	Significance	Unchanged	Decreases (5% to insignificant)
Exchange Market Pressure	Coefficient	Decreases	-
	Significance	Decreases (1% to 5%)	Decreases (5% to insignificant)

Table 5.15

Bangladeshi Regime	Changes	Pre-Crisis to Post Crisis
U.S. Dollar	Weights	Increases
	Significance	Unchanged
Japanese Yen	Weights	-
	Significance	Decreases (5% to insignificant)
Exchange Market Pressure	Coefficient	-
	Significance	Decreases (1% to insignificant)

Maldivian Rufiyaa

IV results not reported as we can assume EMP as an exogenous variable. OLS (2) and OLS (3) reveal largely similar results except for three significant differences. First, the weight on the U.S. dollar in the post-crisis period is insignificant in OLS (2) while it is significant at the 1% level in OLS (3). Second, the coefficient on the

Malaysian exchange market pressure in the post-crisis period is insignificant in OLS (3) while it is significant at the 5% level in OLS (2).

For the pre-crisis and crisis period, the results in OLS (2) and OLS (3) are similar. So, for these periods, we can make judgments using either of them. However, since the results of OLS (2) and OLS (3) differ in the case of the post-crisis period, so it is difficult to argue what is going on there. Moreover, it is difficult to prefer OLS (2) over OLS (3) or vice versa. On one hand, it is possible that OLS (2) is biased because of the endogeneity of the basket weight estimates. However, on the other hand, it is equally reasonable to assume that if the basket weight estimates are not endogenous, then OLS (3) might be giving us inconsistent results because of the high multicollinearity it generates. It is important to point out, though, that the adjusted R-squared value is higher by 0.15 in OLS (3)'s results as compared to OLS (2)'s results for the post-crisis period. So, it is possible that OLS (3) might give us a more accurate results but exercising caution, I will not make any conclusive statements about the post-crisis period..

Using OLS (2) for the first two periods, we see that the weight on the U.S. dollar increases during the crisis period and remains significant. In the post-crisis period, the weight on the dollar falls from 1.00 but it is difficult to figure out the significance of the weight on the U.S. dollar in the post-crisis period. Meanwhile the exchange market pressure loses significance in the crisis period in both OLS (2) and (3). In the post-crisis period, the EMP fails to gain significance in OLS (3) but regains significance in OLS (2), so it is hard to draw any conclusions on the flexibility of the

regime in this period. Comparing the pre-crisis and post-crisis period, we cannot say anything conclusive, given the different interpretations offered by OLS (2) and (3).

Table 5.16

MAL	Time Period	OLS(2)	OLS(3)
C	Pre-Crisis	-0.00 (-1.20)	0.00 (0.77)
	Crisis	0.00 (1.19)	0.00 (0.49)
	Post-Crisis	-0.00 (-0.46)	0.00* (1.73)
USD	Pre-Crisis	0.44*** (3.64)	0.53*** (5.64)
	Crisis	1.00*** (235)	1.00 (185.4)
	Post-Crisis	0.42 (1.49)	0.84*** (6.58)
EUR	Pre-Crisis	0.03 (0.59)	0.02 (0.56)
	Crisis	0.00 (0.35)	0.00 (0.65)
	Post-Crisis	0.11 (1.16)	0.05 (0.68)
JAP	Pre-Crisis	-0.01 (-0.16)	0.00 (0.4)
	Crisis	0.00 (0.67)	0.00 (0.71)
	Post-Crisis	-0.13 (-1.41)	-0.11 (-1.41)
GBP	Pre-Crisis	0.06 (1.18)	0.06 (1.44)
	Crisis	-0.00* (-1.91)	-0.00 (-1.63)
	Post-Crisis	0.15 (0.98)	0.09 (0.85)
MALEMP	Pre-Crisis	0.51*** (4.63)	0.43*** (5.08)
	Crisis	-0.00 (-0.49)	-0.00 (-0.33)
	Post-Crisis	0.57** (2.15)	0.17 (1.50)
USD* MALEMP	Pre-Crisis		-5.4 (-1.5)
	Crisis		0.10 (0.54)
	Post-Crisis		-7.51 (-1.40)
EUR* MAL EMP	Pre-Crisis		3.87 (0.75)
	Crisis		-0.00 (-0.00)
	Post-Crisis		30.9*** (5.34)
JAP* MALEMP	Pre-Crisis		6.80** (2.35)
	Crisis		-0.07 (-0.54)
	Post-Crisis		-11.2** (-2.40)
GBP* MALEMP	Pre-Crisis		-11.9** (-2.20)
	Crisis		0.05 (0.55)
	Post-Crisis		-3.46 (-0.40)
Observations	Pre-Crisis	500	500
	Crisis	73	73
	Post-Crisis	104	104
Adjusted R-squared	Pre-Crisis	0.81	0.85
	Crisis	1.00	1.00
	Post-Crisis	0.76	0.91

Table 5.17

Maldivian Regime	Changes	Pre-Crisis to Crisis	Crisis to Post-Crisis
U.S. Dollar	Weights	Increase	Decreases
	Significance	Unchanged	Ambiguous
Exchange Market Pressure	Coefficient	-	-
	Significance	Decreases (1% to insignificant)	Ambiguous

Table 5.18

Maldivian Regime	Changes	Pre-Crisis to Post-Crisis
U.S. Dollar	Weights	Ambiguous
	Significance	Ambiguous
Exchange	Coefficient	Ambiguous
Market Pressure	Significance	Ambiguous

Nepal

In Nepal's case, we are relatively sure that India is the only anchor currency due to the official announcement by the Nepalese authorities, for decades, to trade 1.6 Nepalese Rupees for 1 Indian rupee. Therefore, it is difficult to imagine the Nepalese authorities following a different anchor. However, it is possible that they may be exercising different degrees of flexibility at different. For instance, in 2010 the authorities considered giving the Nepalese rupee more flexibility. Thus, our analysis will look at the tightness of the fit of the model and the significance of the Indian Rupee as an anchor currency for Nepal.

One concern that may arise is that Indian Exchange rate could be correlated with the error term in such a regression. However, this concern is unreasonable. Due to the small size of the Nepalese economy compared to the Indian economy, it is difficult to imagine domestic shocks from Nepal largely affecting the Indian exchange rate.

The IV regression results are not required. OLS (2) and OLS (3) show highly similar results, except for the weight on the Indian rupee during the crisis period, which differs by 0.09 in the two regressions. However, as long as we keep this in mind, we can use either one of them for further discussion. Taking OLS (2) as a starting point, we cannot conclusively say what happened to the weight on the Indian rupee in the crisis period because OLS (2) and (3) give different interpretations. However, what can be argued is that the pre-crisis and post-crisis weights on the Indian rupee have remained the same, and have remained significant at the 1% level. Moreover, the Nepalese EMP shows us that the Nepalese exchange rate became less flexible during the crisis period while it regained its pre-crisis level of flexibility in the pro-crisis period. In all three periods, the EMP is significant. However, the differences in EMP value across crisis periods are less than or equal to 0.05, which means that one could assume that the flexibility remained largely consistent.

Comparing the pre-crisis and post-crisis results, we observe the weight on the Indian Rupee and the coefficient on EMP remains the same, implying that no change

occurred. This is largely consistent with the fact that the Nepalese Rupee is pegged to the Indian rupee and exchanges at around 1.6 Nepalese Rupee for an Indian Rupee

Table 5.19

NEP Coefficients	Time Period	OLS(2)	OLS(3)
C	Pre-Crisis	-0.00* (-1.75)	-0.00 (-1.32)
	Crisis	-0.00 (-0.71)	0.00 (0.46)
	Post-Crisis	-0.00 (-1.56)	-0.00* (-1.75)
IND	Pre-Crisis	0.69*** (12.6)	0.69*** (12.6)
	Crisis	0.79*** (5.86)	0.7*** (4.93)
	Post-Crisis	0.70*** (8.41)	0.7*** (8.62)
NEPEMP	Pre-Crisis	0.26*** (5.69)	0.26*** (5.85)
	Crisis	0.2** (2.05)	0.21** (2.19)
	Post-Crisis	0.25*** (3.58)	0.24*** (3.11)
IND* NEPEMP	Pre-Crisis		-0.55 (-0.36)
	Crisis		-2.08*** (-3.05)
	Post-Crisis		1.79 (1.59)
Observation	Pre-Crisis	395	395
	Crisis	73	73
	Post-Crisis	105	105
Adjusted R-Square	Pre-Crisis	0.83	0.83
	Crisis	0.91	0.92
	Post-Crisis	0.90	0.90

Table 5.20

Nepalese Regime	Changes	Pre-Crisis to Crisis	Crisis to Post- Crisis
Indian Rupee	Weights	Ambiguous	Ambiguous
	Significance	Unchanged	Unchanged
Exchange Market Pressure	Coefficient	Decrease	Increase
	Significance	Decreases (1% to 5%)	Increases (5% to 1%)

Table 5.21

Nepalese Regime	Changes	Pre-Crisis to Post-Crisis
Indian Rupee	Weights	Unchanged
	Significance	Unchanged
Exchange	Coefficient	Unchanged
Market Pressure	Significance	Unchanged

Sri Lanka

IV results are not required. A comparison of OLS (2) and OLS (3) reveals remarkably similar coefficients on the independent variables, implying that adding interaction terms did not alter our results. Therefore, we can validly use OLS (2) as the model to make inferences. OLS (2) shows that the coefficient on the U.S. dollar decreased as we moved from the pre-crisis to crisis period, and later increased as we moved out of the crisis to the post-crisis period. We also note that the British Pound becomes significant at the 5% level during the crisis but this significance drops off after the crisis is over. Moreover, the exchange market pressure variable is only significant in the pre-crisis period at the 5% level. We see a 10% significance on it in the post-crisis period but as argued earlier, we will treat only 5% significance and higher to avoid talking about any spurious correlations. Therefore, we cannot say much about the change in the flexibility of the Sri Lankan exchange rate regime other than the fact that in the pre-crisis period, Sri Lanka had very low flexibility.

Comparing the pre-crisis and post-crisis period, the weight on the U.S. dollar remained unchanged while the significance of the Sri Lankan EMP dropped off.

Table 5.22

SRI Coefficients	Time Period	OLS(1)	OLS(2)	OLS(3)
C	Pre-Crisis	0.00*** (3.10)	0.00*** (2.80)	0.00*** (3.19)
	Crisis	0.00 (0.91)	0.00 (0.90)	0.00 (1.57)
	Post-Crisis	-0.00 (-0.33)	-0.00 (-0.1)	0.00 (-0.34)
USD	Pre-Crisis	1.01*** (28.6)	0.99*** (28.5)	0.99*** (28.1)
	Crisis	0.90*** (11.7)	0.90*** (10.4)	0.89*** (9.64)
	Post-Crisis	0.93*** (13.9)	0.95*** (18.6)	0.96*** (22.3)
EUR	Pre-Crisis	0.04 (1.14)	0.03 (0.98)	0.02 (0.70)
	Crisis	-0.09 (-1.10)	-0.09 (-1.12)	-0.07 (-0.75)
	Post-Crisis	-0.03 (-0.66)	-0.04 (-0.83)	-0.05 (-0.89)
JAP	Pre-Crisis	0.02 (0.68)	0.01 (0.47)	0.01 (0.57)
	Crisis	0.04 (0.80)	0.04 (0.77)	0.04 (-0.75)
	Post-Crisis	-0.00 (-0.09)	0.00 (0.09)	0.00 (0.14)
GBP	Pre-Crisis	-0.06 (-1.68)	-0.05 (-1.35)	-0.04 (-1.11)
	Crisis	0.15** (2.63)	0.15** (2.61)	0.15** (2.46)
	Post-Crisis	0.05 (0.84)	0.03 (0.57)	0.04 (0.68)
SRI EMP	Pre-Crisis		0.03** (2.31)	0.03** (2.30)
	Crisis		-0.00 (-0.21)	-0.01 (1.55)
	Post-Crisis		-0.02* (-1.99)	-0.02* (-1.87)
USD* SRI EMP	Pre-Crisis			-1.75 (-1.2)
	Crisis			-3.6** (-2.45)
	Post-Crisis			1.13 (0.59)
EUR* SRI EMP	Pre-Crisis			2.49 *1.50)
	Crisis			2.08 (1.30)
	Post-Crisis			1.32 (0.79)
JAP* SRI EMP	Pre-Crisis			-0.93 (-0.79)
	Crisis			1.3* (1.86)
	Post-Crisis			-0.73 (-0.59)
GBP* SRI EMP	Pre-Crisis			-0.36 (-0.28)
	Crisis			0.48 (0.64)
	Post-Crisis			-1.00 (-0.55)
Observations	Pre-Crisis	500	500	400
	Crisis	73	73	73
	Post-Crisis	100	100	100
Adjusted R-squared	Pre-Crisis	0.83	0.84	0.84
	Crisis	0.96	0.96	0.96
	Post-Crisis	0.95	0.96	0.96

Table 5.23

Sri Lanka Regime	Changes	Pre-Crisis to Crisis	Crisis to Post-Crisis
U.S. Dollar	Weights	Decrease	Increase
	Significance	Unchanged	Unchanged
GBP	Weights	-	-
	Significance	Increase (Insignificant to 5%)	Decreases (5% to insignificant)
Exchange Market Pressure	Coefficient	-	-
	Significance	Decreases (5% to insignificant)	Increase (insignificant to 10%)

Table 5.24

Sri Lanka Regime	Changes	Pre-Crisis to Post-Crisis
U.S. Dollar	Weights	Decrease
	Significance	Unchanged
GBP	Weights	-
	Significance	Unchanged
Exchange	Coefficient	Decrease
Market Pressure	Weights	Decrease

Overall Picture

Changes from Pre-Crisis to Crisis Period

The changes in basket weights and significance as we move from the pre-crisis to crisis period are highlighted below. Some interesting observations are that as we move from pre-crisis to crisis period:

- a. The weight on the U.S. dollar remains unchanged for India and Bangladesh, increases for Maldives and decreases for Sri Lanka. The effect on Afghanistan is ambiguous. No conclusive trend emerges in this case.
- b. The significance of the U.S. dollar in the basket remains unchanged for all currencies except for Nepal, which does not follow the U.S. dollar as an anchor, and for Pakistan, for whom the significance of the U.S. dollar increases in the crisis period. The trend clearly shows that despite the crisis, most countries retained the U.S. dollar as an anchor currency in their basket.
- c. We see a rise in the weights and significance in the Yen and Pound for some currencies. One explanation is that countries diversified their basket peg during the crisis to ensure that they were not reliant on only a single currency given the highly volatile global economic environment. A second explanation is that these could be spurious correlations, caused primarily by the small sample size in the crisis period.
- d. For most countries, the significance of the Exchange Market Pressure variable drops during the crisis period, making it difficult to infer flexibility. In the

case of Nepal and Bangladesh for which the significance does not drop out, we see reduced flexibility because of the lower coefficient on EMP. While we do not know how the coefficients of other EMP values would change had they remained significant but a hypothesis that can be drawn from this is that flexibility decreased during the crisis period.

Table 5.25

		AFG	BAN	IND	MAL	NEP	PAK	SRI
Dollar	Weight	A	U	U	I	-	-	D
	Significance	U	U	U	U	-	I	U
Yen	Weight	-	I	-	-	-	-	-
	Significance	I	U	-	-	-	-	-
Pound	Weight	-	-	-	-	-	-	-
	Significance	-	-	-	-	-	-	I
Indian Rupee	Weight	-	-	-	-	A	-	-
	Significance	-	-	-	-	U	-	-
EMP	Weight	A	D	-	-	D	-	-
	Significance	A	D	D	D	D	I	D

Key:

“U” means Unchanged

“I” means Increase

“D” means Decrease

“A” means Ambiguous

Changes from Crisis to Post-Crisis Period

The changes in basket weights and significance as we move from the crisis to post-crisis period are highlighted below. Some interesting observations are that as we move from crisis to post-crisis period:

- a. The weight on the U.S. dollar increases for some countries while decreases for others. No clear trend emerges.
- b. The significance of the U.S. dollar in the basket remains unchanged for Bangladesh, Pakistan and Sri Lanka. Again, in the case of the Indian Rupee, the significance of the U.S dollar weight drops out while the result is ambiguous for Maldives. As before, the trend suggests that the significance of the U.S. dollar remains relatively consistent but given the contradicting in the case of the Indian Rupee and Maldivian Rufiyaa, we should be careful in drawing conclusions here.
- c. The surprising significance that we saw in the crisis period on the Yen and Pound for some currencies drops out in the post crisis period. Again, one explanation is that once the financial crisis was over, countries started pegging to the currencies in line with their policy, as opposed to diversifying to minimize risk. A second explanation is that due to a larger sample size in the post-crisis period, we have been able to remove the spurious correlations.
- d. The changes in the coefficient and significance of EMP vary by country and no clear trend emerges in this case.

Table 5.26

		BAN	IND	MAL	NEP	PAK	SRI
Dollar	Weight	I	-	D	-	D	I
	Significance	U	D	A	-	U	U
Yen	Weight	-	-	-	-	-	-
	Significance	D	-	-	-	-	-
Pound	Weight	-	-	-	-	-	-
	Significance	-	-	-	-	-	D
Indian	Weight	-	-	-	A	-	-
Rupee	Significance	-	-	-	U	-	-
EMP	Weight	-	-	-	I	A	-
	Significance	D	U	A	I	U	I

Changes from Pre-Crisis to Post-Crisis Period

The changes in basket weights and significance as we move from the pre-crisis to post-crisis period are highlighted below. Some interesting observations are that as we move from pre-crisis to post-crisis period:

- a. The weight on the U.S. dollar decreases for Pakistan and Sri Lanka, and increases for Bangladesh. The effect on Maldives is ambiguous. No conclusive trend emerges in this case.
- b. The significance of the U.S. dollar in the basket remains unchanged for three out of five currencies (considering that Nepal pegs only to the Indian Rupee). , for whom the significance of the U.S. dollar increases in the crisis period. The

trend clearly shows that despite the crisis, most countries retained the U.S. dollar as an anchor currency in their basket.

- c. When comparing the pre-crisis and post-crisis scenarios, we observe that the significance on the yen and the pound either does not come into the picture or drops out immediately out of the crisis is over. This again suggests that something specific to the crisis period causes the high significance in the crisis period.
- d. For most countries, the significance of the Exchange Market Pressure variable either drops out post-crisis or remains unchanged. One reason for this could be the relatively smaller sample size in the post-crisis period compared to the pre-crisis period. Furthermore, we see increase, decrease, unchanged and ambiguous flexibility for Pakistan, Sri Lanka, Nepal and Maldives respectively.

Table 5.27

		BAN	IND	MAL	NEP	PAK	SRI
Dollar	Weight	I	-	A	-	D	D
	Significance	U	D	A	-	U	U
Yen	Weight	-	-	-	-	-	-
	Significance	D	-	-	-	-	-
Pound	Weight	-	-	-	-	-	-
	Significance	-	-	-	-	-	-
Indian	Weight	-	-	-	U	-	-
Rupee	Significance	-	-	-	U	-	-
EMP	Weight	-	-	A	U	I	D
	Significance	D	D	A	U	U	

General Conclusions

First, from the unchanged significance of the U.S. dollar in most cases for each of the three time changes - pre-crisis to crisis, crisis to post-crisis and pre-crisis to crisis - we observe that countries maintain the U.S. dollar as a basket currency even in the crisis. This is consistent with the fact that countries choose basket weights based on certain policy considerations and if a global crisis makes them worried about higher volatility of exchange rates because of their weights on global currencies, then as opposed to changing the basket weights, the authorities should increase flexibility of their regime. As mentioned earlier choice of basket weights are based on policy considerations alone, and the policy depends on factors listed in Chapter 2.

Second, we see two countries diversifying their basket of currencies during the crisis. This could be a pre-meditated move or caused by inaccurate analysis due to the smaller sample size. This would seem to go against the argument presented in the previous paragraph, however, since only two of the five currencies see this rise in significance on the Yen and Pound, during the crisis period, of which one already had significance on the Yen in the pre-crisis period, it would be difficult to conclude that countries were diversifying their basket weights due to the crisis. Theoretically, it would not make sense for them to do so, unless there was a simultaneous policy shift alongside the crisis.

Third, as for changes in flexibility we cannot say much. Due the wide-spread insignificance of the EMP, especially in crisis and post-crisis results, there is no conclusive argument that can be presented.

Structural Breaks

While the previous analysis gives us inferences into the effects of the global crisis on South Asian exchange rate regimes, the problem with that analysis is that it imposes a pre-determined sample size and break points on the analysis. When we divide the sample up to pre-crisis, crisis and post-crisis periods, we are essentially making the prior assumption that the regression results would be different in that period. However, there are a few problems with that approach. First, there is no clear cut date of when the crisis started affecting countries. It is possible that the effects of the crisis started way earlier in some countries, which have close economic relationships with the U.S., as opposed to in other countries which are further removed geographically and economically from the U.S. Then, in that case, imposing the same time period for pre-crisis, crisis and post-crisis period would be problematic. Second, even if we assume that all countries were affected by the crisis at the same time, we still do not know the precise point when the crisis started or when the crisis started affecting the countries. This could have been in 2007 when international capital flows started changing patterns or in 2009 when the major effects of the crisis started reaching the world. Finally, when we divide the time period up into pre-crisis, crisis and post-crisis periods, since we are using weekly exchange rate data, we may end up with a disproportionate distribution of the sample size. As in our case, the sample size for the pre-crisis period was as high as 500 while that for the crisis period was often as low as 73. With a lower sample size, we can be less confident about our results and any changes that we observe in the crisis period could be attributed to the low sample size in the crisis and post-crisis periods.

A better approach, as mentioned earlier would be to estimate endogenously the structural break points within the regression analysis. This would allow us to get the precise dates of the times when structural changes in the exchange rate regime occurred. An established methodology for such analysis is to use the Bai-Perron structural breaks technique (Bai and Perron, 2003). When the Bai-Perron Structural Breaks technique gives us the break points, we can use those break-points to divide the sample up around it. This technique would be much more appropriate, as then we can also make the assumption that between the structural breaks, the weight estimates are relatively stable. Naturally, if they were unstable or shifting largely in between the structural break points, we would have observe a structural break at the precise point where they were underwent the shift. Therefore, this means that we do not have to be concerned about the endogeneity of the weights of the basket currencies vis-à-vis the reserves (and by extension, EMP – recall that EMP is composed of a sum of changes in reserves and currency) because in the time-periods with no structural break, we are assuming stable coefficients that are not affected by the EMP variable. Any changes caused in the coefficient by crisis situations brought about by the EMP will also be captured by the structural breaks.

Furthermore, our discussion earlier showed how anchor currencies are chosen based on longer term policies of a country. Once the anchor currencies are chosen, the home authorities monitor movement within a band around the exchange rate gotten from the basket currencies. When the exchange rate starts fluctuating too much, the authorities can just increase the flexibility to allow for the increased volatility. The authorities would only change the basket weights if there is a shift in policy; such a

policy shift is highlighted by a structural change in the exchange rate regime, which is precisely what the Bai-Perron structural breaks technique provides us with.

Moreover, to ensure that our structural breaks are not based on some error in our analysis, we will relate the precise structural break points to actual occurrences in the home currency that could have caused the break. However, as a point of caution, the break points obtained from the Bai-Perron analysis should not be taken as the “exact date” on which the break occurred. This is because the Bai-Perron technique relies on our choice of the minimum sub-sample size. Using the sub-sample size that we provide, the structural break points could vary by a few observations; in our case, it may vary by months but that should not be a sign of concern given that we have weekly data, and naturally a difference of a few observations could translate into a large difference in terms of months. Thus, it is difficult to choose the “right” sub-sample size. The literature has established 0.15 as the standard but this could possibly vary by each country. For some countries, we may need to smaller minimum sub-sample sizes to retrieve the structural break points, which were not very pronounced. For others, the break points could be so prominent that a larger minimum sub-sample size could give us the same break-point.

To provide the structural break points and show how they vary across each country, and for each country, how they vary across the choice of minimum sub-sample size, let us proceed to a discussion of Tables 5.28 to 5.34 .

Structural Break Points for South Asian countries

Each of the break points obtained through the Bai-Perron structural break analysis has been listed in the table below. Sticking with the literature, I will use 0.15 as the minimum sub-sample size to get structural breaks in the exchange rate regime. However, to demonstrate how the breaks vary across choices of minimum sub-sample sizes, I have included the breakpoints obtained from those as well. Furthermore, the structural break analysis is done for each of the regressions separately, since the breaks are determined based off each regression. Once structural break points are identified, the sample is divided using those break points.

One potential concern is: which sub-sample do we include the actual break-point in? Do we include it in the sub-sample prior to the break-point or the sub-sample after the break-point or should we just exclude it? This should not be a matter of huge concern here especially because the break points are not to be taken as “exact dates,” as mentioned previously. Therefore, as opposed to decreasing the sample size by an observation by excluding the observation on the break date, we should just include it in either the sub-sample prior to the break or the sub-sample after the break. As general practice, in this thesis, the break point observation is included in the sub-sample preceding it.

Some notable observations from the structural break points obtained by the Bai-Perron analysis:

1. Decreasing the minimum sub-sample size leads to a greater number of breaks generally while increasing the minimum sub-sample size leads to fewer breaks

generally. Moreover the dates of the structural break-points vary as we change the minimum sub-sample size.

2. For Afghanistan, Bangladesh and Nepal, there are no structural break points across all three regression types.
3. Structural breakpoints changed across the regressions. For instance, Pakistan's exchange rate regime had no structural break in OLS (1) but 3 structural breaks in OLS (2).
4. The dates of the structural break vary across each regression.
5. Since the Bai-Perron structural break analysis technique only works with Ordinary Least Square Regression, we will have to make the assumption that the same break points work for the Instrumental Variable Regression as the ones for OLS (2). The assumption is double checked by finding the break points using Quandt-Andrews unknown breakpoint test after the IV regression. The Quandt-Andrews test confirms that the original structural breakpoints from OLS (2) are confirmed as valid.

Table 5.28

	Regression Type	Minimum Sub-Sample Size	No. of Breaks	Structural Break Dates
Afghanistan	OLS (D)	0.10	2	11/18/2001 3/09/2003
		0.15	0	-
		0.20	0	-
	OLS(1)	0.10	0	-
		0.15	0	-
		0.20	0	-
	OLS(2)	0.10	3	2/03/2008 11/16/2008 5/24/2009
		0.15	0	-
		0.20	0	-

Table 5.29

	Regression Type	Minimum Sub-Sample Size	No. of Breaks	Structural Break Dates
Bangladesh	OLS(1)	0.10	0	-
		0.15	0	-
		0.20	0	-
	OLS(2)	0.10	0	-
		0.15	0	-
		0.20	0	-

Table 5.30

	Regression Type	Minimum Sub-Sample Size	No. of Breaks	Structural Break Dates
India	OLS(1)	0.10	1	10/12/2008
		0.15	1	10/12/2008
		0.20	1	10/12/2008
	OLS(2)	0.10	2	6/03/2007 10/26/08
		0.15	2	11/05/06 10/26/08
		0.20	2	3/05/06 10/26/08

Table 5.31

	Regression Type	Minimum Sub-Sample Size	No. of Breaks	Structural Break Dates
Pakistan	OLS(1)	0.10	1	10/21/2001
		0.15	0	-
		0.20	0	-
	OLS(2)	0.10	4	10/14/01 6/01/03 9/09/07 10/26/08
		0.15	3	5/05/02 1/28/07 10/26/08
		0.20	2	6/25/06 10/26/08

Table 5.32

	Regression Type	Minimum Sub-Sample Size	No. of Breaks	Structural Break Dates
Sri Lanka	OLS(1)	0.10	0	-
		0.15	0	-
		0.20	0	-
	OLS(2)	0.10	1	4/29/01
		0.15	1	4/29/01
		0.20	0	-

Table 5.33

	Regression Type	Minimum Sub-Sample Size	No. of Breaks	Structural Break Dates
Maldives	OLS(1)	0.10	0	-
		0.15	0	-
		0.20	0	-
	OLS(2)	0.10	4	7/2/2000 12/09/01 3/23/03 9/12/10
		0.15	2	10/20/2002 1/17/2010
		0.20	2	10/20/02 5/24/09

Table 5.34

	Regression Type	Minimum Sub-Sample Size	No. of Breaks	Structural Break Dates
Nepal	OLS(1)	0.10	0	-
		0.15	0	-
		0.20	0	-
	OLS(2)	0.10	0	-
		0.15	0	-
		0.20	0	-

Regressor Endogeneity Test for Exchange Market Pressure

The regressor endogeneity test is run on the Two-stage-least square regression that treats the EMP as exogenous. The test shows us that we can treat the EMP as exogenous for most cases. Therefore, for those cases, we will use OLS (2), given that we are assured of the exogeneity of EMP.

Table 5.35

Time Period	AFG	BAN	BHU	IND	MAL	NEP	PAK	SRI
1	NR	NR	NR	NR	R	R	NR	NR
2	-	-	NR	NR	NR	-	NR	NR
3	-	-	NR	R	NR	-	R	-
4	-	-	-	-	-	-	NR	-

Note: Time periods indicated are not uniform for each country. As mentioned previously, the time periods depend upon each country's individual structural break points.

Inferring Bands around Basket-Predicted Exchange Rate

We have seen how countries are following a basket of currencies in the previous section. In a completely fixed exchange rate regime, the local authorities would follow changes in the anchor currencies without any flexibility. Thus, in that case, we can basically use the basket pegs to accurately predict the actual exchange rate, a rare feat. The basket-predicted exchange rate, which refers to the exchange rate predicted by the basket weights, would be highly accurate in that case. However, if we assume that a country follows a basket of currencies closely, but allows fluctuations around the basket-predicted exchange rate based on macroeconomic fluctuations, then we can naturally envision a band around the basket-predicted exchange rate, which the local authorities monitor. When the fluctuations increase beyond the band set by the local authorities, they intervene to prevent fluctuation beyond the band set by the local authorities.

In the next section, in addition to the discussion about the regressions that have been run on sample periods identified by structural breaks, I will use the basket weights obtained to predict the exchange rate of the local currency and compare the movement of the actual currency with the predicted exchange rate. The difference between them will give us an idea of the band that the authorities are monitoring around the basket-predicted exchange rate to allow fluctuations. It is difficult to account for the “crawl” given that the nature of the crawl is unknown. We can make the simplifying assumption that the crawl is simply a linear relationship that the local exchange rate follows; however, this would not be based on any valid reasoning since countries have been known to follow complicated processes of crawls. So in order to

account for the crawl and to keep our focus on the fluctuations around the basket-predicted exchange rate, we will equate the basket-predicted exchange rate and the actual exchange rate every year because we assume that accounting for the proper form of crawl should keep the basket-predicted exchange rate close to the actual exchange rate, while of course allowing fluctuations. This practice is well-recorded in the literature as in the work of Jie (2010). However, with that said, the bands should be interpreted qualitatively, as opposed to focusing on the “exact number of the band,” to see what the general level of the bands can tell us about the flexibility of the exchange rate regime. Thus, given the assumption of annually equating the basket-predicted exchange rate and the actual exchange rate, we should be careful in drawing conclusions from small differences. For instance, in comparing a band of 3% and one of 4% we cannot conclusively say whether one country was more flexible than the other, since we do not have the underlying crawl value. However, in comparing a band of 10% and one of 1%, we can confidently assert the higher flexibility of one regime over the other. In cases where the EMP variable is not significant, analysis of the bands will be especially useful as it will help us get insight into the flexibility of the regime.

Regression Results – by structural breaks

Afghanistan

IV regression not required. Thus, we will use OLS (2) to infer the Afghan exchange rate regime. The coefficient on the U.S. Dollar is significant and large (0.71). The exchange market pressure, significant at the 5% level, reveals a low-to-moderate flexibility of 0.33. Moreover the adjusted R-squared is 0.97, reflecting a very well-fitted model.

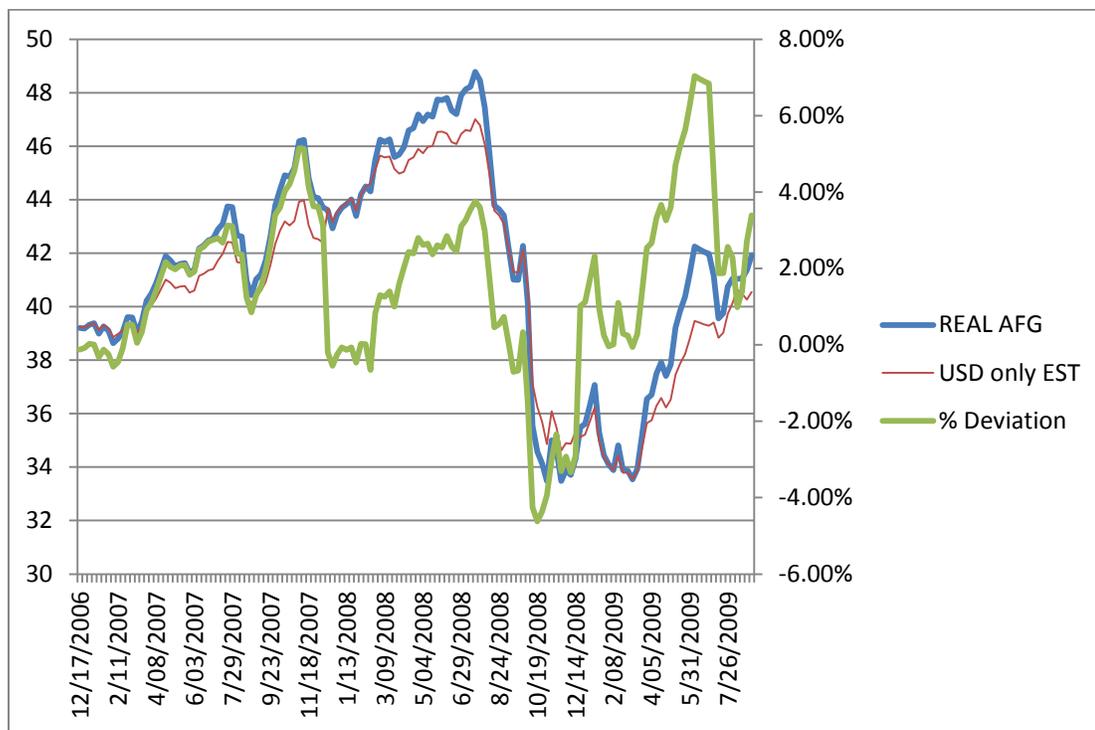
Table 5.36

AFG Coefficients	OLS (Different Range)	OLS(1)	OLS(2)
C	-0.01 (-0.96)	-0.00 (-0.23)	-0.00 (-0.80)
USD	0.93*** (3.54)	0.98*** (38.0)	0.71*** (5.40)
EUR	-0.11 (-0.87)	-0.00 (-0.04)	0.03 (0.76)
JAP	-0.12 (-0.70)	-0.03 (-0.81)	-0.05 (-1.40)
GBP	-0.61 (-1.26)	0.05 (1.19)	0.00 (0.12)
AFGEMP			0.33** (2.52)
Observations	687	143	143
Adjusted R-squared	-0.00	0.95	0.97

In terms of the flexibility of the Afghan exchange rate, we observe that the Afghan exchange rate has operated within a band of 7% around the basket-predicted

exchange rate throughout the time period as shown by the % deviation in the graph. This reflects a low-to-moderate level of flexibility as predicted by the coefficient on EMP in our regression.

Figure 5.3



Note: In each of the figures, the “USD only EST” refers to the basket-predicted exchange rate of Afghanistan while the “Real Afg” refers to the actual Afghanistan Exchange Rate. The % deviation represents the percentage difference between the two at each point in time. The right-hand axis represents the values for the % deviation while the left-hand axis refers to the values represented by the actual exchange rate and the basket-predicted exchange rate.

Nepal

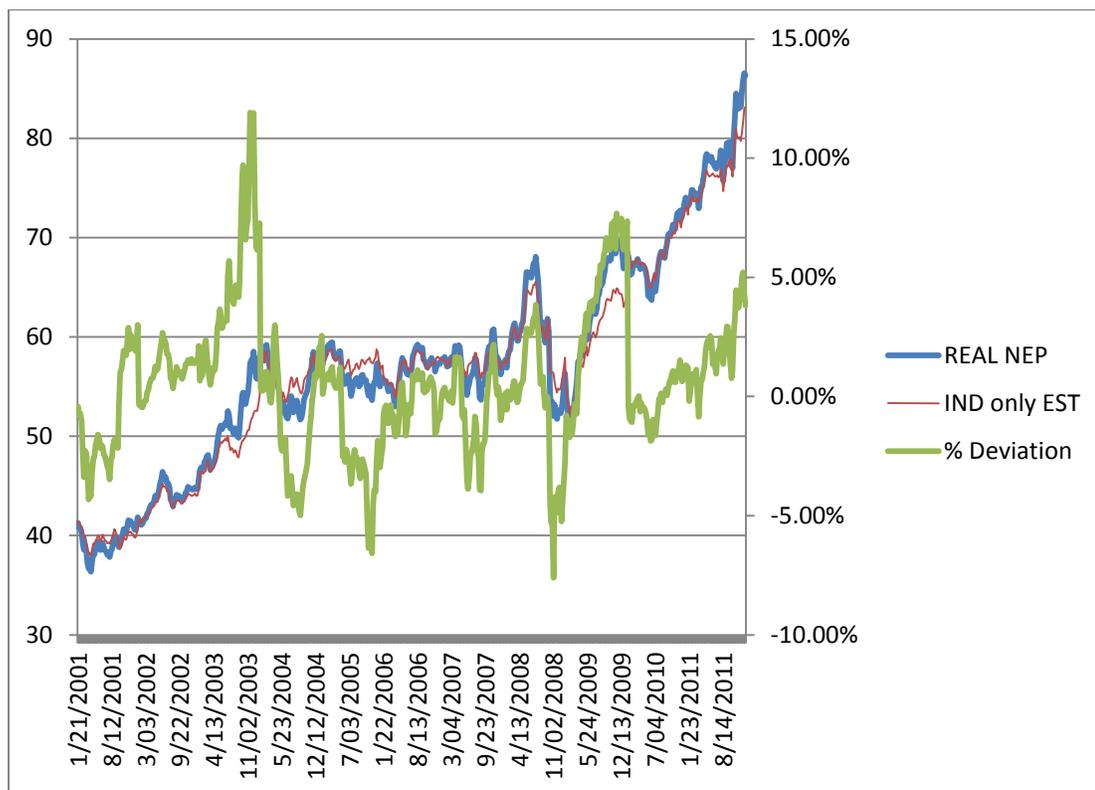
For Nepal, we do not require the IV regression. Thus, using OLS (2), as a reference point for the inference, we observe a large value and high significance on the Indian rupee. Moreover, the EMP variable is significant at the 1% level, so we can infer the degree of flexibility of the regime using the coefficient on it. A coefficient of 0.23 reflects a low-to-moderate level of flexibility of the exchange rate regime. An adjusted R-squared of 0.86 reflects a well-fitted model.

Table 5.37

NEP Coefficients	OLS(1)	OLS(2)
C	0.00 (0.12)	-0.00** (-2.18)
IND	0.98*** (43.7)	0.72*** (15.1)
NEPEMP		0.24*** (6.10)
Observations	687	572
Adjusted R-squared	0.82	0.86

Figure 5.4 gives us further insight into the flexibility of the Nepalese exchange rate regime. Throughout the time period, the Nepalese exchange rate has operated within a band of around 12% around the basket-predicted exchange rate as shown by the % deviation in the graph. However, if we exclude the outlier in around 2003, the band would be around 10%. This reflects a moderate level of flexibility, slightly in contrast to our findings for the Afghan exchange rate, especially keeping in mind that the EMP variable for Nepal is lower than that for Afghanistan. This could

suggest two things. First, that the EMP variable cannot be compared across countries to compare *de facto* flexibility because the values of the EMP variable do not match up with the bands. However, there is no theoretical reasoning behind this claim. Second, that the Afghan regime does in fact have a higher degree of exchange rate flexibility but it wasn't faced by as many shocks as Nepal might have faced. Again, there is not much factual knowledge supporting this claim. Finally, what seems like the most conclusive argument is that since we are using different sample periods, we may not get flexibility levels that compare to the EMP values. For instance, in a larger sample, as of Nepal's there is a greater chance of outliers as opposed to in a smaller sample, as of Afghanistan. Moreover, if we only compare 2006-2009, which happens to be the sample of Afghanistan's regime analysis, then we see that the Nepalese regime was managed within a band of around 7%, which is comparable with the band that we observed for Afghanistan's exchange rate regime.

Figure 5.4

India

In India's case, we observe two structural breaks. The first structural break occurs in November 2006, which can largely be attributed to the changes in the capital control restrictions that were occurring around that time and the changing nature of India's trade (Patnaik and Shah, 2009). The second structural break is observed in October 2008, which can be attributed to the onset of the global financial crisis. Therefore, the analysis will be divided into three sub-periods based on these two structural breaks.

Furthermore, IV results will be displayed for the third time period.

For the first time period, we see a large and statistically significant weight on the U.S. dollar with relatively low flexibility as indicated by an EMP value of 0.25. An R-squared value of 0.93 demonstrates the strong fit of the model. In the second time period, the weight on the U.S. dollar remains large and statistically significant. The EMP variable is insignificant, making it difficult to infer flexibility. Meanwhile, we see statistically significant weights on the Euro and Yen in this time period. The coefficient on the Yen is negative, so it is hard to interpret that weight, while the weight on the Euro is surprisingly high to around 0.42. The high weight on the Euro could be due to the increasing trade between India and the Euro region during this time period. Between 2006 and 2008, annual exports from India to the Euro region increased by 48% as compared to the 13% increase in annual exports from India to the U.S.⁸. However, after 2008, the boost in exports from India to the Euro region stopped and became stagnant, which may imply that the weight on the Euro should have been removed after structural break in 2008. That is precisely what happened. In both the OLS (2) and IV in the third time period, the significance on the Euro drops out. However, the IV and OLS (2) give us different interpretations. While OLS (2) suggests a huge increase in flexibility of the Indian regime with an EMP climbing to 0.70 and no significance on the U.S. dollar, the IV gives a more balanced view. The IV regression indicates that a large and statistically significant weight on the U.S. dollar, and no significance on the Exchange Market Pressure, making it difficult to interpret flexibility. Given the endogeneity of the EMP variable, we will stick to the IV results, which suggest that the weight on the U.S. dollar is still large although we are unsure of the level of flexibility, which we'll try to analyze using the figures ahead.

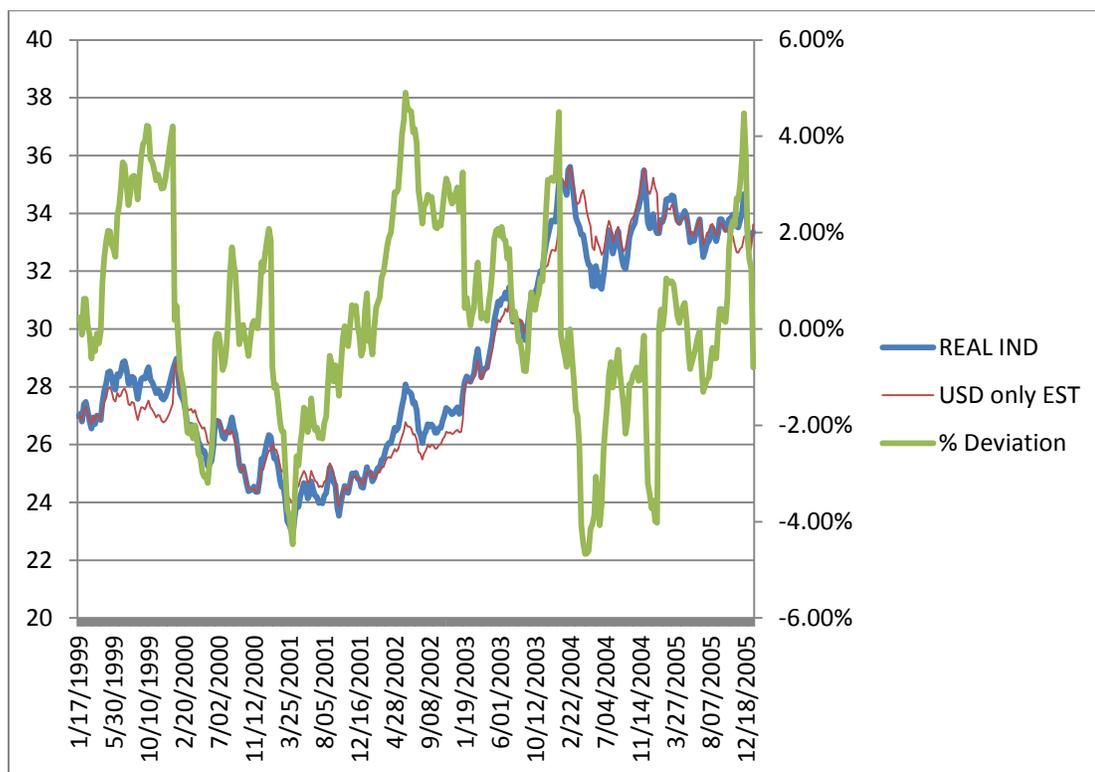
⁸ Calculated using Direction of Trade Statistics from IMF

Table 5.38

IND Coefficients	Time	OLS(1)	Time	OLS(2)	Time	IV
C	1	0.00 (0.97)	1	-0.00** (-2.43)	1	-
	2	0.00* (1.72)	2	0.00 (0.15)	2	-
			3	-0.00 (-0.9)	3	0.00 (1.44)
USD	1	0.85*** (30.4)	1	0.64*** (12.2)	1	-
	2	0.52*** (4.57)	2	0.70*** (3.46)	2	-
			3	0.08 (1.28)	3	0.90** (2.14)
EUR	1	0.01 (0.18)	1	0.01 (0.23)	1	-
	2	-0.04 (-0.56)	2	0.42*** (3.52)	2	-
			3	0.06 (1.3)	3	-0.15 (-1.02)
JAP	1	-0.02 (-0.80)	1	0.05** (2.34)	1	-
	2	-0.01 (-0.07)	2	-0.26*** (-3.1)	2	-
			3	0.05 (1.08)	3	-0.02 (-0.10)
GBP	1	0.06 (1.55)	1	0.01 (0.49)	1	-
	2	0.02 (0.22)	2	-0.07 (-0.63)	2	-
			3	0.00 (0.03)	3	0.01 (0.10)
IDNEMP	1		1	0.26*** (5.88)	1	-
	2		2	0.17 (1.30)	2	-
			3	0.72*** (12.18)	3	-0.60 (-0.99)
Observations	1	510	1	409	1	-
	2	172	2	103	2	-
			3	170	3	170
Adjusted R-squared	1	0.87	1	0.93	1	-
	2	0.48	2	0.83	2	-
			3	0.84	3	-0.33

In the first time period, the Indian exchange rate has been managed within a band of approximately 4% around the basket-predicted exchange rate. This reflects a very level of flexibility, which is consistent with what we predicted from the coefficient on EMP in our regression. It is worth mentioning how regularly the spikes in the graph in terms of the difference between the actual exchange rate and the basket-predicted exchange rate are cut managed under 4%, which seems to represent a genuine case of a band.

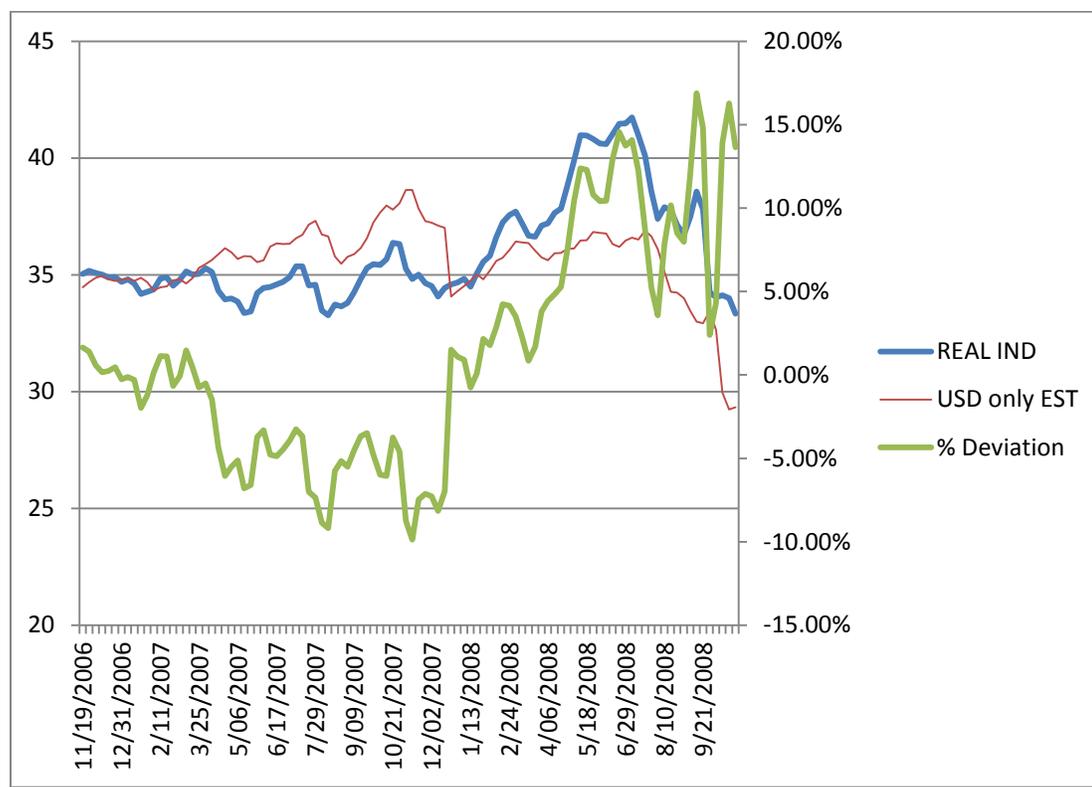
Figure 5.5



In the second time period, we notice a band of around 15%, which reflects greater flexibility of the exchange rate around the basket-predicted exchange rate. Since we had no inference on the EMP variable from our regression, we can infer

from the 15% band that the Indian regime had a moderate level of flexibility in this period. At the very least, we can compare the 15% band to the 4% band to assert that the Indian regime is more flexible in the second time period.

Figure 5.6

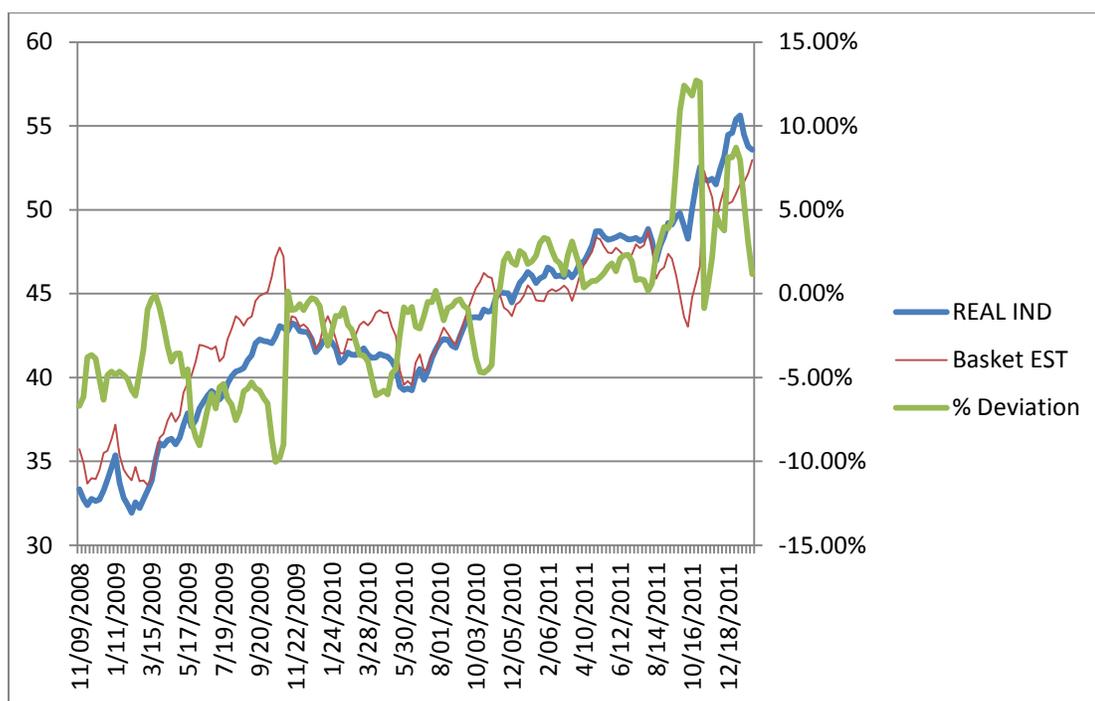


In the third time period, we notice a band of around 13%, which reflects a similar degree of flexibility as in the second time period. Since we had no inference on the EMP variable from our regression, we can infer from the 13% band that the Indian regime had a moderate level of flexibility in this period. However, worth noting is the fact that from October 2009 to September 2011, the Indian exchange rate was managed within a band of 5%, but the band increased sharply after that towards the end of 2011 and early 2012. So it is possible that the countries alter the band

every now and then, which is not necessarily reflected in the structural breaks unless the change in flexibility is significant enough. Towards the end of 2011 and start of 2012, we see larger fluctuations which can be attributable to the financial crisis that India has been struck with in this time due to the large current account and fiscal account deficit . However, despite the crisis, the fact that the Indian Rupee has remained within a 15% band shows some degree of intervention by the Reserve Bank of India.

Comparing the figures for the second and third time-periods, we can see that the deviations seem to be much more managed in the third time-period as compared to the second time-period. However, this is mere conjecture based on looking at the figures and should not be taken factually unless there is further evidence to support it.

Figure 5.7



Pakistan

In Pakistan's case, we observe three structural break points. The first break point occurs on 5th May 2002, the second on 28th January 2007 and the third on 26th October 2008. The geopolitical and economic underpinnings behind the structural break points will be with each regression. As a starting point, I divided the sample into four sub-periods based on the three structural breaks.

For the first time-period, we see a low-to-moderate weight on the U.S. dollar, which is statistically significant. We also notice relatively high flexibility in the exchange rate regime with an EMP coefficient of 0.58. However, after the first structural break, we observe that the weight on the U.S. dollar becomes very large, and the coefficient on the EMP variable becomes very low, decreasing from 0.58 to 0.22, reflecting a much lower level of flexibility. Moreover, there is a low, but statistically significant weight on the Euro as well. As in the case of India, this probably reflects the shifting direction of trade with greater exports to the Euro region, thus increasing the incentive to maintain some stability with the Euro. From 2002-2007, the period represented by the second time period, we see an increase in annual trade of 48% comparable to the increase in annual exports to the U.S.⁹. However, from 2007-2010, annual exports increased by only 9%, which suggests that the weight on the Euro might be dropped after 2007, which is what happens as we'll see later. However, for now, it is important to identify the first structural break points. We notice that as we shift from the first time-period to the second time-period, the

⁹ Calculated using Direction of Trade Statistics from IMF

weight on the U.S. dollar increases substantially and the flexibility in exchange rate decreases substantially. For this to happen, a significant increase in foreign exchange reserves would be necessary. Given that economic sanctions were placed on Pakistan in 1998 by the U.S. in light of its nuclear weapons tests, it is reasonable to assume that Pakistan had a relatively lower level of foreign exchange reserves at that point due to the restrictions in trade and foreign aid with its largest export partner, the U.S.. However, after the 9/11 attacks, the United States removed the sanctions and started working with the Pakistani government to fight the war in Afghanistan. Given this close coordination economically, with larger trade due to the lifting of sanctions and greater foreign aid to Pakistan for its involvement in the war, Pakistan naturally had a greater incentive to follow the U.S. dollar much more closely than before. Moreover, with the increase in foreign reserves, it now had the capability to do so as well. This explains the shift from the first exchange rate regime in Pakistan to the second regime.

As we shift to the third time period, which lasts from January 2007 to October 2008, we observe similar interpretations from OLS (2) and IV results. The coefficients on the U.S. dollar and Euro become insignificant in both cases. The only difference is in the interpretation of the EMP. In the IV regression, the EMP variable becomes insignificant and given the endogeneity of the EMP variable in the third time period, we will prefer the IV result over the OLS (2). So, we cannot say much about the flexibility of the exchange rate regime in this time period because of the insignificance of the EMP variable. However, we can confidently assert that the weights on the dollar and euro have become insignificant. Given that there is no

statistically significant weight on any of the potential anchors, one could reasonably assume that the State Bank of Pakistan must then be floating the currency in this time period. This time period, 2007-2008 corresponds to the time when a sharp rise in international oil and food prices, policy inaction and political turmoil led to macroeconomic imbalances in Pakistan. The economy slid into a balance of payments crisis and had a shortage of foreign exchange reserves (SASEP, 2009). Given the shortage of reserves and balance of payments crisis, it is clear why the State Bank of Pakistan chose to let the exchange rate float in this time period as opposed to keeping it fixed to the U.S. dollar. To keep it fixed to the U.S. dollar, they would have needed to use foreign exchange reserves regularly, which they did not have due to the balance of payments crisis. Therefore, our findings fit well into the geopolitical and economic situation in Pakistan at that time.

The fourth time period identified by the structural breaks is from November 2008 to December 2011. In this period, we see that the weight on the U.S. dollar has become significant again at the 1% level and rose to 0.53, a substantial increase from the insignificant weight in the third period. Furthermore, we get significance on the EMP variable, which registers a coefficient of 0.49 reflecting a moderate level of flexibility. However, compared to the last time period, this period should reflect much lower flexibility. The fact that the Pakistani authorities were able to manage their exchange rate again reflects that the balance of payments and foreign reserves situation must have improved in this time period. These results blend well with reality because there was a rapid decline in international commodity and oil prices during 2008 and 2009, which facilitated improvement in the external situation of Pakistan's

economy. This coupled with other reforms led Pakistan out of the Balance of Payments crisis in this time period. The Pakistani foreign reserves had at one point fallen to three months worth of imports, but the situation improved rapidly between 2008 and 2011, allowing Pakistan to improve the situation of its foreign reserves (SASEP, 2009). With improvement in foreign reserves, Pakistan put weight back on the U.S. dollar and reduced its flexibility to follow a managed float regime. This interpretation was confirmed through an interview with an official from the State Bank of Pakistan.

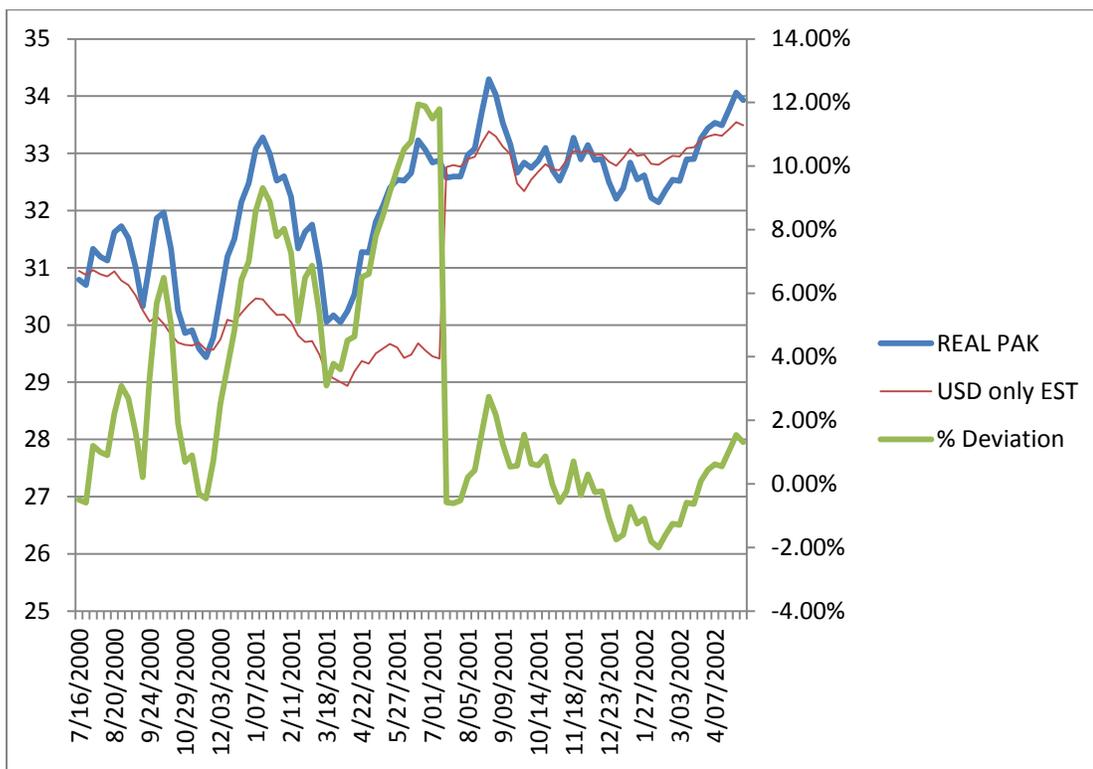
Therefore, it seems like throughout the entire sample size, Pakistan's ideal exchange rate policy was one of following a managed float anchored around the U.S. dollar. However, macroeconomic instability and reserves crises had prevent Pakistan from doing that in the first and third time periods. But as soon as the reserves situation improved, Pakistan started following its ideal envisioned managed float again. This goes back to an argument raised in Chapter 3 regarding how a country's exchange rate anchors are chosen based on specific factors, and under a reserves crisis, the country increases its flexibility but as soon as the reserves crisis is over, the country reduces its flexibility back and returns to its original preferred managed float policy.

Table 5.39

PAK Coefficients	OLS(1)	Time	OLS(2)	IV
C	0.00*** (3.39)	1	-0.00 (-0.85)	-
		2	-0.00** (-2.16)	-
		3	0.00* (1.88)	-0.00 (-0.14)
		4	-0.00 (-0.86)	-
USD	0.96*** (25.6)	1	0.37*** (3.45)	-
		2	0.76*** (9.68)	-
		3	0.09 (0.71)	-1.95 (-0.33)
		4	0.53*** (5.62)	-
EUR	0.01 (0.23)	1	-0.10 (-1.27)	-
		2	0.08*** (2.68)	-
		3	0.03 (0.24)	-0.14 (-0.19)
		4	0.00 (0.34)	-
JAP	-0.03 (-0.96)	1	-0.01 (-0.11)	-
		2	-0.01 (-0.44)	-
		3	-0.00 (-0.07)	0.30 (0.35)
		4	0.00 (0.10)	-
GBP	-0.02 (-0.39)	1	0.00 (0.01)	-
		2	-0.017 (-0.64)	-
		3	0.04 (0.48)	-0.61 (-0.34)
		4	-0.06 (-1.04)	-
PAKEMP		1	0.58*** (5.35)	-
		2	0.22*** (2.80)	-
		3	0.82*** (9.78)	3.17 (0.48)
		4	0.49*** (6.31)	-
Observations	599	1	96	-
		2	247	-
		3	91	91
		4	165	-
Adjusted R-squared	0.84	1	0.81	-
		2	0.96	-
		3	0.94	-0.38
		4	0.96	-

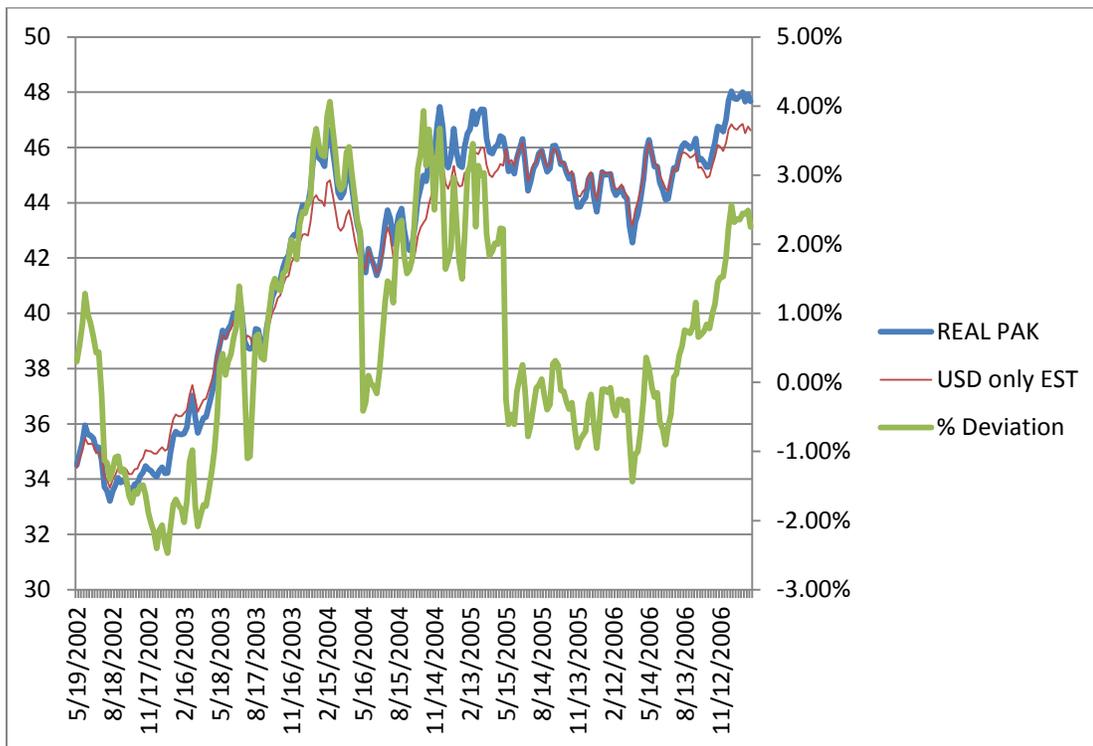
In the first time period, we observe the State Bank of Pakistan managing its exchange rate under a band of 12% around the basket-predicted exchange rate for the Pakistani rupee. This seems consistent with the relatively high level of flexibility indicated by a coefficient of 0.58 on the EMP.

Figure 5.8



Given that we observe an EMP coefficient of 0.22 in the second time-period, one would expect a smaller band in this time period. That is precisely what we find. In the second time period, the State Bank of Pakistan maintains a band of approximately 4% around the basket-predicted Pakistani rupee exchange rate. This band is substantially lower than the band observed in the first time period, which is consistent with the difference in EMP in the two time periods.

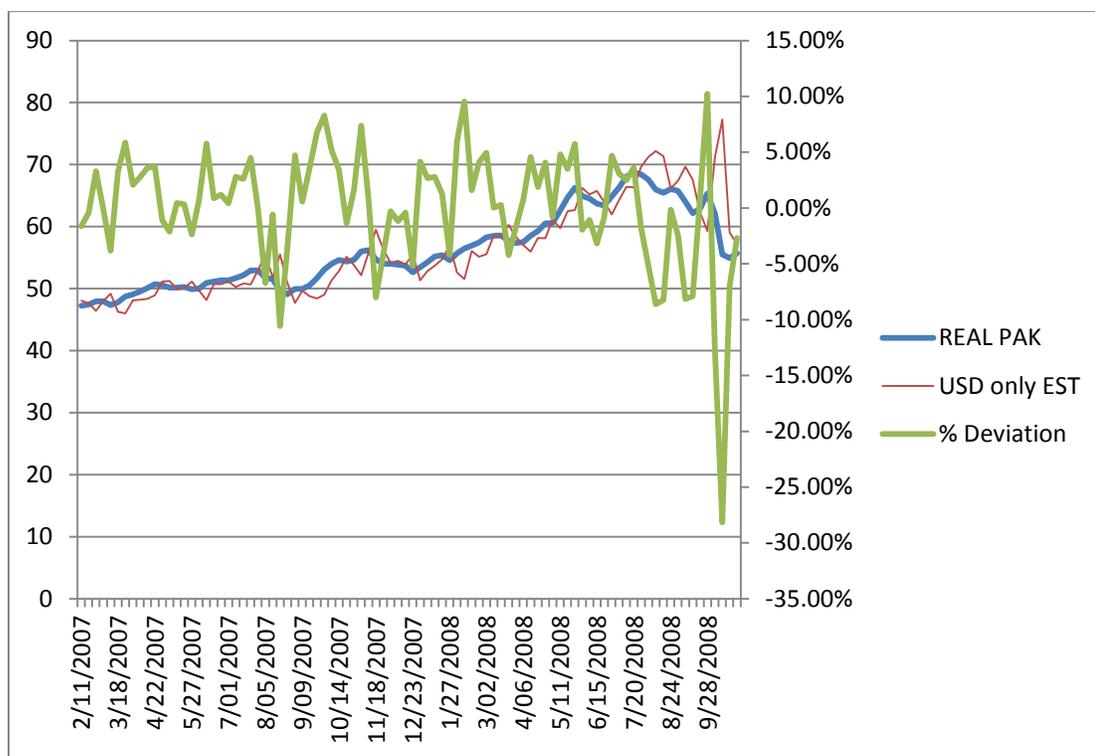
Figure 5.9



In the third time-period, we observe a band of 10% for the most part, but towards the end of 2008, we observe that the State Bank allows deviations as large as 27.5% around the basket-predicted exchange rate. Since the EMP did not give us any insight into the flexibility and that we did not have any statistically significant weights on basket currencies, such high flexibility is entirely possible. An alternate explanation is that since the Bai-Perron Breakpoint test cannot identify the “exact date” for the break point, our estimation of the breakpoint could have been off by a few observations. So, if we had taken September 2008, instead of October 2008 as the break point, the exchange rate in the time period between January 2007 and September 2008 would have been largely under a band of 10% while the observations beyond that would have been passed on to the next sub-sample. This is merely a

hypothesis and robustness testing by adjusting break-points is out of the scope of this thesis. However, this is certainly a worthy area to look into for further research on this topic. For now, we'll take what we have and assume a band of 27.5% in this time period, largely reflective of the high flexibility and lack of anchor currencies in this time period.

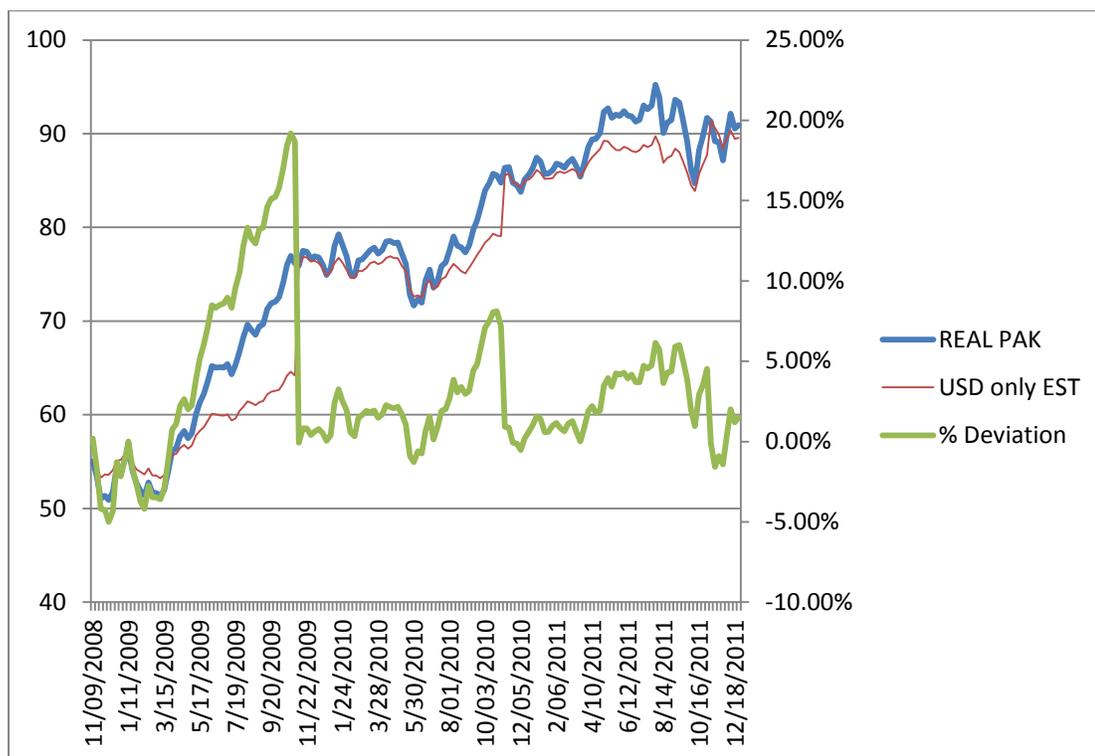
Figure 5.10



Finally, in the last time period, we observe a band of 20%, particularly because of some of the earlier observations. From late 2009 to 2011, the State Bank of Pakistan has managed the exchange rate within a 10% band around the basket-predicted exchange rate of the Pakistani Rupee. Again, due to the high EMP value of 0.50, this is not an unusual finding and a 20% band is reasonable to assume. Despite the relatively similar EMP value in the first and fourth time period, we do see a larger

band in the fourth time period. So it is difficult to say whether the exchange rate regime was more flexible in the first or fourth time periods.

Figure 5.11



Maldives

IV results are reported for the first time period. There are two structural breaks in the Maldivian Rufiyaa. The first of the two breaks occurs on 10/20/2002. This does not seem closely linked with any official geopolitical or economic occurring in the country at that time. The most plausible hypotheses is that since the structural break is close to 2001, it could be linked to the readjustment by the Maldivian authorities of its peg to the U.S. dollar that occurred in 2001; So, it's possible that the break may be capturing that re-adjustment on the repercussions or affects of the readjustment

(EPPTSAR, 2010). Furthermore, as mentioned before, there is a degree of error in the Bai-Perron Structural break analysis and it's entirely possible that the technique missed the break point by a year. However, since we are not sure if the readjustment of the peg actually led to a shift in the exchange rate regime, we cannot use that as a break point. Thus, we will stick to breakpoint generated by the Bai-Perron technique.

The second structural break occurs around 1/17/2010. This result is consistent with the economic situation of the country. Maldives relies largely on tourist arrivals to generate foreign exchange earnings. However, owing to the global economic, the number of tourist arrivals to Maldives had declined significantly leading to a sharp decline in their foreign exchange earnings in 2009. As a result, due to the foreign reserves shortage, it became unsustainable for the country to maintain the close peg to the dollar, and thus, it was forced to change its exchange rate regime (EPPTSAR, 2010).

Since the EMP is endogenous in the first time period, we will rely on the IV results. The IV results show a large and statistically significant weight on the U.S. dollar, as compared to a much small and less significant weight suggested by OLS (2). Given that Maldives has maintained a close peg to the U.S. dollar since 1994, our IV results reflect the actual situation. Hence, we are reassured of the validity of our methodology of preferring IV over OLS (2) when the EMP is endogenous. Furthermore, in the first period, the EMP variable is insignificant, so it hard to get an idea of the degree of flexibility of the regime.

In the second time period, we observe a very large coefficient on the U.S. dollar, which remains highly significant as well. We observe very low flexibility with the EMP coefficient being 0.01, but it only significant at the 10% level. However, the adjusted R-squared of 1.00 basically confirms the tight peg that the Maldivian Rufiyaa is following vis-à-vis the U.S. dollar. So this suggests that the first structural break point could very well have been related to the re-adjustment of the peg in 2001.

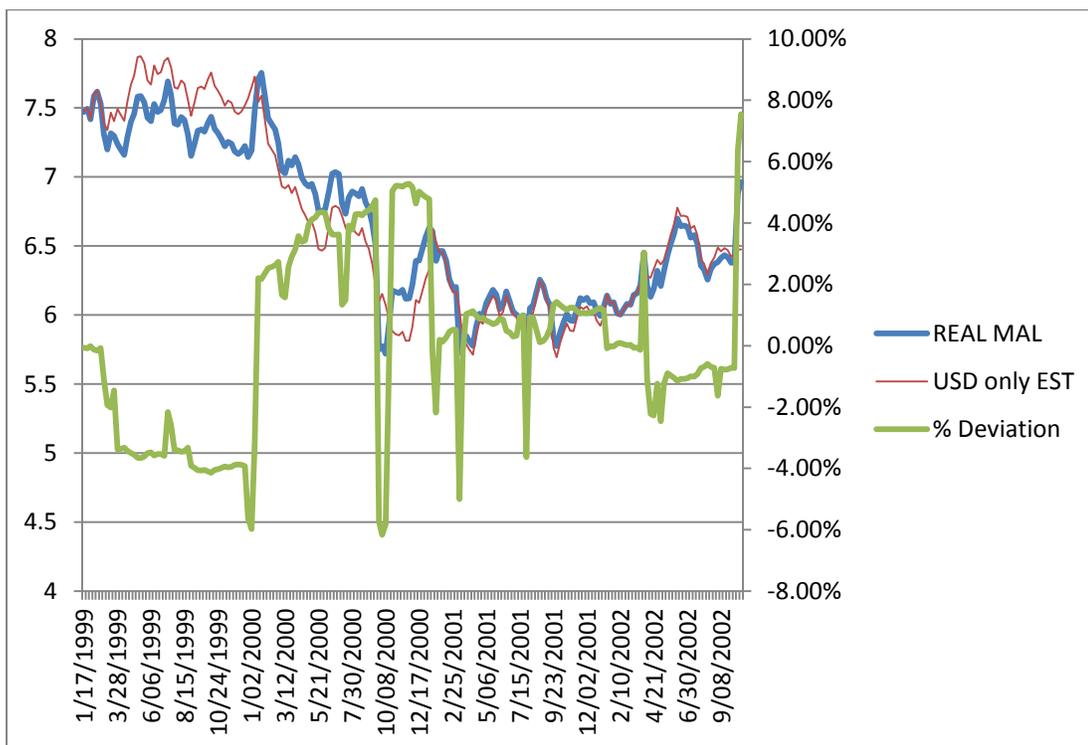
In the third time period, the coefficient on the U.S. dollar becomes insignificant and the EMP coefficient increases to 0.59 reflecting a moderate to high degree of flexibility. Again, this is consistent with the background that I presented earlier regarding this structural break. The second structural break has occurred as the Maldivian authorities ran out of foreign reserves and were unable to keep the peg to the dollar. That is precisely what we observe in the third period through our analysis.

Table 5.40

MAL Coefficients	OLS(1)	Time	OLS(2)	IV
C	0.00 (1.04)	1	0.00 (0.30)	0.00 (0.24)
		2	0.00 (0.96)	-
		3	-0.00 (-0.65)	-
USD	0.92*** (27.1)	1	0.18* (1.82)	1.07*** (3.82)
		2	0.97*** (63.6)	-
		3	0.45 (1.65)	-
EUR	0.14 (1.62)	1	-0.10 (-1.5)	0.24 (1.13)
		2	0.00 (0.84)	-
		3	0.12 (1.22)	-
JAP	-0.02 (-0.42)	1	-0.07 (-1.49)	0.08 (0.72)
		2	0.01* (1.79)	-
		3	-0.17* (-1.70)	-
GBP	0.03 (0.64)	1	0.20*** (2.69)	0.19 (0.70)
		2	-0.00 (-0.47)	-
		3	0.14 (0.91)	-
MALEMP		1	0.79*** (11.6)	-0.35 (-1.01)
		2	0.01* (1.74)	-
		3	0.59** (2.21)	-
Adjusted R-squared	0.68	1	0.87	-0.06
		2	1.00	-
		3	0.76	-
Observations	687	1	198	198
		2	378	-
		3	101	-

In the first time period, we observe a band of 6% around the basket-predicted Maldivian exchange rate. While we are unaware of the degree of flexibility, the band reflects low flexibility of the Maldivian exchange rate regime during this time period.

Figure 5.12



In the second time period, where the Maldivian is known to follow a dollar peg, we see a very small band of 2% around the basket-predicted Maldivian exchange rate. This result reflects a very low level of flexibility and is consistent with the fact that the Rufiyaa is a pegged exchange rate during this time period. Compared with the first time period, the exchange rate regime has lower flexibility in this period.

Figure 5.13



We realize that in the third time period, the Maldivian Rufiyaa breaks away from the peg, therefore we would expect to see a much greater band around the basket-predicted exchange rate since the basket-predicted exchange rate would be unable to act as a reference point when the Rufiyaa is floating. The figure is consistent with this, as it reflects a band of as high as 30% during this time period, reflecting a very high degree of flexibility around the basket-predicted exchange rate. This is also consistent with the large coefficient of 0.59 on the EMP.

Figure 5.14



Sri Lanka

IV regression is not required. Based off OLS (2), we observe a Structural Break identified on 4/29/01. This break point is close to the announcement by the Central Bank of Sri Lanka, on January 23 – 2001, to freely float its exchange rate (IMF, 2002). Therefore, there is good reason to believe that the structural break point that we observed coincides or is at least caused by the announcement by the Central Bank

In the first time period, before the announcement of the freely floating rate, we see a large weight on the U.S. dollar (0.78) which is significant at the 1% level.

Moreover, we see a coefficient of 0.13 on the Sri Lankan Exchange Market Pressure which reflects relatively low exchange rate flexibility.

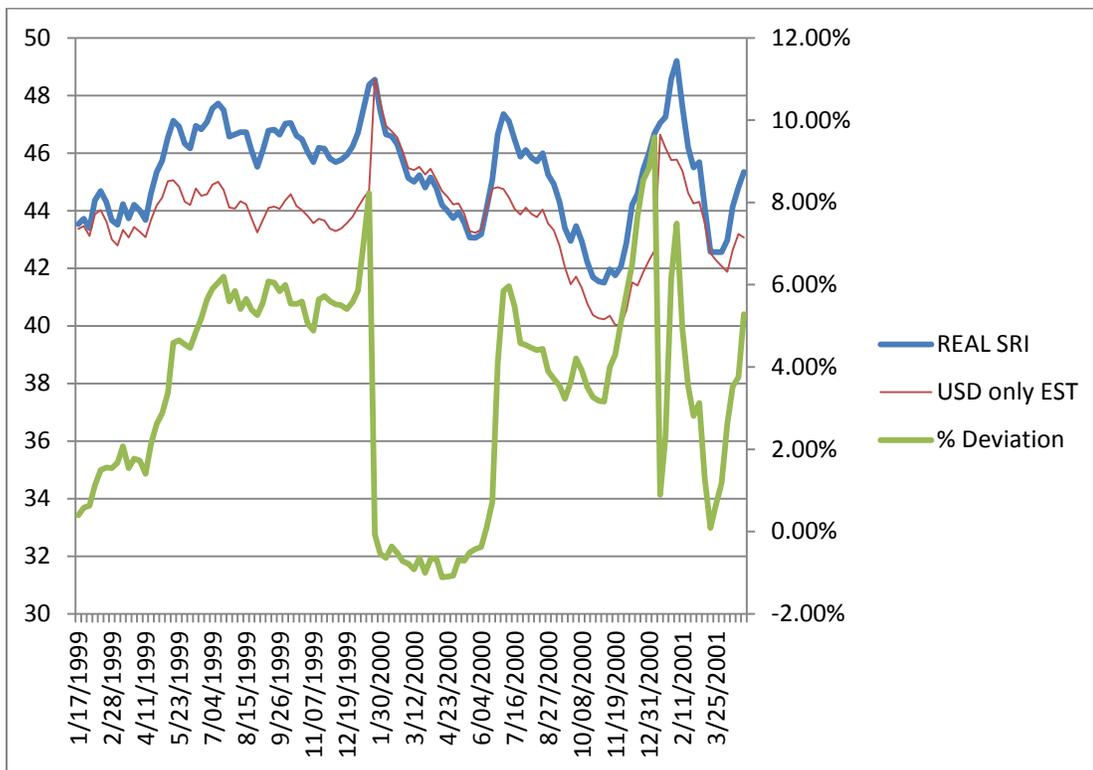
After the structural change, the Sri Lankan authorities have placed a much larger weight on the U.S. Dollar, increasing it from 0.78 to 0.98. The coefficient on the exchange market pressure has become insignificant though, making it difficult for us to infer the change in flexibility. The authorities have announced that the change in regime was to move towards more flexibility, however, it is difficult to deduce that without any information on the exchange market pressure. However, an analysis of the band that the Central Bank of Sri Lanka monitors could give us useful insights.

Figure 5.41

Sri Coefficients	OLS(1)	Time	OLS(2)
C	-0.00 (-0.23)	1	0.00*** (3.88)
		2	0.00* (1.78)
USD	0.98*** (38.0)	1	0.78*** (8.72)
		2	0.98*** (33.0)
EUR	-0.00 (-0.04)	1	0.00 (0.04)
		2	-0.03 (-0.93)
JAP	-0.03 (-0.81)	1	0.04 (1.05)
		2	0.00 (0.18)
GBP	0.05 (1.19)	1	0.09 (1.24)
		2	0.04 (1.06)
SRIEMP		1	0.13*** (2.75)
		2	0.00 (0.42)
Observations	143	1	121
		2	552
Adjusted R-squared	0.95	1	0.79
		2	0.92

In the first time period, we observe a band of approximately 10%. The result is slightly surprising, given the very low value, 0.13, of the Sri Lankan EMP.

Figure 5.15



In the second time period, we observe a band of around 8%. As we did not have a statistically significant weight on the EMP, we cannot deduce flexibility in any meaningful way from that. The band however, suggests relatively same or even lower flexibility for the Sri Lanka rupee in the second time period than in the first time period. This result shows that there is no evidence that the Sri Lankan exchange rate regime has become more flexible in the second time period, as has been argued by the Central Bank of Sri Lanka. Even though, the structural change was supposed to coincide with greater flexibility, instead, we see relatively same level of flexibility and a large weight on the U.S. dollar.

Figure 5.16



Bangladesh

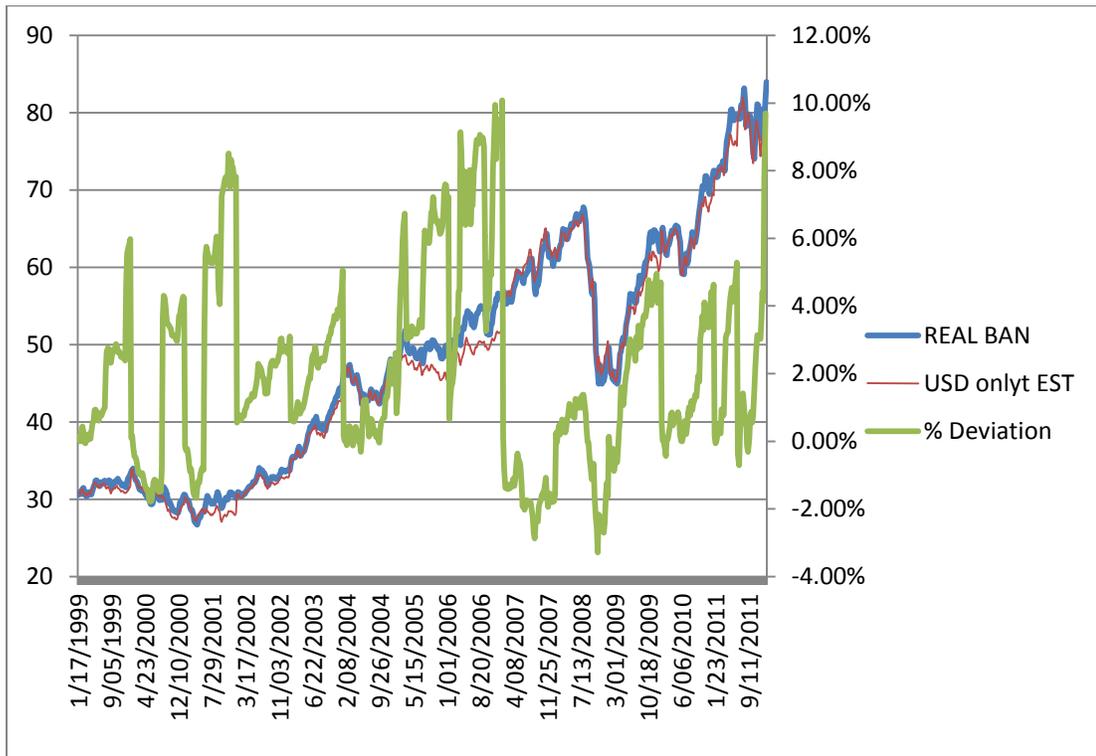
IV regression not required. Using OLS (2), we observe a large weight and high significance on the U.S. dollar (0.86). The exchange market pressure variable reveals that the Bangladeshi exchange rate has low flexibility. Furthermore, the high adjusted R-squared suggests that the model fits well.

Table 5.42

Ban Coefficients	OLS(1)	OLS(2)
C	0.00*** (3.61)	0.00*** (2.85)
USD	0.98*** (49.3)	0.86*** (22.5)
EUR	0.01 (0.27)	0.01 (0.31)
JAP	-0.01 (-0.67)	-0.02 (-1.50)
GBP	0.00 (0.05)	0.02 (1.08)
BANEMP		0.11*** (3.84)
Observations	678	678
Adjusted R-squared	0.88	0.90

The analysis shows that the Bangladeshi authorities are following a band of approximately 10% around the basket-predicted Bangaldeshi exchange rate. With an EMP value of 0.11, a 10% band seems relatively high but it is consistent with the result obtained in Sri Lanka's case where an EMP of 0.13 corresponded with a 10% band as well.

Figure 5.17



Larger Picture

Comparison of basket weights

To get a general picture of the exchange rate regimes in South Asia, the general findings are summarized here:

Early 2000

Key observations include that in 2000:

1. All countries, except for Nepal which pegs to the Indian Rupee, have a statistically significant weight, which varies from low to high, on the U.S. dollar.
2. India, Maldives and Nepal followed other anchor currencies as well in addition to the U.S. dollar.
3. Exchange rate flexibility varied from very low to medium.

Table 5.43

	AFG	BAN	IND	MAL	NEP	PAK	SRI
U.S. Dollar	M ***	H ***	M***	H***		L***	H ***
Euro							
Yen			VL **				
Pound				VL ***			
Indian Rupee					M ***		
EMP	L **	VL ***	L ***		VL ***	M***	VL ***

For each of the basket weights, the following key is used:

H = 0.75-1.00

M = 0.50-0.75

L = 0.25-0.50

VL = 0.00-0.25

A = Ambiguous

Significance is reported in a standard manner.

End 2011

Key observations include that in 2011:

1. Most countries continue to have a statistically significant weight, which varies from low to high, on the U.S. dollar. The only exception in this case is the Maldivian Rufiyaa which does not follow the dollar very closely anymore.
2. Maldives and Nepal follow other anchor currencies as well in addition to the U.S. dollar.

3. Exchange rate flexibility still varies from very low to medium.

Table 5.44

	AFG	BAN	IND	MAL	NEP	PAK	SRI
U.S. Dollar	M ***	H ***	L***	-	-	M***	H ***
Euro				-	-	-	-
Yen				VL **	-	-	-
GBP				-	-	-	-
Indian Rupee				-	M ***	-	-
EMP	L **	VL ***	-	M **	VL ***	L***	-

Overall Picture

A degree of discretion is used to make inferences if we have slightly dissimilar findings through the time periods. A coefficient weight and significance is only reported if we find it in the majority of the time periods. In cases where there is substantial ambiguity, an “A” sign will be placed

Key observations include that in the time period from 2000-2011:

1. Most countries had a statistically significant weight, which varied from medium to high, on the U.S. dollar.
2. India and Nepal followed other anchor currencies as well in addition to the U.S. dollar.
3. Exchange rate flexibility varied from very low to medium.

Table 5.45

	AFG	BAN	IND	MAL	NEP	PAK	SRI
U.S. Dollar	M ***	H ***	M***	H***	-	M***	H ***
Euro	-	-	-	-	-	-	-
Yen	-	-	VL **	-	-	-	-
GBP	-	-	-	-	-	-	-
Indian Rupee	-	-	-	-	M ***	-	-
EMP	L **	VL ***	-	L *	VL ***	M***	-

Comparison of EMP and Band

Table 5.46

Time Period		AFG	BAN	IND	MAL	NEP	PAK	SRI
1	EMP	0.33	0.11	0.26		0.24	0.58	0.13
	Band	7%	10%	4%		12%	12%	10%
2	EMP				0.01		0.22	
	Band				2%		4%	
3	EMP				0.59			
	Band				30%			
4	EMP						0.49	
	Band						20%	

Correlation between Coefficient on EMP and Band = 0.73

The high correlation between EMP and the Band % shows that the Band % can be used as a useful approximation of the degree of flexibility of an exchange rate regime, especially in cases where the EMP is insignificant.

To understand why we do not receive a perfect correlation or even higher correlation between EMP and the Band, let us look at an example. We see two contrasting cases in the form of Bangladesh and India. While Bangladesh has a lower EMP coefficient, it has a much wider band. On the other hand, India has a higher EMP coefficient but a smaller band. At first sight this may seem to contradict the relationship between EMP and Band, but this deserves further analysis. The EMP is measuring the degree of intervention by the central bank or state authorities in managing the exchange rate. If we assume that all countries face equal shocks, then yes, we should expect a much better correlation between EMP and the band but countries face different frequency and intensity of shocks. For instance, a country with a 2% band might not face any substantial shocks, which means that the central bank does not have to intervene even though theoretically it has lower flexibility in mind; this would give us a higher EMP despite the low band. On the other hand, a country with a 10% band might face substantial shocks causing its central bank to intervene regularly to prevent the exchange rate from moving outside the band; this would give us a much lower EMP despite the higher band. So, looking at the EMP and band results in the aforementioned table, we can get an idea of how regularly authorities are intervening in the exchange rate market, how large the band is and what inference it gives us about the degree or intensity of shocks the country faces. However, further discussion of this is out of the scope of this thesis.

The key point is that we must exercise caution when comparing EMP with the band directly. However, with that said, both EMP and the band can give us slightly different, but useful insights. For instance, if we notice a country consistently keeping deviations within a certain band in a manner that it is clear that the authorities are intervening when the deviation is becoming greater than the band width, then in that situation, the band used in conjunction with the band gives us very useful insight.

Meanwhile, this reiterates the reasoning behind using the Frankel Wei Synthesis technique because it does not calculate the EMP in isolation but uses regression analysis to get a coefficient on EMP in connection with the weights on the potential anchors.

Chapter 6 - Conclusion

Findings

Ever since the distinction between *de jure* and *de facto* exchange rate regimes has been well-established, exchange rate regime analysis has become a popular area of study among economists. Multiple analysis techniques have been proposed in the past, but over the past couple of decades the focus has converged to a technique developed by Frankel and Wei that is a synthesis of two other prominent techniques. Building off of Frankel and Wei's work, I started this thesis with the primary goal of contributing to the literature on *de facto* regime analysis. After providing a comprehensive literature review, I have analyzed and provided insight into numerous contentious issues in the literature including the data used, choice of numeraire, exchange market pressure and broadly, the empirical methodology used in various studies. I then incorporate some innovations into my analysis as well as conducting thorough robustness checks on my results. Through the VAR approach, this thesis explicitly checks for intra-regional dependencies, which is a largely missing practice in the literature. Moreover, the thesis sheds light on the potential endogeneity of the weights in a country's exchange rate basket vis-à-vis the Exchange Market Pressure and proposes a solution through the use of interaction terms. In the context of the flexibility of regimes, I have built on the work of Jie (2010) to calculate the bands that central banks monitor around the basket-predicted exchange rate. Finally, recognizing that the Frankel-Wei synthesis regression is a locally useful solution when weights are relatively stable, the outcomes from the regressions are compared

and linked with the geopolitical and economic situations in the studied countries in order to provide more confidence in these findings.

Given that South Asia has largely been ignored in *de facto* exchange rate regime analysis, the second goal of this thesis was to provide an analysis of the exchange rate regimes in South Asia. A general finding is that all South Asian countries in the region, with the exception of Nepal, are currently following managed floats with primary weight on the U.S. dollar, ranging from 0.5 to 1.0, and with very low to medium flexibility, assessed by EMP coefficient values ranging from 0.0 to 0.5. The large and statistically significant weight on the U.S. dollar could be reflective of the dollar's status as a global reserve currency. Furthermore, much of the trade for South Asian countries could be denominated in dollars. Overall, the region has similar regimes and implicit exchange rate coordination seems to be happening already. However, if South Asian countries are to work towards economic integration, this implicit coordination must be built upon by explicit exchange rate coordination. Whether that is feasible or not is a question that SAARC must address collaboratively.

Finally, this thesis analyzed the effect of the global financial crisis on South Asian exchange rate regimes. The results show that despite the crisis, the U.S. dollar remains an important anchor currency for almost all South Asian countries. However, interestingly, some countries diversified their exchange rate baskets in the crisis period but moved back to anchoring only to the U.S. dollar in the post-crisis period. Meanwhile, it is difficult to assess the changes in flexibility across the crisis due to

the insignificance of the EMP variable in most specifications. The insignificance on the EMP means that we cannot say anything conclusive about the flexibility.

Weaknesses

The last sentence naturally brings us to the weaknesses of the current analysis. First and foremost, we notice that the use of Instrumental Variables for EMP always leads to insignificance on the EMP variable. This makes it difficult to understand the flexibility of the exchange rate regimes. Therefore, one area for future research would be to propose and implement better instruments for the EMP variable. There is the possibility that the EMP variable will still be insignificant because that is the “true” result. However, to ensure that this is not a weakness related to the current set of instruments, we should try another set of instruments as well for robustness.

Second, South Asian countries only have monthly foreign reserves and monetary aggregate data. So, if the analysis is being conducted by using weekly exchange rate data, the monthly reserves and monetary aggregate data must be interpolated. This could lead us to less accurate results because we are “estimating” the weekly reserves and monetary aggregate data from monthly data. If we had weekly data, then we could have much more confidence in the accuracy of our results. On a similar note, when using the EMP variable, we are primarily interested in the reserve changes due to policy intervention and not due to changes in currency valuation. However, the available reserve data does not differentiate between them. Therefore, economists must either try to develop techniques to obtain reserve changes

caused primarily by policy intervention or at least be cognizant of this problem and try to account for it in their research.

Finally, as mentioned earlier, due to the lack of knowledge about the crawl pattern of exchange rate regimes, more research needs to be devoted to developing a better understanding of the nature of the crawl so that it can be accounted for in the exchange rate analysis. In this thesis, I had to re-calibrate the basket-predicted exchange rate and the actual exchange rate every year to account for the missing “crawl” in the regression. As opposed to using ad-hoc measures to account for the crawl, such as re-calibration every year, it would be best if the crawl portion could be accounted for explicitly in the regression analysis.

In terms of further research, the focus in the literature must certainly turn towards finding better instruments for the EMP variable, and weekly reserves and monetary aggregate data. Building off this, research in this area has done a great job at providing a variety of robustness tests by using different frequencies of data and various numeraires. However, there is still no consensus on the best practices in the area or the advantages and disadvantages of different approaches. A more theoretical understanding must be developed of why different numeraires or different frequencies affect our results in a specific manner, so that best practices can be developed from that.

Finally, it is important to realize that the FW synthesis technique may not necessarily reflect the methodology employed by the various central banks to calculate their basket pegs. For instance, the Central Bank of Kuwait calculates its

basket weights using exchange rate in levels while the State Bank of Pakistan does the same by using first differences. Therefore, in each case it is important to link back or connect our results in some capacity to the geopolitical and economic situation in the country. This is important, so that our results are not based on isolated data analysis but so that it can be linked to specific occurrences in a country, which can provide us with a better understanding of changes in exchange rate regimes.

Appendix A – Unit Root test

Currency	Numeraire	ADF Test – Levels	ADF Test – First Differences
Afghanistan Afghani	Australian Dollar	Not Rejected	Rejected***
	Swiss Franc	Not Rejected	Rejected***
Bangladeshi Rupee	Australian Dollar	Not Rejected	Rejected***
	Swiss Franc	Not Rejected	Rejected***
Euro	Australian Dollar	Not Rejected	Rejected***
	Swiss Franc	Not Rejected	Rejected***
Great British Pound	Australian Dollar	Not Rejected	Rejected***
	Swiss Franc	Not Rejected	Rejected***
Indian Rupee	Australian Dollar	Not Rejected	Rejected***
	Swiss Franc	Not Rejected	Rejected***
Japanese Yen	Australian Dollar	Not Rejected	Rejected***
	Swiss Franc	Not Rejected	Rejected***
Maldivian Rufiyaa	Australian Dollar	Not Rejected	Rejected***
	Swiss Franc	Not Rejected	Rejected***
Nepalese Rupee	Australian Dollar	Not Rejected	Rejected***
	Swiss Franc	Not Rejected	Rejected***
Pakistani Rupee	Australian Dollar	Not Rejected	Rejected***
	Swiss Franc	Not Rejected	Rejected***
Sri Lankan Rupee	Australian Dollar	Not Rejected	Rejected***
	Swiss Franc	Not Rejected	Rejected***
U.S. Dollar	Australian Dollar	Not Rejected	Rejected***
	Swiss Franc	Not Rejected	Rejected***

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