Dollar Peg or Euro Peg?

An Application of the Synthesis technique on the Indian rupee

Suvojit Lahiri Chakravarty

Ram Lal Anand College (Eve)

Benito Juarez Road, N Delhi- 110021

Email Address- www.suvojitchakravarty@yahoo.co.in

The author is Reader of Economics at Ram Lal Anand College (Eve).

Abstract

This paper examines the defacto exchange rate regime for the Indian economy using a time series of monthly data from 1999:1 to 2008:12.using the synthesis technique of Frenkel & Wei (2008). The technique covers both the dimensions of estimating the exchange rate regime viz, inferring weights of the currencies in the basket peg and estimating flexibility around an anchor currency. This methodology is suitable as India along with other emerging economies have followed variants of band basket crawl in the last decade. The second part of the study focuses on the question of impossible trinity and the degree of monetary independence for the Indian economy for the same period in the light of increasing capital flows.

Jel Classification – F 31, F41

Key Words- Synthesis technique, impossible trinity, monetary independence

Dollar Peg or Euro Peg?
An Application of the Synthesis technique on the Indian rupee

Introduction

The exchange rate of the Indian rupee became 'market determined' from March 1993. However the RBI has control over the exchange rate and actively intervenes in the foreign exchange market to reduce the volatility of the rupee so as to maintain orderly conditions in the market (Goyal et al 2009). There has been quite a few studies in this area, trying to ascertain the true level of flexibility of the Indian rupee- Cavoli & Rajan (2007), Shah & Patnaik (2007), Pattnaik (2007). The results show that the rupee is still effectively pegged to the US dollar. However in the recent period the euro is gradually gaining greater importance in influencing movements in the Indian rupee but this is at the expense of the pound and the yen rather than the US dollar (Cavoli & Rajan 2007).This may be due to the fact that Europe is slowly emerging as India's largest trading partner.Together with this India has experienced a tremendous rise in foreign capital flows and financial integration with the rest of the world in the recent past. (Kohli 2009).

A key insight of open economy macroeconomics is the concept of the 'impossible trinity'. According to this theory, no country can simultaneously have an open capital account, a fixed exchange rate and an independent monetary policy. This implies that once the capital account is open under a fixed exchange rate, the monetary policy is fine tuned to uphold the fixed exchange rate.

After World War II, under the Bretton Woods system, many countries adopted fixed but adjustable exchange rates and independent monetary policy. This was done by closing the capital account. However in the recent period capital account has become more open in quite a number of countries. This has been a matter of concern for the policy makers, especially for emerging economies, as they are faced with two problems – (1) to frame a monetary policy addressing the problems of the domestic economy & (2) to maintain a stable exchange rate to boost export growth. Some countries have adopted flexible exchange rates as a route to

monetary independence, some have chosen a fixed exchange rate and others have opted for a managed float with limited monetary independence (Frenkel 1999).

India maintained a system of strong capital controls which made it possible for the RBI to maintain a fixed exchange rate and an independent monetary policy prior to the nineties decade. After that, restrictions on the current account and capital account were gradually eased and this process acclerated after 2000 (D'Souza 2008). It is important to emphasize here that India has neither a fully open capital account nor a completely fixed exchange rate. The current policy comprises of a partially open capital account and a pegged (but not fixed) exchange rate. This is done so that the monetary policy can be used as an effective tool to address domestic concerns (Kohli 2009).

In the recent times, two important committee reports have generated a lot of interest—The High Powered Expert Committee on making Mumbai an International Financial Centre headed by Percy Mistry and The Committee on Financial Sector Reforms headed by Raghuram Rajan. The reports argued for further deregulation of the capital account and the financial sector, an inflation targeted monetary policy and an unified financial sector regulatory architecture.

Against this backdrop, the objective of this paper is two fold. First we want to ascertain the true degree of flexibility of the Indian rupee vis-a vis the currencies of her major trading partners using the synthesis technique of Frenkel & Wei (2008). Second we want to test the degree of monetary independence of the RBI through the comovement of the short term interest rates in an era of liberalized capital flows using the approach of Obstfeld, Shambaugh & Taylor(2003). The rest of the paper is organized as follows. In section 1 we review the literature on exchange rate classification. Section 2 explains the synthesis technique. The results are discussed in section 3. In section 4 we review the literature on capital flows, exchange rate stability and monetary independence. Section 5 discusses the methodology for testing monetary independence and the results and finally section 6 concludes.

(1) Classification of Exchange Rate Regimes

Classifying exchange rate policies pursued by countries has been one of the greatest problems faced by researchers.The reason is there is a big difference between the regimes that countries follow in practice(defacto exchange rate regimes) and the regimes that their

respective governments officially claim to be following (dejure exchange rate regimes). The IMF regularly publishes exchange rate arrangements reported by its member countries in the annual publication titled 'Annual Report on Exchange Arrangements and Exchange Restrictions'. Prior to 1997,this classification was based totally on what was declared by the member countries regarding their exchange rate policy. This official or dejure classification was not found to be satisfactory by the researchers. The main drawbacks were that- firstly, it failed to capture between what the countries claimed to be doing and what they were doing in practice. For eg, Levi–Yeyati and Sturzeneggar (LYS) (2005) argue that 'many alleged floaters intervene in the exchange market while several fixers devalue periodically to accommodate independent monetary policies.' The second problem was that it does not distinguish between all the major different categories of exchange rate regimes that are relevant for research.

To address these shortcomings, the IMF adopted a modified system in 1999, distinguishing between various types of pegged regimes and classifying exchange rate regimes on country's defacto policies. The new system, after an extensive classification, identified the following categories of exchange rates (1) regime with another currency as legal tender including currency unions; (2) currency boards; (3) conventional currency pegs (against a single currency or a basket of currencies); (4) pegged exchange rates within horizontal bands; (5) crawling pegs; (6) crawling bands; (7) managed floating with no predetermined path for exchange rate; (8) independent floatingThis system marks a significant improvement over the previous classification. Also it has adopted a mixed dejure- defacto classification where the self declared regimes are adjusted for anomalies.

Several studies on exchange rate regimes have tried to come up with their own defacto exchange rate regime classification. An early study by Holden, Holden & Suss (1979) attempts to characterize the defacto exchange rate regime taking into account nominal exchange rate volatility and the degree of intervention in the foreign exchange market as measured by variations in international reserves. Poirson (2001) creates an index of defacto exchange rate flexibility based on the ratio of nominal exchange rate volatility to variations in reserves, both in absolute value, with changes in reserve normalized by the monetary base. Bubula and Otker Robe (2002) construct a monthly database of defacto exchange rate regimes of all IMF member countries since 1990 using the IMF's 1999 nomenclature. The classification is based primarily on information obtained through bilateral discussions with member countries and

from contracts with the IMF desk economists. These views are then supplemented with other sources of information including press reports, news, articles and supported by observed exchange rate and reserves behaviour to arrive at the final view on the defacto regime.The usefulness of this measure is that it provides a historical database of the revised classification made by the IMF in 1999 and is very useful for time series study.

More recently there has been quite a number of studies which attempts to discern the true 'defacto' exchange rate regimes of the countries, for eg, Calvo and Reinhart (CR)(2002), Levi Yeyati and Sturzenegger (LYS) (2003 &2005),Reinhart And Rogoff (RR) (2004) and Shambaugh (2004).

CR (2002) construct variability of foreign exchange reserves, interest rates & exchange rate. They find that variability of foreign exchange reserves and interest rates is high relative to the variability of the exchange rate for many emerging economies. This suggests that many countries that claim to float have intervened actively to prevent appreciation of their currencies. Thus they coined the term 'fear of floating' to explain the fact that emerging economies shy away from substantial exchange rate volatility through active intervention.

LYS (2005) produce a defacto exchange rate regime classification for 156 countries from 1974 to 2000. They apply cluster analysis to countries' observed volatility of exchange rate and reserves. The cluster with high volatility of reserves and low volatility of exchange rates identifies the group of fixers and the cluster with low volatility of reserves and high volatility of exchange rates identifies the group of floaters. They conclude that their classification is significantly different from the dejure classification provided by the IMF. RR (2002) present a monthly database of exchange rate regimes for 153 countries over the period 1946-2001. They follow a broadly similar nomenclature to that of the new IMF classification. Exchange rates are classified and verified mainly by applying a variety of descriptive statistics to either official and market determined parallel exchange rates depending on whether a country has a unified or multiple exchange rates. The strength of their approach is that –the use of free market information in the form of parallel exchange rates, the use of long time series and the separation of 'freely falling episodes'. Shambaugh (2004) examines the exchange rate classification issue for 155 countries from 1973-2000.Here he focuses on whether the exchange rate stayed within a band.The base country is first identified for the respective countries and it is tested whether the exchange rate stayed within (+/-) 2 percent bands against the base

currency. In addition, to prevent breaks in the peg status due to one-time realignments, any exchange rate that had a percentage change of zero in eleven out of twelve months is considered fixed.

It is interesting to note that the various studies which have tried to classify defacto regimes do not agree with each other (Frenkel& Wei 2008). There are various explanations for the variation in conclusions reached by the different classification schemes : difference in methodology, different choices as to where to draw the line between regimes, differences in timing of data , etc.

There exists a second branch of literature which is different from the research on flexibility vs fixity debate. This applies to countries that have pegged their currencies to a basket of currencies. This approach tries to discern from actual data the implicit weights placed on the constituent foreign currencies of the basket. This approach was pioneered by Frenkel & Wei (1994) whereby the ordinary Least Squares (OLS) methodology is used so as to test the influence of other currencies that are supposed to constitute the basket on the local currency. This approach has been widely used by others including Frenkel& others (2001), Cavoli & Rajan (2005,2007), Shah& Pattanaik (2007), Pattnaik (2007)

Frenkel & others (2001) use the Frenkel & Wei (1994) methodology to assess the exchange rate regimes for a number of emerging economies from 1986 to 1999 using monthly data. Their results suggest that it is easy to verify the exchange rate regime when the band is relatively narrow and the peg involves a single currency. A higher band width as well as the adoption of multiple instead of simple basket pegs and frequent parity realignments make econometric verification of the announced regime difficult.

Cavoli & Rajan (2005) examines the exchange rate flexibility of five Asian countries (Indonesia, Korea, Malaysia, Phillipines, Thailand) post the financial crisis of 1997-98 till mid 2004 using montly data.The results show that the exchange rate regimes for Korea, Thailand & Indonesia underwent a transition from soft dollar pegs to floating exchange rates (cum inflation targeting) after the crisis. Malaysia's regime reverted to a fully fixed exchange rate vis-a –vis the dollar since September 1998. The Phillipines however maintained a 'dirty' floating exchange rate regime.

Cavoli & Rajan (2007) carries out the same exercise for the Indian economy using monthly data from 1985:1 to 2004:12. The results show that the dollar is the dominant

currency in determining the rupee but post 1999 the euro is becoming a significant currency in determining movements in the Indian rupee (about 20%). Shah & Pattnaik (2007) tests the exchange rate regime for India for the period 1992:8 to 2004:11 using daily data. They argue that although officially India had a market determined exchange rate, in reality the rupee was pegged to the dollar. This is borne out by the extremely low volatility of daily returns on the INR/USD[1] compared to that of other exchange rates such as the INR/Euro & INR/ Yen. Tests based on the Frenkel & Wei (1994) methodology show that the USD is overwhelmingly the dominant currency in explaining fluctuations of the Indian currency. Pattnaik (2007) carries out the same exercise for an updated data set from 1993:4 till 2007:1 for a number of countries including India. The basic conclusion for India remains unaltered.

The two approaches serve two different purposes. The first approach of the regime classification literature tries to uncover the true degree of exchange rate flexibility by comparing the variability of the exchange rate (vis-à-vis the anchor currency) to the variability of reserves. However it is unable to identify the relevant anchor. On the other hand the second approach specializes in inferring the relevant anchor currency or basket under the null hypothesis of a perfect fit but fails to explain the error term under the alternative hypothesis that the country is not perfectly pegged to a major currency or to a basket.

(2) The Synthesis Technique

Frenkel & Wei (2008) have devised a new synthesis technique whereby these two approaches are brought together to produce a single equation suitable for use in inferring defacto regimes across different levels of flexibility and different anchors. The starting point of this technique is the approach formulated by Frenkel & Wei(1994). The implicit assumption here is that the home currency is indeed determined by a currency basket. If we know the list of currencies in the basket or a list that includes as a subset those that are used in the basket then we have to regress changes in the log of H, the value of the home currency on the changes in the log values of the candidate currencies, X_js.

The reasons to work in terms of changes rather than levels are – (1) it helps to address concerns of nonstationarity & (2) it allows (by including a constant term) for the likelihood of a trend appreciation or trend depreciation against the dollar or a broader basket (Frenkel & Wei 2008).

[1] INR=Indian Rupee, USD= US dollar

Algebraically this can be represented as

$$\Delta \log H_t = c + \sum_{j=1}^{n} w(j) [\Delta \log X(j)_t] \qquad (1)$$

If the exchange rate is indeed governed by a strict basket then we can recover the true weights w(j) as long as we have more observations than currencies. In reality few countries have such strict basket pegs. In that case one must reexamine eq(1) and think about the non basket factors. The introduction of the exchange market pressure (emp) variable as one of the explanatory variables should improve the estimates of eqn(1) as it allows for the fluctuations in the demand for currency that can push the exchange rate away from the central basket parity. This in some way can help to measure to what extent the authorities intervene to stabilize the currency.

Thus the modified eqn is

$$\Delta \log H_t = c + \sum_{j=1}^{n} w(j) [\Delta \log X(j)_t] + \beta [\Delta emp_t] \qquad (2)$$

Here β captures the defacto degree of exchange rate flexibility. $\beta = 1$ means the currency floats freely and there is no foreign exchange market intervention & $\beta = 0$ means the exchange rate is purely fixed and most currencies lie somewhere in between.

Δemp_t is defined in two ways-

(a) $\Delta emp_{1t} = \Delta \log EMP_{1t} = \Delta \log H_t + \Delta \log Res_t$ where Res_t is reserves in period t

(b) $\Delta emp_{2t} = \Delta \log EMP_{2t} = \Delta \log H_t + \Delta Res_t / MB_{t-1}$ where MB_{t-1} is monetary base in period t-1

Before the estimation of equation (2), the choice of numeraire currency has to be discussed. Here Frenkel & Wei(1998) notes that if the exchange rate is truly a rigid basket peg, the choice of the numeraire currency is immaterial because if the linear equation holds precisely in terms of any one 'correct' numeraire, it will hold true for any other numeraire as well.However if the true regime is more variable then the choice of the numeraire does make some difference to the estimation. A weighted index such as the special drawing right (SDR) is better suited than a single remote currency in this case. The reason is the numeraire should be similar to that used by the authorities in measuring what constitutes a large deviation from the reference basket and thereby deciding whether to intervene or allow to be reflected in the

exchange rate.This will help to minimize the possibility of correlation between the error term and the numeraire.

Lastly, Frenkel & Wei (2008) in their estimation of 20 currencies have used the adding up constaint ie , Σ w(j) =1. They argue that imposing such a constraint is necessary as there are only 48 observation per regression and so saving degrees of freedom is essential. We have decided not to impose this adding up constraint in our analysis as we don't have any degrees of freedom problem as our data set is quite adequate and the currencies considered in the estimation of equation (2) for the Indian case is a subset of the total number of currencies which comprise the basket and so imposing the constraint may distort the results

(3) Results

Equation (2) is estimated for the Indian economy using a time series of monthly data from 1999:1 to 2008:12. The rationale for choosing 1999:1 as our starting point is that the euro came into existence from this month. We have tried to examine the degree of influence between the Indian rupee and a vector of major currencies viz, the US dollar, UK pound, the euro and the Japanese yen using the synthesis technique.Data for the variables are obtained from two sources- International Financial Statistics and RBI – Handbook of Statistics for the Indian Economy (various issues).

Thus we have,

$$\Delta \log H_t = c + w(1)\Delta \log X1_t + w(2)\Delta \log X2_t + w(3)\ \Delta \log X3_t + w(4)\ \Delta \log X4_t + \beta [\Delta emp_t] + u_t \qquad (3)$$

Where H_t = value of the exchange rate of the Indian rupee with respect to the SDR

$X1_t$, $X2_t$,$X3_t$,$X4_t$ = value of the exchange rate of the US dollar, UK pound, euro, yen with respect to the SDR respectively.

For emp_t we have used both the definitions discussed in the previous section.

The OLS estimates for India using both the definitions of emp are summarized in table (1). It is clear from the results that the US dollar is the dominant currency in determining the value of the Indian rupee in both the cases. When emp_1 is used, the US dollar is marginally insignificant at the 10% level of significance whereas the other currencies are strongly insignificant. The emp term is significant and has a value of 0.28 implying a managed float. The results differ slightly when emp_2 is used in the estimating equation.Here the level of insignificance of the US dollar is slightly more.

We have tried to extend the analysis using a different measure of emp. Recent research (Vanpoeck and others 2007) on emp suggests that a better measure of emp can be obtained if different volatilities of the components are taken care of. This can be done by using variance smoothing weights in the expression for emp. In addition, changes in interest rate should also be included along with change in reserves and exchange rate as the authorities can sometimes resort to interest rate changes to control the demand for the home currency (Eichengreen, Rose & Wyplosz 1996).However following Baig (2001), Bayoumi and Eichengreen (1998), Cavoli & Rajan (2007), we exclude interest rate changes in the emp equation as it is not always clear whether interest rate variations capture policy changes or general market conditions.

Thus the new measure of emp is,

$$\Delta emp_{3t} = \Delta \log EMP_{3t} = \Delta \log H_t + (varH/var\ res)\ \Delta Res_t/MB_{t-1}$$

Where var H = variance of $\Delta \log Ht$

var res = variance of $\Delta Res_t/MB_{t-1}$

The result using this new measure of emp (table 2) shows that the US dollar and the emp term are significant at the 1% level whereas the other currencies are insignificant showing strong evidence of a dollar peg. We have tried to cross check our results by estimating equation (3) without the emp term (table 2) (Frenkel & Wei 1994). The value of adjusted R^2 has diminished as the emp term is excluded but the US dollar is the still the dominant currency to which the rupee is pegged and is also highly significant.

From the above analysis we can conclude that the Indian rupee is a defacto soft US dollar peg which is consistent with the other studies in this area namely Cavoli & Rajan (2007), Shah & Pattnaik (2007).

(4) Monetary Independence

In this section we discuss the issue of monetary independence in a regime of fixed exchange rate and progressively open capital account.Frenkel (1999) has argued that financial markets in the recent decade have become more integrated internationally and so the choice comes down to giving up on exchange rate stability or monetary independence. He however adds that a country may have half stability and half independence. In his own words ‘There is nothing in existing theory, for example, that prevents a country from pursuing a managed float

in which half of every fluctuation in demand for its currency is accommodated by intervention and half is allowed to be reflected in the exchange rate.'

From economic theory, the advantages of a fixed exchange rate can be summarized as (1) reduced transactions cost and exchange rate risk that can discourage trade and investment (2) a credible nominal anchor for monetary policy. In contrast, a flexible exchange rate allows the authorities to pursue independent monetary policy. This is helpful when the country is in a recession: the authorities through an expansionary monetary policy and devaluation of the currency can step up demand of domestic goods.

Thus, according to the traditional view, under fixed exchange rates and unrestricted capital flows, domestic interest rates must follow closely those prevailing in the country to which the domestic currency is pegged. However under a flexible exchange rate arrangement, the domestic interest should be less sensitive to international interest rate changes, other things equal. For countries with intermediate regimes, the sensitivity to international interest rates should be less than peggers (Obstfield & Taylor 2003).

There is also an alternative view held by some economists (Calvo & Reinhart 2002, Hausman, Panizza & Stein 2001) ie, there exists ' fear of floating' that prevents countries with flexible exchange rate regimes to allow their currencies to float freely. In these countries (mostly emerging economies) factors like exchange rate pass through & foreign currency liabilities are potential barriers to pursuing an independent monetary policy irrespective of the exchange rate. Thus these countries, even if formally floating are importing the monetary policy of major currency countries much like the peggers.

There has been quite a number of studies in this area. Borenzstein & others (2001) test for monetary independence by focusing on some countries whose regimes can be defined as either currency boards (Argentina , Hongkong) or floating regimes (Mexico, Singapore). They study the effect of specific US monetary policy shocks measured by changes in the futures funds rate on the domestic interest rates and exchange rate of the sample countries.The results show that interest rates in Hong kong seem to react one-for-one to US monetary shocks while interest rates in Singapore increase by about 0.3 basis points(bp) to a 1 bp increase in US interest rates. However the results for the comparison between Argentina & Mexico with respect to US interest rate shocks are inconclusive. Floating exchange rates did not seem to have appreciable benefits in insulating Mexico from shocks to international risk premia.

Hausman & others (1999) find that the reaction of domestic rates to US rates is insignificantly different across exchange rate regimes. They use monthly data from 1960 to 1998 for eleven countries. In addition they use daily data for 1998-99 for Mexico, Venezuela & Argentina and find the reaction of domestic interest rates to international interest rates is highest for Mexico, the country with the most flexible exchange rate regime.

Frenkel (1999) regresses quarterly & monthly domestic interest rates in several emerging market countries on the US Federal funds rate. He concludes that interest rates in countries with less firm tie to the dollar (Mexico & Brazil) show much higher interest rate responses than countries having currency boards or dollarization (Argentina, Hongkong or Panama). The standard errors of the coefficients are also larger in the former case.

Frenkel & others (2002) in their paper, try to establish major empirical regularities concerning the sensitivity of domestic interest rates to international interest rate under different currency regimes. They work with a large group of countries comprising industrial and middle income developing countries and the time span for their study comprises three decades ie, 1970s,1980s,1990s. Their pooled estimates show that the responsiveness of domestic interest rates to foreign interest rate is higher under pegged regimes than under intermediate and floating regimes. In their dynamic specification, country specific estimates show a long run adjustment of interest rates under all regimes with a faster speed of adjustment under hard pegs than under the other regimes.

Obstfeld & others (2003) undertakes a similar type of study of international interest rate transmission but with a vastly expanded data base encompassing historical episodes as far back as 1870. This is done to check whether the trilema has endured over a long course of history. They find that there was rapid transmission of interest rate shocks during fixed rate episodes under the gold standard era when there were less restrictions on capital flows. During the Bretton Woods era, due to the presence of widespread capital controls, domestic interest rates were not too constrained by fixed exchange rates. In the modern era, with barriers to capital flows dismantled, there is a sign of reversion to the gold standard period in the sense that there is increased interest rate transmission among fixed rate countries.

Shambaugh (2004) studies the extent of monetary independence for both pegged and non pegged countries. The author takes a sample of over hundred developing and industrial countries from 1973 to 2000.The results show that pegged countries' interest rates respond

more to base interest rate changes than non pegged countries during this period. The effects of capital controls and common shocks are taken into consideration and it is seen that the general conclusions are not altered. Thus from the literature review it is clear that there exists evidence of both the views—(1) the traditional view , (2) the alternative view

In the Indian context, a system of strong capital controls backed by the Foreign Exchange Regulation Act (FERA) was present from the early seventies. This made it possible for the authorities to achieve monetary autonomy and fixed exchange rate prior to 90s (Bhattacharya 2006). After that, removal of restrictions on the current and capital accounts were initiated. This led to a loss of monetary policy autonomy in the 90s (Pattnaik 2005). She highlights two periods in her study; period 1 (June 1993 to Nov 1995) & period 2 (August 2001 to the end of 2003). Both periods witnessed a surge in capital inflows which forced the Central Bank to intervene and prevent the rupee from appreciating. This resulted in a surge in foreign assets thereby increasing money supply. She concludes that the Central Bank had to sterilize its impact but it was only partial in the sense that the drop in domestic assets was not as large as the rise in foreign assets.

Goyal (2008) on the other hand argues that in the absence of complete capital account convertibility (as in India), partial flexibility of the exchange rate gives varying degrees of monetary autonomy, a la Frenkel (1999). A high rate of growth of output may lead to the demand for the country's product to rise faster than productivity leading to a real exchange rate appreciation. This may result in more maneuverability of the monetary authorities in fixing the domestic interest rate.

We aim to test the trilemma for the Indian economy by looking at the responsiveness of short term domestic interest rate to base country (US) interest rate as our previous exercise reveals that the dollar is the dominant currency in the basket. The earlier approach of measuring independence of monetary policy, which centers on the estimation of offset coefficient ie, the fraction of an exogenous domestic credit expansion that leaks away through foreign reserve outflows is beset with identification problems caused by the endogeneity of central bank policy (Obstfeld 1982).

(5) Methodology and Results

The objective of our study is to look into the presence of a significant levels relationship between Indian interest rates and a base country (US) interest rate using a time

series of monthly data from 1999:1 to 2008:12 and also examine the dynamics between the two rates. For this purpose we use the Autoregressive Distributed Lagged (ARDL) approach of Pesaran & Shin (2001). This has two advantages compared to the standard multivariate cointegration test such as Johansen & Juseluis (1990)- (1) it allows to test relationships between variables which are integrated of different orders, (2) it allows for testing for a equilibrium relationship as part of the general model as well as estimating the full dynamic relationship between the variables. Given the uncertainity over the order of integration of the variables due to the lack of power of most unit root tests, this technique is quite helpful.

The ARDL procedure involves two stages. At the first stage the existence of the long run relationship between the variables is investigated. This is achieved by testing the significance of the lagged levels of the variables in the error correction form of the underlying ARDL model.

Analytically, $R_t = a + bR_{bt-1} + \varepsilon_t$ (4)

The error correction specification of eqn (4) can be written as,

$$\Delta R_t = a_o + \sum_{i=1}^{n-1} b_i \Delta R_{t-i} + \sum_{i=0}^{n-1} c_i R_{bt-i} + \gamma_1 R_{t-1} + \gamma_2 R_{bt-1} + u_t \quad (5)$$

where R_t = Indian short term interest rate

R_{bt} = US short term interest rate

u_t = stochastic error term.

The null hyp of the non- existence of a long run relationship is defined as Ho $\gamma_1 = \gamma_2 = 0$ against H_1 $\gamma_1 \neq 0$, $\gamma_2 \neq 0$. The relevant statistic is the F statistic for the joint significance of γ_1 & γ_2 which in this case has a non- standard distribution irrespective of the order of integration of the regressors. If the null can be rejected, the existence of the long –run relation is confirmed. Pesaran et al (2001) proposes lower and upper critical values for the F statistic. If the computed F statistic exceeds the upper critical value, the null of no cointegration can be rejected irrespective of the order of integration of the variables. Conversely, if the test statistic falls below the lower critical bound then the null hypothesis of no cointegration cannot be rejected. If the test statistic falls between the lower and upper critical values then the result is inconclusive.If cointegration is confirmed, the coefficients of the long run relationship can then be estimated and inference on their statistical significance can be made.

In the second stage the long run relationship can be embedded in the short run error correction model and the dynamic properties of the model assessed.The model has a general form

$$\Delta R_t = a_o + \sum_{i=1}^{n-1} b_i \Delta R_{t-i} + \sum_{i=0}^{n-1} c_i R_{bt-i} - \pi(R_{t-1} - \beta_0 - \beta_1 R_{bt-1}) + w_t \qquad 5(a)$$

where w_t is a error term, π denotes the speed of adjustment back to equilibrium following a shock and is referred to as the adjustment coefficient, β_0 &β_1 are the long run coefficients. The number of lags denoted by the subscript i are determined empirically by the Schwarz Bayesian information criteria (SBC).

For short term interest rate variables, we have used three month treasury rate (Frenkel et al 2002) for both India and USA.[2] As interest parity is technically derived using the form log (1+R) (Shambaugh 2004), where R is the interest rate, we use log(1+R) in place of R as the relevant interest rate variable. Data for the Indian rate is obtained from the RBI Bulletin (various issues) whereas the US data is obtained from the Federal Reserve website, www.federal reserve.gov.

The results from the estimation of the error correction model are presented in Table 3. The F statistic shows that the null of no cointegration is strongly rejected.The error correction term is negatively sloped and is highly significant. The coefficient of the error correction term is 0.15 suggesting that the adjustment of the Indian interest rate back to equilibrium following a disturbance in the US interest rate is a slow process with only 0.15 of the discrepancy between the actual and the equilibrium interest rate being reduced in one month.This provides evidence of Goyal's(2008) proposition that the RBI has some degree of autonomy regarding monetary policy in a regime of restricted K mobility and defacto dollar peg.

Table 4 presents the diagonistic tests. The model residuals show that there is no evidence of autocorrelation, misspecification or hetroscedasticity but the LM statistic do reject the null hypothesis of normality of the residuals. However given the significantly large sample

[2] Some authors(Shambaugh 2004) have used the federal funds rate. We have tested our analysis with federal funds rate and the results were broadly similar

size, we can still use the normal distribution of the estimates asymptotically by relying on the Central Limit Theorem (Theil 1978).

Conclusion

The task of identifying the defacto exchange rate regime has created a widespread interest among economists particularly in the era of unrestricted capital flows. Here there are two important issues ie, inferring defacto weights and inferring defacto flexibility. Most of the studies available in the literature have given importance to only one or the other. The synthesis technique encompasses both the approaches ie, estimation of the weights of the currencies included in the basket and estimation of the EMP term showing the policy stance of the monetary authorities regarding the flexibility of the exchange rate. We have used this technique for measuring the degree of flexibility of the Indian rupee. The results show that the dollar is still the dominant currency in the basket but the authorities also allow some degree of flexibility of the exchange rate in the light of increasing capital flows. The second part of the study examines the degree of monetary independence for the Indian economy, through the comovement of short term interest rates.The results show that the RBI still retains some degree of monetary independence in the presence of substantial capital flows .This may be important to address the concerns of the domestic economy.

Table 1

Frenkel – Wei OLS estimates

Dep Variable	**Indian Rupee**	**Indian Rupee**
US Dollar	**-0.23 (0.12)**	**-0.19 (0.20)**
UK Pound	**0.02 (0.80)**	**0.01 (0.87)**
Euro	**0.06 (0.63)**	**0.07 (0.55)**
Yen	**0.06 (0.34)**	**0.06 (0.32)**
Δemp_1	**0.28 (0.00)***	**---**
Δemp_2	**---**	**0.27(0.00)***
Constant	**-0.01(0.00)***	**-0.00 (0.00)***
Adj R-sq	**0.63**	**0.65**
DW	**1.58**	**1.50**
Obs	**120**	**120**

Figures in brackets are the p values. * represent the variable is significant at the 1% level.

Table 2

Frenkel – Wei OLS estimates

Dep Variable	**Indian Rupee**	**Indian Rupee**
US Dollar	**-0.31 (0.01)***	**-0.58 (0.00)***
UK Pound	**0.00 (0.94)**	**0.02 (0.86)**
Euro	**0.04 (0.67)**	**0.12 (0.43)**
Yen	**- 0.03 (0.49)**	**0.03 (0.75)**
Δemp_3	**0.83 (0.00)***	**---**
Constant	**-0.00(0.00)***	**-0.00 (0.75)**
Adj R-sq	**0.75**	**0.30**
DW	**1.65**	**1.61**
Obs	**120**	**120**

Figures in brackets are the p values. * represent the variable is significant at the 1% level.

Table3

Error Correction Representation for the ARDL model

Dependent variable ΔR_t

Variable	**Coeff**	**T ratio**	**pvalues**
ΔR_{t-1}	**-.34**	**-4.03**	**(0.00)**
ΔR_{bt}	**.13**	**2.98**	**(0.004)**
Constant	**.0056**	**2.62**	**(0.01)**
Ecm(-)	**-.15**	**-3.36**	**(0.001)**
Fstat	**11.04**		

R^2=.24, $\bar{R}^2$ =21 . Ecm = R_t - .82R_{bt-1} - .035 Constant

The critical bounds for the 10% significance level for 1 variable with intercept are 4.04- 4.78.

Table 4

Diagonistic tests

LM Test	$\chi 2$(calculated)	p value
Serial correlation	**12.22**	**(.42)**
Functional form	**.13**	**(.35)**
Normality	**65.93**	**(.00)**
Heteroscedasticity	**9.93**	**(.22)**

References

Baig T (2001) – 'Characterising Exchange Rate Regimes Post-Crisis East Asia' Working Paper No.01/152, IMF.

Bayoumi T & Eichengreen B (1998) – 'Exchange Rate Volatility Intervention: Implications of the Theory of Optimum Currency', Journal of International Economics, 45(2): 191-209

Bhattacharya K (2006) – ' Monetary policy approaches in India' Bank of International Settlements, Paper No.31

Borenzstein E, Zettelmeyer J & Philippon T (2001) – 'Monetary Independence in Emerging Markets: Does the Exchange Rate Regime Make a Difference? IMF Working Paper No. 01/1

Bubula A & Okter- Robe I (2002) – 'The Evolution of Exchange Rate Regimes Since 1990: Evidence from Defacto Policies, IMF Working Papers, No 02/155

Calvo G A & Reinhart C M (2002) – 'Fear of floating' Quarterly Journal of Economics Vol 117, pp 379-408

Cavoli T & Rajan R (2005) – 'Have Exhange Rate Regimes in Asia Become More Flexible after the Crisis? Revisiting the Evidence' International Macroeconomics and Finance Program, University of Adelaide

Cavoli T & Rajan R (2007) – 'The Extent of Exchange Rate Flexibility in India : Basket Pegger or Closet US Dollar Pegger?' in Sugata Marjit edt. Indian Macroeconomics Annual , Centre for Studies in Social Sciences, Calcutta

D'Souza E (2008) – 'Globalisation's Underbelly: Capital flows and the Indian Economy' Economic and Political Weekly August 30. pp 34-38.

Eichengreen B, Rose A K & Wyplosz C (1996) – 'Contagious Currency Crises'- NBER Working Paper 5681

Frenkel J & Wei S (1994) – 'Yen Bloc or Dollar Bloc? Exchange Rate Policies of the East Asian Economies' in Macroeconomic Linkages: Savings, Exchange Rates and capital Flows. Ed. by Ito E & Krueger A O (University of Chicago Press)

Frenkel J (1999) – ' No Single Currency Regime is Right for All Countries or at All Times' Princeton Essays in International Finance 215.

Frenkel J, Fajnzylber E , Schmukler S L & Serven L (2001) – 'Verifying Exchange Rate Regimes' Journal of Development Economics, Vol 66, No 2, pp 351-86.

Frenkel J , Schmukler S L & Serven L (2002) – 'Global Transmission of Interest Rates: Monetary Independence and Currency Regime. NBER Working Paper No. – 8828.

Frenkel J & Wei S (2008) – 'Estimation of Defacto Exchange Rate Regimes: Synthesis of the Techniques for Inferring Flexibility and Basket Weights' IMF Staff Papers Vol 55, No. 3

Goyal A (2008) – 'Macroeconomic Policy and the Exchange Rate – Working Together' India Development Report , Oxford University Press

Goyal A, Nair R A & Samantaraya A (2009)- 'Monetary Policy, Forex Markets, and Feedback under Uncertainity in an Open Economy' Paper presented at the Eleventh Annual Conference on Money and Finance in the Indian Economy, IGIDR (Mumbai) Jan 23-24,2009

Hausmann R, Gavin M, Pages- Serra C & Stein E (1999)- ' Financial Turmoil and the Choice of Exchange Rate Regime,' mimeo, Inter- American Development Bank.

Holden P, Holden M & Suss E C (1979) – 'The Determinants of Exchange Rate Flexibility: An Empirical Investigation,' Review of Economics and Statistics Vol 61, pp 327-33

Johansen S and Juselius K (1990): 'Maximum Likelihood Estimation and Inference on Cointegration and Applications to the Demand for Money', Oxford Bulletin of Economics and Statistics., 52, 169-209

Kohli R (2009) – ' Financial Integration, Capital Controls and Monetary Independence' Economic and Political Weekly, June 27

Levy –Yetati, E & Sturzenegger F (2003) – 'To Float or to Trail: Evidence on the Impact of Exchange Rate Regimes on Growth' American Economic Review, Vol 93, No 4, pp 1173-1193

Levy –Yetati, E & Sturzenegger F (2005) – 'Classifying Exchange Rate Regimes, Deeds vsWords' European Economic Review, Vol 49, No.6, pp 1603-35.

Obstfeld M (1982)- 'Can We Sterilize? Theory and Evidence. American Economic Review Vol 72, pp 45-50

Obstfeld M, Shambaugh J & Taylor A (2003)- 'The Trilemma in History : Tradeoffs among Exchange Rates, Monetary Policies and Capital Mobility' NBER Working Paper No.- 10396

Pattnaik I (2005)- 'India's experience with a pegged exchange rate' in S Bery, B Bosworth, A Panagariya (eds.), 'The India Policy Forum 2004' pp.189-226. Brookings Institution Press and NCAER.

Pattnaik I (2007)- 'India's currency regime and its consequences' Economic and Political Weekly, March 17, URL: http:// openlib.org/home/ila/PDFDOCS/ 11182.pdf

Pesaran M H, Shin Y & Smith R J (2001): 'Bounds testing approaches to the analysis of level relationships' Journal of Applied Economics 16(3) 289-326

Poirson H (2001) – 'How do Countries Choose their Exchange Rate Regimes? IMF Working Papers, No WP/01/46

PM Committee (2007)- 'Mumbai: An International Financial Centre' Ministry of Finance, Govt of India (India: Sage Publications)

Rajan Committee (2008) - ' A Hundred Small Steps : Report of the Committee on Financial Sector Reforms' Planning Commission (New Delhi: Govt of India).

Reinhart C M & Rogoff K S (2004) – 'The Modern Theory of Exchange Rate Arrangements: A Reinterpretation' Quarterly Journal of Economics Vol 119, pp 1-48

Shah A & Pattnaik I (2007) – 'India's experience with capital flows: The elusive quest for a sustainable current account deficit 'In S Edwards(ed) , ' Capital controls and capital flows in emerging economies: Policies, practices and consequences ' chapter 13, pp 609-643. The University of Chicago Press. URL : http:// www.nber.org/papers/w11387.

Shambaugh J (2004) – 'The Effects of Fixed Exchange rates on Monetary Policy' Quarterly Journal of Economics, Vol 119, No.1, pp 301-52

Shambaugh J (2004)- 'The Effects of Fixed Exchange Rates on Monetary Policy' Quarterly Journal of Economics Vol 119 , pp 301-52

Vanpoeck A, Vanneste J, Veiner M (2007) – 'Exchange Rate regimes and Exchange Market Pressure in the New EU Member States' Journal of Common Market Studies Vol 45(2), pp 459-485