EXCHANGE MARKET PRESSURE, GOVERNMENT DEBT, US MONEY SUPPLY, GDP GROWTH AND MARITIME TRADE: AN EMPIRICAL EVIDENCE FROM INDIA

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ABSTRACT

Exchange Market Pressure (EMP) indices are used as comprehensive indicators of pressure on a currency. This paper examines the relationship of India government debt, India's GDP, world money supply and world GDP with exchange market pressure in India. We use quarterly data from 1992: II to 2018: III. The results suggest a significant positive relationship between EMP and the India government debt and GDP and a negative relationship between EMP and world money supply. The relationship between EMP and world GDP is found to be insignificant.

This study sheds light on the complex dynamics of EMP and its determinants in India, highlighting the impact of key economic factors and historical events on currency stability. These findings have important implications for policymakers and stakeholders in maritime trade, providing insights into the economic factors influencing currency stability in maritime trade.

KEYWORDS

Exchange market pressure, Exchange rates, Reserve, Debt, Money supply, GDP, Maritime trade

JEL: C02, C43, E00, F31, F41, F14, L91.

1. INTRODUCTION

Increasing internal debt and consequent credit creation, other things remaining the same, puts an upward pressure on INR via excess money supply and consequent flight of foreign capital. Domestic GDP rise may create upward as well as downward pressure on currency via its effect on net export and expectation generated fund flow. Growth abroad may create downward (via decrease in foreign money supply) as well as well as upward (via demand for export) pressure on INR the net effect will depend on which one of the two is stronger. Whether INR depreciates or not because of the above variables will also be dependent on the currency regime the Bank of India Reserve Bank of India (BOJ) follows. India abandoned the fixed parity of INR with Pound Sterling in September 1975 and linked it to a weighted basket of currencies of its main trading partners (Mathur, 1999). This regime was replaced in March 1992 by partial convertibility which was called Liberalized Exchange Rate Management System (LERMS). In this system the RBI allowed 40 percent of current account transactions to be exchanged at RBI rates and the rest at the existing market rates. INR was formally put on full current accounts convertibility during 1994. While de-jure currency regime in the country, post 1993, has been of managed float, de-facto currency regime has been different during different periods (Guru and Sharma,2013).The country has carefully relaxed its capital account since early 1980s and at present one can say that the state of capital accounts in India is the most liberalized ever since late 1950s in the history. There is no doubt, however, that many types of capital controls still stay (Tarapore Committee, RBI, 2006). The Reserve Bank of India, sometimes, allows the market to work out a level for INR on its own. At times it also intervenes by buying INR thereby depleting India's foreign exchange reserves. The RBI also has the option of increasing its policy rate of interest to check the selling pressure on local currency. As a result of these steps the currency may not depreciate but the pressure may shift to foreign exchange reserve or domestic interest rates. Pressure on currency may also show up in capital controls and trade restrictions but these effects will be minimal given the fact the country has commitment to a binding currency and trade regime. As a comprehensive measure of pressure on a currency the literature suggests various ways to construct indices of exchange market (EMP). Girton and Roper (henceforth G-R) (1977) in their seminal work gave the first index of EMP. This model also gives a functional relationship of EMP with the variables which affect it. Thus, this model is suitable for the study of the behavior of EMP as well as the variables responsible for its behavior. Bank of International Settlement used the idea of EMP in case of ERM (European Exchange Rate Mechanism) crisis of 1992-1993. IMF in its World Economic Outlook (2009) used EMP index as a component of EM-FSI (Emerging Market Financial Stress Index). To assess the behavior of India's EMP and its relationship with internal debt, GDP and external money supply and external GDP we estimate the G-R Model for the Indian economy for the period 2001-I to 2017-IV.

2. EMP, GOVERNMENT DEBT, GDP; INTERNATIONAL MONEY SUPPLY, GDP: THE MODEL

Following is the mathematical version of the G-R model:

$$EMP_t = -\beta_1 \Delta d_t + \beta_2 \Delta m^*{}_t + \beta_3 \Delta y_t - \beta_4 \Delta y^*{}_t \qquad (2.1)$$

Here,

EMP_t = Exchange market pressure at time t.

Δs_t = Percentage change in nominal exchange rate.

Δf_t = Percentage change in forex reserve to previous period monetary base.

Δd_t = Percentage change in domestic debt at time t.

Δm^* = Percentage change in the rest of the world money supply at time t.

Δy_t = Percentage change in domestic growth rate at time t.

Δy_t^* = Percentage change in international GDP at time t. Here we have-

$$EMP_t = \Delta s_t + \Delta ft \qquad (2.2)$$

The model suggests that an increase in government debt (Δd_t) and rest of the world GDP (Δy^*) decrease the value of national currency and the level foreign exchange reserve or both and increase in the rest of the world money supply (Δm^*) and national GDP (Δy_t) decreases the value of national currency and level of foreign exchange reserve. GR estimated the above for Canadian economy for the period 1952-74. All the coefficients of the above model were found to be significant. The estimated coefficients did also have appropriate signs validating the G-R model of Exchange Market Pressure. A simplified version of the G-R model was devised for Brazil by Michael Connolly and Jose Dantas de Silveira (henceforth C-S) (1979). The C-S model retained the partial equilibrium approach of the G-R model but removed foreign GDP as an independent variable by making a small country assumption (Mathur, 1999). Following is the mathematical form of the model -

$$EMP_t = -\beta_1 \Delta d_t + \beta_2 \, \delta p_t^* + \beta_3 \Delta y_t \qquad (2.3)$$

Here all the symbols have the same meaning as in equation (2.1), δp_t^* is percentage change in international price level. C-S estimated this model for Brazil for the period 1955-75 and a sub-period of 1962-1975. On empirical estimation it was found that, for both the periods, all the coefficients had signs as per the G-R hypothesis, however all the three coefficients were significant only for the sub- period 1962-75. For the entire period, the coefficients of price and income were not significant. On the basis of F test, for both the periods, the monetary model was not rejected at 1 percent level of significance. Following Nicholas Sargen (1975) they ran another regression using only change in log of nominal exchange rate as a component of EMP and they found that in this case the results are poorer for the entire period and dramatically worse for the period 1962-75 when there were fewer exchange restrictions. On the basis of these results C-S concluded that the monetary model of exchange market pressure performs fairly well for 1955-75 period and very well for 1962-75 periods in explaining movement of reserve and exchange rates. The poorer performance before 1961 was because of greater exchange rate restrictions in Brazil and also because of the fact that the purchasing power relationship did not hold well in the pre-1962 period. The monetary model assumes purchasing power parity besides others, the authors also test it and conclude that it holds up well particularly after 1961. C-S introduced another variable *Q* on the right-hand side of the equation 2.3. This was done to test the sensitivity of EMP to its composition. Here Q is s_{t-1} / f_{t-1} . s_t = *Ln (Nominal exchange rate)*, and f_t=*Ln (Forex reserves)*, The estimated coefficient of *Q* was found to be insignificant indicating thereby that EMP is high or low is not decided by this fact that which component of the EMP is more or less. Modeste (1981) estimated the C-S model for the economy of Argentina over the period 1972-78. He also conducted a test to ascertain whether EMP is independent of its composition. The result shows that the coefficient of the variable *Q* is insignificant indicating thereby that EMP is independent of relative role of exchange rate or foreign exchange reserve in absorbing the pressure. This finding is the same as the finding of G-R for Canada and C-S for Brazil. Estimated coefficients have correct signs and are close to their hypothesized value.

In the case of time series data, the relationship between variables may undergo a structural change i.e. the values of the estimated parameters may not remain the same for the entire period of analysis. In the face of structural change, a model may become unfit for analysis and prediction purposes. On the basis of quarterly data Hodgson and Schenck (1981) tested the stability of Exchange Market Pressure model for seven advanced countries. The sample period is 1959-II to 1976-I for six of the countries i.e. Canada, France West Germany, Belgium, Netherlands and Switzerland For the United Kingdom the sample period is 1964-II to 1976-I, this is due to data availability problem. They found that during disruptions and rearrangements of world- money- markets stability of EMP models may suffer. For example, the period from mid 1960s to through the early 1970s there were important events like oil crisis, collapse of Bretton Woods so during these periods the empirical models show instability. The equations of France, Germany and Belgium begin to show instability in about 1965 or 1966. The disruption appeared to have continued into 1974 for Belgium and France and into 1971 for Germany. The equations for United Kingdom begin to show instability in about 1969. This continues for only one quarter for Netherlands (1969-III) and until 1975 for U.K. Switzerland's equation was unstable only during the period 1962-II to 1962-III. Canada's equation was stable for whole sample period. Hodgson and Schneck(ibid) used the following model for their stability analysis-

$$\begin{aligned} EMP_t = \alpha + \beta_1 \Delta s_{t+1} + \beta_2 \Delta y_t + \beta_3 \Delta p_t \\ + \beta_4 \Delta a_t + \beta_5 \Delta d_t + \beta_6 \Delta y_t^* + \beta_7 p_t^* \\ + \beta_8 \Delta a_t^* + \beta_9 \Delta d_t^* + \beta_{10} f_t^* + v_t \end{aligned} \qquad (2.4)$$

Here all the variables have the same meaning as in all the above equations. There is one new variable introduced in this model i.e. α = Deposit expansion multiplier. The world variables are weighted averages of the corresponding variables for individual countries. Kim (1985) used a modified form of C-S approach to the GR model. He used the model to study the Korean economy for the period 1980-83. Following is the mathematical model of Kim-

$$EMP = -\beta_1 \Delta d_t + \beta_2 \Delta p_t^* + \beta_3 \Delta y_t - \beta_4 \Delta mm_t \qquad (2.5)$$

Here the new variable mm is money multiplier. The result of regression strongly supports the monetary model of EMP. All estimated coefficients have correct sign and significantly differ from zero. Only exception is the foreign price variable which is not significant. The relationship between EMP and the domestic credit is quite strong. The authors introduce an extra variable Q to test the sensitivity of the EMP to relative share of its components. They found that the coefficient of Q is statistically insignificant. Here Q has the same meaning as in the C-S model above. As a final test only percentage change in forex reserves (ft) is used as dependent variable. Essentially the overall fit remains the same though it yields some trade- off between the explanatory power of the foreign price variable and that of other independent variable. A poor fit result if the percentage change in nominal exchange rate s_t is used as the dependent variable. The author concludes that Korean data fits well with the monetary model of the EMP. Ghartey (2002) empirically tested the G-R model for the economy of Jamaica. He used quarterly data for the period 1962-II to 1997-IV. The results reported are consistent with the theory and other empirical studies. Results are poor if only percentage change in forex reserves (Δft) is used a component of the EMP. In this case coefficient of Δy_t is positive although insignificant. Besides the above studies there are studies by Wohar and Burkett (1989) for Honduras, Thornton (1995) for Costa Rica, Mah (1991) for Korea, Bahmani-Oskoee and Bernstein (1999) for Canada, France, Germany, Italy, UK, US and India Burdekin and Burkett (1990) for Canada and USA, Wohar and Lee (1992) for India, Taslim (2003) for Australia, the G-R model was first adapted to Indian conditions by Pradhan, Paul and Kulkarni (1989). Though the G-R model, its version C-S model and some other versions of monetary approach to EMP performed well on empirical tests they suffered from some problems. They are partial equilibrium models, they did not incorporate the role of expectations and all of their empirical studies are based either on annual data and quarterly data and not on monthly data which would have been more appropriate in capturing the EMP and its determinants (Mathur,1999). Hallwood and Marsh (2004) incorporated rational expectation as independent variable in the G-R equation and estimated the model for the economy of the United Kingdom for the period 1925-31. Here is the mathematical model used by the authors for estimation. For empirical estimation, the authors use the following model-

$$\begin{aligned} EMP_t = -\beta_1 d_t + \beta_2 d_t^* - \beta_3 \left(\Delta y_t - \Delta y_t^* \right) \\ - \beta_4 4 \Delta r_t - \beta_5 E \frac{dx_t}{dt} - \beta_6 E \frac{dc_t}{dt} \end{aligned} \qquad (2.6)$$

In this equation, $E(dx_t/dt)$ is expected movement of nominal exchange rate from central parity and $E(dc_t/dt)$ is expected movement of the central parity. Following is the relationship between exchange rate and central parity and the band around it as specified in Svensson (1991, 1993)

$$e_t = x_t + c_t$$

Here c_t is the central parity and x_t is proportionate deviation from the central parity and e_t is nominal exchange rate (all are in natural logarithms i.e. in percentage form). This equation says that nominal exchange rate will vary along central parity within a band. Taking derivative of the above equation with respect to time and putting expectations on both sides we have-

$$E\frac{de_t}{dt} = E\frac{dx_t}{dt} + E\frac{dc_t}{dt}$$

Following Svensson (ibid) Hallwood and Marsh (2003) define the upper and lower band of the proportionate change in central parity with respect to time in respect of gold import points, i.e.-

$$\frac{x_t^{'} - x_t}{dt} \le E\frac{dx_t}{dt} \le \frac{x_t^{''} - x_t}{dt}$$

We have, x′ = Lower bound of x and x″ = upper bound of x

Assuming uncovered interest rate parity-

$$i_t - i_t^* = \mathrm{E}\frac{de_t}{dt}$$

Based on the equation for the rationally expected range for deviation from central parity and the equation for rationally expected changes in the nominal exchange rate under the assumption of uncovered interest rate arbitrage we have-

$$\left(i_t - i_t^*\right) - \frac{x_t^{'} - x_t}{d_t} \le \frac{E\left[dc\right]}{dt} \le \left(i_t - i_t^*\right) - \left(x_t^* - x_t\right)$$

Mathur (1999) presented a modified version of the G-R model to incorporate expectation as independent variable. She presented the following modified G-R model –

$$EMP = \beta_1 \Delta d_t + \beta_2 \Delta m_t^* + \beta_3 \Delta Y_t + \beta_4 \Delta Y_t^* + \alpha e_t^e + v_t \qquad (2.7)$$

Here e_t^e = Expected percentage change in nominal exchange rate. The values of e_t^e are the forecast values using autoregressive random walk with one period lag.

She makes an empirical estimation of the original G-R model as well as the modified G-R model (M-G-R) for India for the period December 1986 to July 1998 using monthly data. She found that the performance of the G-R model was not good. She retested the G-R model by dividing the entire period into two sub-periods of December 1986 to June 1991 and from March 1992 to July 1998, to take into account the structural change that may have happened in July 1991 (due to balance of payment crisis) when INR was devalued substantially and introduction of LERMS in March 1992 (ibid). In this case also the performance of the G-R model did not improve. Estimation results of the M-G-R model were a significant improvement over the results of the G-R model. All the coefficients in the case of M-G-R were found to be significant and adjusted R^2 indicated a good fit. Coefficient of the e^e was found to be negative which was contrary to the model. The author says that the poor performance of the model on empirical test may be due to the partial equilibrium approach to EMP which the G-R model takes e.g. the model relates αe^e to money market and not to other variables like balance of payment etc.(ibid).

3. DATA AND ESTIMATION OF THE EMP MODEL FOR INDIA

In this paper we estimate the G-R model for India by using quarterly time series data spread over 2001-II and ending 2017-IV. These five variables are exchange market pressure (EMP, the dependent variable). Percentage change in bank domestic credit to the government (Δd_t) change in international money supply (Δm_t^*), percentage change in India's GDP (Δy_t), percentage change in international GDP (Δy_t^*). All USA data is taken from the U.S. Bureau of Economic Analysis, Board of Governors, Federal Reserve USA. The source of Indian data is the Database on Indian Economy (DBIE) Reserve Bank of India. The real sector data about Indian economy is taken from the Central Statistical Organization, Ministry of Statistics and Programme Implementation, Government of India. All India related variables are measured in Rs Billion and those about USA are measured in Billions of USD. Units of measurement do not matter for our analysis as all independent variables are transformed to percentage scale and dependent variables are transformed to per unit scale. There are sixty-seven observations in the sample out of which there are three missing observations which have been deleted while estimating the results. Before estimating the model, it is important to run the data through certain basic diagnostic tests. In the case of time series data stationary test is required to ensure that the regression results are not spurious (Granger and Newbold,1974). A look at the simple time series plot of all the five variables reveals that all of them are stationary. Augmented Dicky Fuller Test also substantiate the stationarity of the data, the tau statistics reported in the table is less than the critical tau statistics at 5% level of significance hence we reject the null hypothesis of unit root implying thereby that the data is stationary. Classical Linear Regression Model assumes of no multicollinearity among the independent variables. In the presence of perfect linear relationship among regressors coefficients will become indeterminate. In case of strong correlation, though not perfect, variances may get inflated thereby widening confidence intervals leading to errors in hypothesis testing. The variance inflation factor (VIF) in the case of all the four is less than 10. Thus, we can conclude that multicollinearity does not pose any serious problem here (though pairwise correlation coefficient between Δd_t and Δm_t^* is high. The classical linear regression model (CLRM) assumes equal variances of the error term. In the presence of unequal variances (heteroscedasticity) OLS estimators are not with minimum variance and confidence intervals may not be reliable. We conduct the Breusch Pagan test to check for heteroscedasticity. The p value reported from the chi square table (for nR^2 is extremely high indicating there is no heteroscedasticity in the data. Presence of auto correlation in the data creates the same set of problems which heteroscedasticity presents. We conduct Breusch-Godfrey test with four lags to check the presence of auto correlation in the data. p value of the F statistics $(n - p) R^2$ is extremely low thereby indicating the presence of autocorrelation in the data. The test also reports the Ljung Box Q statistics the p value of this statistics is quite high (5% level of significance) indicating that there is no autocorrelation in the data. Thus, there is a confusing picture here. To get rid of this problem we have run HAC (Heteroscedasticity and Auto correlation Consistent) OLS regression.

We estimate the following model for India. This is regression through origin because the model demands such a fit.

$$EMP_t = \beta_1 \Delta d_t + \beta_2 \Delta m_t^* + \beta_3 \Delta y_t + \beta_4 \Delta y_t^* + v_t \qquad (3.1)$$

Here,

EMP = Exchange Market Pressure (Dependent variable).

Δdt = Percentage change in domestic debt of the government sector.

Δm_t^* = Percentage in the rest of the world money supply. (M1 supply in the USA). (70 percent of international trade is invoiced in USD hence USD supply is taken here to represent the rest of the world money supply).

Δy_t = Percentage change in the growth rate of India.

Δy_t^* = Percentage change in the growth rate of USA.

The result of the OLS regression is reported in the Table:1 below.

One has to keep in mind that models through origin have typically high R^2 (raw r^2) and F values, but this is not an issue here because there is no alternative model to compare as the G-R Model suggests a regression through origin. The overall significance of the model is also extremely high as indicated by the extremely low p value of the F statistics. The value of adjusted R^2 (raw r^2) is 0.97 percent indicating thereby that the variables included in the model explain 97 percent of the changes in EMP. β_1, β_2 and β_3 are significant at 5% (because the p values associated with these coefficients are lower than 0.025 for two tailed test i.e. 0.0164,0.0299,0.000 respectively) level and β_4 is not significant because the p value associated with β_4 is 0.3272 which is higher than 0.025 for two tailed test. Mathematical signs of the coefficients of Δd_t *and* Δm_t^* are positive and negative respectively and this is not in line with the G-R model whereas the mathematical signs of the coefficients of Δy_t and Δy_t^* are matching with the hypothesis of the G-R model. The value of $\beta 1$ is 87.15, it means that with one percent increase in the debt (banking system net credit to the government) the EMP in India increased by 87 points for the sample period. The value of β_2 is −47.05, this means that with one percent increase in *M*1 supply in the USA for the sample period the EMP in India eased by 47.05 points with the availability of cheap foreign money in the country. The value of β_3 is 77.10, implies that with one percent increase in India's GDP the EMP in the country increased by 77.10 points. The G-R model suggests a negative relationship between growth in domestic GDP and EMP i.e. a rise in GDP should ease the pressure on local currency. In the case of India, however, we are seeing that a rise in GDP increases pressure on currency. Rise in GDP can have effect on EMP via current account and capital account i.e. balances of trade and net flow of foreign capital. GDP rise may increase trade gap via increase in import and consequent depreciation leading to increase in EMP. GDP rise, at the same time, may reduce EMP via currency appreciation resulting from increase in net flow of foreign capital. Which effect will dominate

Table 1. OLS, using observations 2001:2–2017:4 (T = 66) Dependent variable: EMP

	Coefficient	**Coefficient**	***t*-ratio**	**p-value**
Δdt	87.1588	35.3166	2.4679	0.0164
Δm_t^*	−47.0543	21.1647	−2.2232	0.0299
Δy_t	77.1073	2.05761	37.4742	0.0000
Δy_t^*	−1.43376	1.45189	−0.9875	0.3272
Mean dependent variable	70.77886		S.D. dependent var	10454.50
Sum squared residual	1.47e+08		S.E. of regression	1541.080
R^2	0.979275		Adjusted R^2	0.978272
F (4, 62)	172499.6		P-value (F)	1.2e–124
Log-likelihood	−576.0425		Akaike criterion	1160.085
$\hat{\rho}$	0.261502		Durbin–Watson	1.476740

will depend on the period of analysis, future expectation of economic agents vis-a-vis returns and the exchange rate regime of the country in question. The result of our regression says that, at least for the period of analysis, the current account effect of GDP rise in more dominating than the capital account effect. The relationship between US GDP and India's EMP is not found to be significant.

3.1 MARITIME TRADE

India's maritime trade plays a crucial role in its economy, with the country heavily reliant on seaborne trade for both imports and exports. The relationship between Exchange Market Pressure (EMP) indices, government debt, GDP, world money supply, and world GDP has significant implications for India's maritime trade. The positive relationship between EMP and India's government debt suggests that higher levels of government debt can lead to increased pressure on the Indian rupee, potentially impacting the cost of imports and exports via maritime routes. Similarly, the positive relationship between EMP and India's GDP implies that fluctuations in India's economic growth can influence currency stability, affecting the competitiveness of maritime trade.

Furthermore, the negative relationship between EMP and world money supply indicates that changes in global liquidity conditions can impact India's currency stability, potentially affecting the cost and volume of maritime trade. The insignificant relationship between EMP and world GDP suggests that global economic growth may not have a direct impact on India's currency stability, but it could indirectly affect maritime trade through its impact on other variables such as world money supply and trade volumes.

The findings regarding the structural break analysis and the impact of the US financial crisis of 2007-08 on EMP and its determinants are also relevant to India's maritime trade. The fact that the crisis had no significant effect on the relationship between EMP and its determinants, except for the relationship between EMP and India's GDP, suggests that India's currency stability and maritime trade were relatively insulated from the direct impacts of the crisis. However, the change in the relationship between EMP and India's GDP post-recession highlights the need for India to carefully manage its economic policies and trade relationships to ensure currency stability and competitiveness in maritime trade.

Overall, the study provides valuable insights into the complex dynamics of EMP and its determinants in India, highlighting the importance of factors such as government debt, GDP, and global liquidity conditions in shaping currency stability and maritime trade.

4. CONCLUSION

In this paper we estimated the G-R model for India over the period 2001:2-2017:4. The G-R model gives an index of EMP and relates it to the variables determining it following a monetary approach. We used the OLS method to estimate the model. Before running the regression, we put the data to standard diagnostic tests to ascertain that the data is stationary, and it conforms to the basic assumptions required for the CLRM. The empirical analysis reveals that for the period of our analysis government debt from the banking sector played the most important role in increasing exchange market pressure in India followed by GDP growth, increase in international money supply helped in decreasing exchange market pressure whereas international GDP growth had no significant influence on the EMP in India.

These findings have important implications for policymakers and stakeholders in India's maritime sector, emphasizing the need for proactive measures to manage currency risks and enhance competitiveness in maritime trade.

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