Available online at www.ijapie.org

INTERNATIONAL JOURNAL OF ADVANCED PRODUCTION AND INDUSTRIAL ENGINEERING

IJAPIE-2017-07-320, Vol 2 (3), 89-93

IJAPIE
Connecting Science & Technology with Management.

A Journal for all Products & Processes.

A Literature Review: Girton and Roper Model of Exchange Market Pressure

[1]Sanjay Kumar, [2]Nand Kumar*

([1]Associate Professor, Department of Economics, Dyal Singh College. Delhi University, NewDelhi.
[2]Associate Professor, Department of Humanities, DelhiTechnologicalUniversity, New Delhi, India)*
Email: nand.dce@gmail.com

Abstract : In this manuscript we present a review of theoretical and empirical studies of the Girton and Roper Model of Exchange Market Pressure. Girton and Roper in their seminal work on exchange market pressure (EMP) give the first model dependent index of EMP. This model and its modified versions are used extensively in literature to study EMP in a country or region. keywords: Exchange market pressure. Exchange rates.Foreign exchange reserve.Credit.

Keywords: Exchange market pressure, internal debt, GDP, International money supply.

---

1. THE GIRTON AND ROPER MODEL

As a comprehensive measure of pres-sure 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 constructed the first index of EMP. There are two approaches to EMP index in literature - model- dependent approach and modelindependent approach (Gilal, 2011). In the first approach EMP components and their weights are decided on the basis of a mathematical -econometric model. In the second approach weights are not decided on the basis of any model rather subjective further be classified as monetary approach and ISLM approach. The G-R model of EMP is based on monetary framework. The model was designed specifically for Canadian managed float during the period 1952-62 (Connolly and Silviera,1979) Demand and supply equations and purchasing power parity are the two basic conditions in this approach. The key message of this model is that excess supply of domestic credit puts pressure on currency and reserves. Following are the sets of equations capturing the essence of the G-R model-

$$M_t^d = P_t \, Y_t^{\beta} \; e^{-\alpha it} \qquad (1)$$

$$M_t^{d*} = P_t^* \, Y_t^{\beta *} \; e^{-\alpha i * t} \qquad (2)$$

$$M_t^s = F_t + D_t \qquad (3)$$

$$M_t^{s*} = F_t^* + D_t^* \qquad (4)$$

Here subscript t denotes that we are dealing with time series data.

M_t^d= Domestic demand for money in a country at time t.
P_t= General price level in the economy at time t.
Y_t= Real national income. i = Domestic rate of interest.

α and β are the parameters of the model.

α =Discount factor.

β =Elasticity of money demand with respect to national income.
D = Domestic credit.

F = Foreign Exchange. Thus F and D together show monetary base of the economy.
$*$ denotes the variable related to the rest of the world.
All small letters show percentage of a variable. Greek letters denote behavioural constants which are the parameters of the model.Money market equilibrium in the internal as well as external markets implies that changes in demand and supply are equal. Therefore we take the log and the first difference of both sides of the equations (3) and (4).

$$\Delta m_t^s = \Delta d_t + \Delta f_t = \Delta p_t + \beta \Delta y_t - \alpha \Delta i_t = \Delta m_t^d \qquad (5)$$

$$\Delta m_t^s * = \Delta d_t^* + \Delta f_t^* = \Delta p_t^* + \beta^* \Delta y_t^* -$$

$$\alpha^* \Delta i^*_t = \Delta m^d_t * \qquad (6)$$

In the above equation $(\Delta d_t = \frac{\Delta D_t}{B_{t-1}})$ is change in domestic bonds and $(\Delta f_t = \frac{\Delta F_t}{B_{t-1}})$ is change in lo-cally held foreign bonds.B_t is domestic monetary base. The two together show change in monetary base. Change in supply of base money is equal to change in demand for the same as per the equations (5) and (6). In the G-R model domestic variables are linked to international variables through the exchange rate equation.

$\Delta p_t = \Delta p^*_t - \Delta e_t + \Delta r_t$. Here Δe_t, Δp_t, Δp^*_t denote percentage change in nominal exchange rate, percentage change in domestic price level and percentage change in international price level respectively. We can write the above equation as $\Delta r_t + \Delta e_t = \Delta p_t - \Delta p^*_t$. Subtracting equation (5) and (6) we have

$$\Delta m_t^s - m_t^{s*} = \Delta d_t + \Delta f_t - \Delta m_t^* = \Delta p_t - \Delta p_t^* +$$

$$\beta \Delta y_t - \beta^* \Delta y_t^* - \alpha \Delta i_t + \alpha^* \Delta i^*_t \qquad (7)$$

It is assumed that percentage change in real exchange rate is a function of the percentage change in the supply of domestic credit and the percentage change in the supply of foreign money (Hacche and Townend, 1981), we have

$$\Delta r_t = \Theta \Delta d_t - \Theta^* \Delta m_t^*, \theta, \theta^* \geq 0 \qquad (8)$$

Putting (8) in (7) we have -

$$\Delta e_t = \Theta \Delta d_t - \Theta^* \Delta m_t^* - \Delta d_t - \Delta f_t$$

$$+ \Delta m^*_t + \beta \Delta y_t - \beta^* \Delta y_t^* - \alpha \Delta i_t + \alpha^* \Delta i^*_t \qquad (9)$$

Assuming perfect capital mobility, we have-

$$\Delta e_{t+1} = \Delta i_t - \Delta i_t^* = -\delta \Delta d_t + \delta^* \Delta m_t^* \quad (10)$$

Putting the values of Δi_t and Δi^*_t from (10) in (9) we have,

$$\Delta e_t = \Theta \Delta d_t - \Theta^* \Delta m^*_t - \Delta d_t - \Delta f_t$$

$$+ \Delta m^*_t + \beta \Delta y_t - \beta^* \Delta y_t^* + \alpha \delta \Delta d_t i - \alpha^* \delta^* \Delta m^*_t \qquad (11)$$

Rearranging we have,

$$\Delta e_t + -\Delta f_t = -(1 - \alpha\delta - \Theta)\Delta d_t + (1 - \alpha^* \delta^* - \Theta^*)\Delta m_t^* +$$

$$\beta \Delta y_t - \beta^* \Delta y_t^* \qquad (12)$$

All the greeks are behavioural constants thus the above equation can be more written in a more compact way.Assuming, $\Phi_1 = (1 - \alpha\delta - \Theta)$ and $\Phi_2 = (1 - \alpha^*\delta^* - \Theta^*)$ we have the GR equation for

exchange market pressure as below-

$$\Delta e_t + \Delta f_t = -\Phi_1 \Delta d_t + \Phi_2 \Delta m^*_t + \beta_1 \Delta y_t - \beta_2 \Delta y_t^* + \nu_t \qquad (13)$$

II. EMPIRICAL STUDIES OF THE G-R MODEL

G-R empirically estimated their model with the the help of the following econometric model:

$$EMP = \beta_1 \Delta d_t + \beta_2 \Delta m_{*t} + \beta_3 \Delta y_t + \beta_4 \Delta y_{t*} + \nu_t \qquad (14)$$

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 sign 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 disregarded foreign variables (except foreign inflation rate) by making a small country assumption

(Mathur,1999) The mathematical form of the following mathematical model -

$$EMP = -\beta_1 \Delta d_t + \beta_2 \delta p_t^* + \beta \Delta y_t \qquad (15)$$

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 196275. 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 is based on the assumption of 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 2.21. Here $Q = \frac{(e_t - 1)}{(f_t - 1)}$ this was done to test the sensitivity of the EMP to its composition. 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) estimates the C-S model for the economy of Argentina over the period 1972-78.He conducts the first 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 CS for Brazil. Estimated coefficients have correct signs and are close to their hypothesised value of minus one for d and plus one for p^* and y.[1]Estimated coefficients of d and y are significant at 5 percent level of significance the estimated coefficient of p^* is however not significant. On the basis of the F test the author found that not all the coefficients are simultaneously equal to zero i.e. all the independent variables together had significant effect on the dependent variable.

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. This structural change may happen because of factors which are exogenous to the model.In the face of structural change a model may become unfit for analysis and prediction purposes. On the basis of quarterly data Hodgson and Schneck (1981) tested the stability of Exchange Market Pressure model for seven advanced countries. The sample period is 1959II 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. The authors applied BrownDurbin Test[2]. 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[3]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 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 used the following model for their stability analysis-

$$EMP_t = \alpha + \beta_t\Delta e_{t+1} + \beta_2\Delta y_t + \beta_3\Delta p_t + \beta_4\Delta a_t + \beta_5\Delta d_t$$

$$\beta_6\Delta y_t^* + \beta_7\Delta p_t^* + \beta_8\Delta a_t^* + \beta_9\Delta d_t^* + \beta_{10} f_t^* + \nu_t \qquad (16)$$

Here all the variables have the same meaning as in all the above equations. There one new variable introduced in this model i.e. a = Deposit xpansion 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-

$$EMP = -\beta_1\Delta d_t + \beta_2\Delta p^*_t + \beta_3\Delta y_t - \beta_4\Delta mm_t \qquad (17)$$

Here the new variable mm is money multiplier. The result of regression strongly support the monetary model of EMP. All estimated coefficients have correct sign and significantly differ from zero as shown by high t values. Only exception is the foreign price variable which has a low t value. The relationship between EMP and the domestic credit is quite strong. The authors introduce an extra variable $Q = \frac{(e_t-1)}{(f_t-1)}$ to test the sensitivity of the EMP to its relative share of its components and found that the coefficient of Q is statistically insignificant. As a final test only percentage in forex reserves (f_t) 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 results 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 model is estimated by Ordinary Least Squares(OLS), Cochrane Orcutt Iteration Technique (CORC), dynamic OLS (DOLS),Maximum Likelihood Estimator (MLE),two stage least squares(2SLS). The results are very good as judged by diagnostic tests such as - t ratios, the coefficient of determination(R^2), the F statistics, the Durbin Watson(DW), Lagrange multiplier test for residuals serial correlation ($\chi_{S}{}^{2}{}_{c}$),Ramsey reset test using the squares of the fitted values ($\chi_F{}^2{}_F$) and heteroscedasticity test based on the regression of squared residuals on squared fitted values (χ^2_H). Sargan's general mis-specification test $(\chi_{s_c}^2)$ is used as diagnostic test for adequacy of instrumental variable. All the results reported are consistent with the theory and other empirical studies. Results are poor if only percentage change in forex reserves (Δf_t) is used a component of the EMP.In this case coefficient of y 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 Japan Burdeking and Burkett(1990) for Canada and USA, Wohar and Lee (1992) forJapan, 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 data which would have been more appropriate in capturing the EMP and its

[1] There are strong and weak versions of the G-R model in literature. In the strong version the coefficients of the independent variables are hypothesised as one in the weak version there is no specific value for the coefficients.See Hodgson and Schneck,(1981) for discussion.

[2] See Khan(1974) ,Smith(1974),Hodgsonand Homes(1977)for previous application of this test.

[3] For evolution of global financial system see Allen(2001).

determinants (Mathur,1999). Hallwood and Marsh(2003) 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 from 1925-31 i.e. interwar period. Here is the mathematical model used by the authorsfor estimation.For empirical estimation the authors use the slope intercept form of this model -

$$EMP_t = -\beta_1 d_t + \beta_2 d_t^* - \beta_3(\Delta y_t - \Delta y_t^*) - \beta_4 \Delta r_t - \beta_5 E\frac{dx_t}{dt} - \beta_6 E\frac{dc_t}{dt} \quad (18)$$

In this equation $E\frac{dx_t}{dt}$ is expected movement of nominal exchange rate within the band and $E\frac{dc_t}{dt}$ 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 we have 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 (1991,1993) 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.-

$$\frac{(x_t' - x_t)}{dt} \leq E\frac{dx_t}{dt} \leq \frac{(x"_t - x_t)}{dt}$$

We have, x'= Lower bound of x and x"= upper bound of x.

Assuming uncovered interest rate parity-

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

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-

$(i_t - i^*_t) - (x^0_t - x_t)/d_t \leq E[dc_t]/dt \leq$

$(it - i*t) - (x0t - xt)$

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 -

$$EMP = \beta_1\Delta d_t + \beta_2\Delta m^*_t + \beta_3\Delta y_t + \beta_4\Delta y_t^* + \alpha e^e_t + \nu_t \quad (19)$$

Here e^e_t= Expected percentage change in nominal exchange rate. The values of $e^e_t$are the predicted values obtained as per the following autoregressive random walk model -

$$e_t = e_{t-1} + \xi_t$$

Here, e_t= Exchange rate at time t.

e_{t-1} = Exchange rate at time t-1.

ξ_t= Random walk error term.

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 e_t^e was found to be negative which wascontrary to the model. The author say 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 $\alpha e_{i\,t}^e$ only to money market and not to other sectors like balance of payment etc. (ibid).

III CONCLUSION

The G-R model gives an index of EMP based purely on monetary approach. Besides it many lacunae the first important advantage of it is that it is the first model dependent index of EMP. Although it ignores real sector interactions totally still , this model is used by many to study exchange market pressure in the case of various economies. There are various attempts to improve on this model and use the improved version to measure the index of EMP in a country empirically. In case of India Mathur (1999) has estimated the G-R model by incorporating expectations into it.

REFERENCES

[1] Allen,Larry (2001). Evolution of Global Financial System. *Reaktion Books Ltd.*. London. Bahmani-Oskooee, M. and Berstein, D.J. (1999). Exchange market pressure during the current managed float. *Applied Economic Letters*, Vol. 6, pp. 585-588

[2] Burdekin, R.C.K, and P. Burkett (1990). A re-examination of the monetary model of exchange market pressure: Canada, 196388. *The Review of Economics and Statistics*, pp. 677-681

[3] Connolly,M.,Da Silveira, J.(1979). Exchange market pressure in postwar Brazil: an application of the Girton-Roper monetary model. *The American Economic Review,* 69(3),pp. 448-45. Retrieved http://www.jstor.org/stable/1807380.

[4] Gilal, Mohammad Akram(2011). Exchange market pressure and monetary policy: a case study of Pakistan (Unpublished PhD. thesis), University of Glasgow, UK.

[5] Girton, L.and Roper, D. (1977). A monetary model of exchange market pressure applied to the post war Canadian experience.*The American Economic Review, Vol. 67*, pp. 537-48.Retrieved from http://www.jstor.org/stable/1813387.

[6] Ghartey, E. (2002). Exchange market pressure and optimal foreign exchange regime in Jamaica. *Social and Economic Studies* 51(2), pp. 49-62. Retrieved http://www.jstor.org/stable/27865276.

[7] Hacche, G., Townend, J. (1981). Monetary Models of Exchange Rates and Exchange Market Pressure: Some General Limitations and an Application to Sterling's Effective Rate. WeltwirtschaftlichesArchiv, 117(4),pp. 622-637. Retrieved http://www.jstor.org/stable/40438974.

[8] Halllwood,C.P. and Marsh,I.W.(2003). Exchange market pressure on the Pound-Dollar exchange rate:1925-31. Department of Economics, University of Connecticut Working Paper No. 2003-23.

[9] Hodgson, J., Holmes, A. (1977). Structural stability of international capital mobility: an analysis of short-term U.S.Canadian bank claims. *The Review of Economics and Statistics*, 59(4),pp. 465-473. doi:10.2307/1928711.

[10] Hodgson,J.S. Schneck, R.G. (1981). Stability of the relationship between monetary variable and exchange market pressure: Empirical evidenceevidence.Southern Economic Journal, Vol. 47, pp. 941-958.

[11] Khan, M. (1974). The Stability of the demand-for-money function in the United States 1901-1965.Journal of Political Economy, 82(6), 1205-1219.Retrieved from

[12] http://www.jstor.org/stable/1830669.

[13] Mah, J.S. (1998). Exchange market pressure in Korea: dynamic specifications.Applied Economic Letters, Vol. 5, pp. 765-768.

[14] Mathur,P.(1999).An exchange market pressure model for India Indian Economic Review, 34(2),new series,pp.127-148.Retrieved from

[15] http://www.jstor.org/stable/29794191.

[16] N. Sargen(1975). An empirical analysis of a monetary model of exchange rate and reserve fluctuations(unpublished paper), Federal Reserve Bank, San Francisco, USA.

[17] Pradhan, H.K., M.T. Paul and K.G. Kulkarni (1989) Exchange market pressure in India:An empirical test of monetary hypothesis.Prajnan, Vol. 18, No.1, 25-37.

[18] Smith, V. Kerry(1974). Re-examination of the trends in the prices of natural resource commodities, 1870- 1972," paper presented at the Econometric Society meetings, San Francisco, USA.

[19] Svensson, L.E.O. (1993) Assessing target zone credibility: mean reversion and devaluation expectations in the ERM: 1979-1992. European Economic Review, 37, pp. 763802.

[20] Taslim, M.A. (2003). A monetary approach to exchange market Disequilibrium in Australia: 1975-197 Australian Economic Papers, Vol. 42(2), pp. 183-196.

[21] Thornton, J. (1995). Exchange market pressure in Costa Rica, 1986-92: An application of the Girton-Roper model.International Economic Journal, Vol. 9(1), pp. 67-72.

[22] Wohar, M. and P. Burkett (1989). External shocks and fiscal deficits in a monetary model of international reserve determination: Honduras, 1960-83. Applied Economics, 21,pp. 921- 929.

[23] Wohar, M.E. and B.S. Lee (1992) An application of the Girton-Roper monetary model of exchange market pressure: The Japanese experience, 1959-1986. Indian Journal of Economics, Vol. 72, Part 4, Issue No.287,pp. 379-407.