THE ACADEMY OF ECONOMIC STUDIES BUCHAREST
DOCTORAL SCHOOL OF BANKING AND FINANCE

DISSERTATION PAPER

Exchange Market Pressure and Central Bank Intervention

student: **MATEI SEBASTIAN**
supervisor: Prof. **MOISĂ ALTĂR**

BUCHAREST, JULY 2001

THE ACADEMY OF ECONOMIC STUDIES BUCHAREST
DOCTORAL SCHOOL OF BANKING AND FINANCE

DISSERTATION PAPER

Exchange Market Pressure and Central Bank Intervention

student: **MATEI SEBASTIAN**
supervisor: Prof. **MOISĂ ALTĂR**

BUCHAREST, JULY 2001

1. Introduction

Since the breakdown of Bretton Woods exchange rate mechanism, the exchange rates of the major industrialized countries have been determined by the demand for and the supply of currencies in the foreign exchange market. This means that the value of a currency with respect to other currencies has been determined by market forces.

However, there is an unusual situation that a country allows its currency to be determined only by market forces. Many monetary authorities have intervened in the foreign exchange market, in order to influence the path of the exchange rate.

The amount of central bank intervention is correlated with the degree of disequilibrium in the foreign exchange market. In this paper, following Weymark (1998), we will define exchange market pressure as the exchange rate change that would have been required to remove this disequilibrium, in the absence of central bank intervention given that the agents form their expectations according to the exchange rate policy actually implemented.

The index of the exchange market pressure will be defined starting from this model independent definition, using a model in which the central bank modifies the monetary base through money market and foreign exchange market intervention. The sterilization of the effects of foreign exchange market intervention is done according to the objectives of the monetary policy at a given moment. In the same time, the central bank tries to influence the path of the exchange rate only by means of purchases or the sales of foreign currencies in the foreign exchange market, the monetary policy being independent of the conditions which prevail in the foreign exchange market.

The rest of the paper is structured as follows: In section 2, we define central bank foreign exchange intervention, we make a distinction between sterilized and unsterilized intervention and we identify the channels through which central bank intervention influences the exchange rate. We define, also, the exchange market pressure and the degree of central bank intervention. In section 3, we use an economic model in order to derive a measure of exchange market pressure. Section 4 deals with the data and empirical estimations. Section 5 analyses the behaviour of the National Bank of Romania in conducting its foreign exchange policy in the period 1997:01-2001:03, based upon the measures of exchange market pressure and the degree of central bank intervention computed for this period. Section 6 concludes.

2. Central bank intervention and exchange market pressure

Central bank intervention in foreign exchange market is defined as the purchase (sale) of foreign currencies conducted by the central bank in the foreign exchange market, with the aim to influence the value of the domestic currency with respect to other currencies. The purchases of foreign currencies increase the liquidity in the banking system, which results in a depreciation of the domestic currency. The sales of foreign currencies in the exchange market drain liquidity from the banking system, determining an appreciation of the domestic currency.

In the literature, there is a clear distinction between central bank interventions that affect the monetary base and central bank interventions that leave the monetary base unchanged. The first type of interventions are known as unsterilized interventions, while the second type are called sterilized interventions. Depending on the type of intervention, one can identify several channels through which the central bank intervention influences the exchange rate.

There is an disequilibrium between the demand and the supply in the foreign exchange market for the domestic currency when, at the prevailing exchange rate, the total amount of foreign goods and assets demanded by domestic residents is different from the total amount of domestic goods and assets demanded by foreigners. We will define exchange market pressure as the measure of the disequilibrium between the demand and the supply for the domestic currency, at a given moment in time.

Exchange market pressure cannot be directly observed. Therefore, the measurement of the exchange market pressure can be done through the building of an index which incorporates the observed changes in the exchange rate and foreign reserves of the central bank. The methodological problem that arises in this approach relates to the fact that changes in the exchange rate and changes in the foreign reserves are not expressed in the same unit of measurement. Therefore, the elasticity of the exchange rate with respect to the foreign reserves must be determined. We will call this elasticity as the conversion factor.

In this paper, the conversion factor will be determined from an economic model, but starting from a definition of the exchange market pressure that is independent of the model specified. This definition is given in Weymark (1998):

> *Exchange market pressure measure the total excess demand for a currency in international markets as the exchange rate that would have been required to remove this excess demand in the absence of exchange market intervention, given the expectations generated by the exchange rate policy actually implemented.*

Weymark (1998) shows that the measures for exchange market pressure derived earlier by Girton and Roper (1977)[1] and Roper and Turnovsky (1980)[2], can be derived within the framework proposed in her paper.

In a general form, exchange market pressure can be expressed in the following form:

$$EMP_t = \Delta e_t + \eta\left[\Delta m_t^{omo} + \Delta r_t\right] \tag{1}$$

where Δe_t represents the (log) change of the exchange rate (defined as units of domestic currency per units of foreign currency), Δm_t^{omo} represents the change in

[1] **Girton, L. şi Roper, D.** (1977) – "A Monetary Model of Exchange Market Pressure Applied to the Postwar Canadian Experience", American Economic Review, 67, 537-48

the monetary base due to central bank money market operations (divided by the one period lagged value of the monetary base), Δr_t represents the change in the foreign exchange reserves of the central bank (divided by the one period lagged value of the monetary base) and η represents the negative of the exchange rate elasticity with respect to the monetary base ($\eta = -\partial\Delta e_t / \partial\Delta m_t$). The term Δm_t^{omo} includes the operations conducted by the central bank in the money market aiming to sterilize the effects of foreign exchange intervention on the monetary base.

The second term in the right hand side of the equation (1) can be derived under the assumption of a constant monetary base multiplier.

The degree of intervention can be measured by the proportion of exchange market pressure which is relieved by central bank intervention. Dividing equation (1) by EMP_t results:

$$1 = \frac{\Delta e_t}{EMP_t} + \frac{\eta\left[\Delta m_t^{omo} + \Delta r_t\right]}{EMP_t}, \qquad (2)$$

where the second term on the right hand side of equation (2) measures the size of the exchange market pressure relieved by central bank's actions in the foreign exchange market. This is called the degree of intervention and is denoted as ω_t.

For the rest of the paper, we make the assumption that the changes in the monetary base engineered through the means of money market operations are completely independent of the conditions on the foreign exchange market. Δm_t^{omo} becomes exogenous to the context of exchange market pressure. The adjusted formula for exchange market pressure can be written as follows:

$$EMP_t = \Delta e_t + \eta\Delta r_t. \qquad (3)$$

In this case, the degree of central bank intervention can be expressed as:

---

[2] **Roper, D. şi Turnovsky, S.J.** (1980) – "Optimal Exchange Market Intervention in a Simple Stochastic Macro Model", Canadian Journal of Economics,13,296-309

$$\omega_t = \frac{\eta \Delta r_t}{EMP_t} = \frac{\Delta r_t}{\Delta r_t + \frac{1}{\eta}\Delta e_t} \quad . \tag{4}$$

3. The Model

In this section, we specify the model which will serve to determine the conversion factor η. A similar specification was used by Spolander (1999) to analyse the exchange market pressure in the case of Finland between 1992-1996 and Kohlscheen (2000) to determine the exchange market pressure and the degree of intervention for Chile between 1990-1998.

The first equation of the model is the money demand equation, which relates the change in the real demand for money positively with the change in a measure of outcome and negatively with a change in the interest rate:

$$\Delta m_t^D = \Delta p_t + \beta_0 + \beta_1 \Delta y_t - \beta_2 \Delta i_t \tag{5}$$

where Δm_t^D represents the change in the (log) nominal demand for money, Δp_t represents the change in the (log) consumer price index (CPI), Δy_t represents the change in the (log) industrial production index and Δi_t represents the change in the nominal interest rate. Parameters β_1 and β_2 are positive and signify, respectively, the demand for money elasticity with respect to the output and demand for money semi-elasticity with respect to the interest rate.

The second equation of the model shows that domestic inflation is determined by foreign inflation and changes in the exchange rate:

$$\Delta p_t = \alpha_0 + \alpha_1 \cdot \Delta p_t^* + \alpha_2 \Delta e_t \tag{6}$$

where Δp_t^* represents the change in the (log) consumer price index in the foreign economy. The coefficients α_1 and α_2 are positive and signify, respectively, domestic CPI elasticity with respect to the foreign CPI and domestic CPI elasticity with respect to the exchange rate.

We consider that the dynamics of the exchange rate is determined by uncovered interest rate parity condition, taking into account an exchange rate risk premium:

$$\Delta e_t = E_t(\Delta e_{t+1}) + (\Delta i_t^* + \Delta\chi_t - \Delta i) \quad (7)$$

where Δi_t^* represents the change in the foreign interest rate and $\Delta\chi_t$ represents the change in the risk premium. The term $E_t(\Delta e_{t+1})$ represents the expected change in the (log) exchange rate in the future period, conditional on information available in the present period.

Making the assumption of the constant monetary base multiplier, the change of the money supply, defined as the first difference of the logarithm of the money supply, is given by:

$$\Delta m_t^S = \Delta m_t^{omo} + \Delta r_t \quad (8)$$

where Δm_t^S represents the growth rate of the money supply, Δm_t^{omo} represents the change in the monetary base induced by money market operations and Δr_t represents the change in the foreign exchange reserves of the central bank. Both variables in the right hand side of equation (8) are divided by the one period lagged value of the monetary base.

Now, we will specify the reaction functions of the central bank. We will assume that the monetary policy reacts to domestic inflation using money market instruments:

$$\Delta m_t^{omo} = \gamma_0 - \gamma_1 \Delta p_t \quad (9)$$

The parameter $\gamma_1 > 0$ represents the money supply elasticity with respect to the domestic consumer price index.

The instruments of exchange rate policy are the sales and purchases of foreign currency in the foreign exchange market. The time variant parameter ρ_t, characterises the exchange rate policy at any moment t. The exchange rate policy reaction function is given by:

$$\Delta r_t = \rho_t \cdot \Delta e_t \quad (10)$$

We will assume that ρ_t can take both positive and negative values, depending on the constraints that the central bank faces in conducting its exchange rate policy.

The following equation closes the model and assumes the equilibrium between the demand and the supply for money:

$$\Delta m_t^S = \Delta m_t^D . \tag{11}$$

In order to solve the system formed by equations (5) – (11), we consider Δp_t, Δi_t, Δe_t, Δm_t^a and Δr_t as endogenous variables, and Δy_t, Δp_t^* and Δi_t^* as exogenous variables. Separating endogenous variables on the left hand side and exogenous variables on the right hand side, we can write the system in the following matrix form:

$$\begin{pmatrix} 1 & -\beta_2 & 0 & -1 & -1) \\ 1 & 0 & -\alpha_2 & 0 & 0 \\ 0 & 1 & (1-L^{-1}) & 0 & 0 \\ \gamma_1 & 0 & 0 & 1 & 0 \\ 0 & 0 & -\rho_t & 0 & 1 \end{pmatrix} \cdot \begin{pmatrix} \Delta p_t \\ \Delta i_t \\ \Delta e_t \\ \Delta m_t^{omo} \\ \Delta r_t \end{pmatrix} = \begin{pmatrix} -\beta_0 - \beta_1 \cdot \Delta y_t \\ \alpha_0 + \alpha_1 \cdot \Delta p_t^* \\ \Delta i_t^* + \Delta \chi_t \\ \gamma_0 \\ 0 \end{pmatrix} \tag{12}$$

where L represents the lag operator: $L^n X_t = X_{t-n}$.

We denote the coefficient matrix in (12) as $A(L)$, the endogenous variables vector as Z_t and the exogenous variables vector as X_t. The system in (12) can be written as:

$$A(L) \cdot Z_t = X_t . \tag{13}$$

Using the Cramer method we solve the system for Δe_t:

$$\Delta e_t = \frac{|A_3(L)|}{|A(L)|} = \frac{A_1 - (1+\gamma_1) \cdot A_2 + A_3 \cdot \beta_2 + A_4}{(1+\gamma_1) \cdot \alpha_2 + \beta_2 - \rho_t - L^{-1} \cdot \beta_2} \tag{14}$$

where:

$$|A(L)| = \begin{vmatrix} 1 & -\beta_2 & 0 & -1 & -1 \\ 1 & 0 & -\alpha_2 & 0 & 0 \\ 0 & 1 & (1-L^{-1}) & 0 & 0 \\ \gamma_1 & 0 & 0 & 1 & 0 \\ 0 & 0 & -\rho_t & 0 & 1 \end{vmatrix} =$$

$$= (1+\gamma_1)\cdot\alpha_2 + \beta_2 - \rho_t - L^{-1}\cdot\beta_2$$

$$|A_3(L)| = \begin{vmatrix} 1 & -\beta_2 & A_1 & -1 & -(1-\lambda) \\ 1 & 0 & A_2 & 0 & 0 \\ 0 & 1 & A_3 & 0 & 0 \\ \gamma_1 & 0 & A_4 & 1 & 0 \\ 0 & 0 & 0 & 0 & 1 \end{vmatrix} = A_1 - (1+\gamma_1)\cdot A_2 + A_3\cdot\beta_2 + A_4$$

$$A_1 = -\beta_0 - \beta_1\cdot\Delta y_t \qquad A_2 = \alpha_0 + \alpha_1\cdot\Delta p_t^*$$

$$A_3 = \Delta i_t^* + \Delta\chi_t \qquad A_4 = \gamma_0 .$$

As the term $|A(L)|$ is constant and depends only on the structural parameters of the model, the change in the exchange rate is determined only by the determinant of the matrix $A_3(L)$. It results that the determinant of the matrix $A_3(L)$ can be interpreted as the negative of the excess demand for domestic currency in the foreign exchange market:

$$|A_3(L)| =: -EDC_t \tag{15}$$

Using (15), the change in the exchange rate can be written as:

$$\Delta e_t = \frac{-EDC_t}{(1+\gamma_1)\cdot\alpha_2 + \beta_2 - \rho_t - L^{-1}\cdot\beta_2} \tag{16}$$

Multiplying (16) with $|A(L)|$ and taking expectations conditional on the information available at time t, we obtain the following first order difference equation:

$$[(1+\gamma_1)\cdot\alpha_2 + \beta_2 - \rho_t]\cdot\Delta e_t = -EDC_t + \beta_2 E_t(\Delta e_{t+1}) \tag{17}$$

The solution of this equation is:

$$\Delta e_t = \frac{-1}{(1+\gamma_1)\cdot\alpha_2 + \beta_2 - \rho_t}\cdot\sum_{k=0}^{\infty} E_t[\delta_k\cdot EDC_{t+k}] \tag{18}$$

where:

$$\delta_0 = 1$$

$$\delta_k = \prod_{j=1}^{k} \frac{\beta_2}{(1+\gamma_1)\alpha_2 + \beta_2 - \rho_t}, \; k \geq 1$$

Using (18) and the definition of Weymark (1998), we define exchange market pressure as:

$$EMP_t = \frac{-1}{(1+\gamma_1)\cdot\alpha_2 + \beta_2} \cdot \sum_{k=0}^{\infty} E_t(\delta_k \cdot EDC_{t+k}) \qquad (19)$$

Using (10) and (18) in (19), we can write the following form of exchange market pressure formula:

$$EMP_t = \Delta e_t - \frac{1}{(1+\gamma_1)\cdot\alpha_2 + \beta_2} \cdot \Delta r_t \qquad (20)$$

From (20) results that the conversion factor and the degree of central bank intervention have, respectively, the following specifications:

$$\eta = -\frac{1}{(1+\gamma_1)\cdot\alpha_2 + \beta_2} \qquad (21)$$

$$\omega_t = -\frac{\Delta r_t}{[(1+\gamma_1)\cdot\alpha_2 + \beta_2]\cdot EMP_t} \qquad (22)$$

In order to determine the foreign exchange market pressure and the degree of central bank intervention, it is necessary to estimate the structural parameters of the model. These are determined by estimating money demand equation (5), domestic inflation equation (6) and money supply equation which appears as a combination of equations (8) and (9). The parameters we need are the money demand semi-elasticity with respect to the interest rate β_2, domestic CPI elasticity with respect to the exchange rate α_2 and money supply elasticity with respect to domestic CPI γ_1.

4. Data and empirical estimations

The data sample covers the period 1997:01 – 2001:03. The sources of the time series used in estimation are the publications of the National Bank of Romania. The variables used have the following interpretation:

Δm_t^D , Δm_t^S - represent the first difference of the monetary aggregate M1

Δp_t , Δp_t^* - represent the logarithm of domestic, respectively, foreign chain weighted consumer price index

Δe_t - represents the first difference of the logarithm of the ROL/USD exchange rate

Δi_t - represents the first difference of the one week BUBOR interbank market interest rate

$\Delta r_t = \dfrac{\Delta R_t}{B_{t-1}}$ - represents a measure for the central bank intervention in foreign exchange market. ΔR_t represents net purchases of currencies of the NBR and B_{t-1} represents one period lagged value of the monetary base

Δy_t - represents the logarithm of the real industrial production chain weighted index

Money demand equation is estimated under the following specification:

$$\Delta m_t^D - \Delta p_t = \beta_0 + \beta_1 \cdot \Delta y_t + \beta_2 \cdot \Delta i_t + \beta_3 \cdot DUM12 \qquad (23)$$

where DUM12 represents a dummy variable for the increase in the money demand in December. The variable DUM12 takes the value of one in December and zero elsewhere.

Domestic inflation equation is estimated under the following specification:

$$\Delta p_t = \alpha_0 + \alpha_1 \cdot \Delta p_{t-1}^* + \alpha_2 \cdot \Delta e_t + \alpha_3 \cdot DUM9703 \qquad (24)$$

where DUM9703 represents a dummy variable for the liberalisation of the foreign exchange market. The variable DUM9703 takes the value of one in March 1997 and zero elsewhere.

Money supply equation will be estimated under the following specification:

$$\Delta m_t^S - \Delta r_t = \gamma_0 + \gamma_1 \cdot \Delta p_t + \gamma_3 \cdot DUM01 \tag{25}$$

where DUM01 represents a dummy variable for the decrease in the money supply in January. The variable DUM01 takes the value of one in January and zero elsewhere.

Since the model is specified in growth rates, it is very likely that the series used are stationary. However, the stationarity of the series was checked with both Augmented Dickey-Fuller and Phillips-Perron tests. The values for the tests, as well as the MacKinnon critical values are presented in Table 1:

Table 1 **Augmented Dickey-Fuller and Phillips-Perron stationarity tests**

MacKinnon critical values for rejection of the null hypothesis of a unit root using ADF Test *1% critical value -3.5682* *5% critical value -2.9215* *10% critical value -2.5983*			MacKinnon critical values for rejection of the null hypothesis of a unit root using PP Test *1% critical value -3.5653* *5% critical value -2.9202* *10% critical value -2.5977*		
Variable	**ADF**	**PP**	**Variable**	**ADF**	**PP**
Δm_t	-6.7092	-10.5223	Δi_t	-5.3485	-6.5424
Δp_t	-4.1752	-3.4527	Δr_t	-3.0223	-3.7022
Δp_t^*	-6.0691	-5.9498	Δy_t	-6.6500	-7.1733
Δe_t	-11.6576	-8.8132			

As expected, the tests seam to indicate the rejection of the hypothesis of existence of a unit root.

Due to the presence of endogenous variables both in the left and right hand side of the equations, we expect the regressors to be correlated with the residuals. Hence, the parameters estimated by ordinary least squares will be biased. This is the reason why in the estimation we used two-stage least squares.

The quality of the estimation results depends upon the instrumental variables used in estimation. We have considered as possible candidates for the role of instrumental variables one period lagged values of all endogenous variables and present and one period lagged values of exogenous variables. The selection of the actual instrumental variables is based on the statistical significance of the coefficients estimated by running OLS regressions having the endogenous variables as regressands and all the candidate variables as regressors. The following set of variables was found to be significant: $Q = [\Delta p_{t-1}\ \Delta y_t\ \Delta i_t\ \Delta p_t^*\ \Delta e_{t-1}]'$. Each equation was estimated individually, but the set of instrumental variables was the same in all equations.

The estimates for money demand equation are given in Table 2:

Table 2 **Money demand equation**

Dependent variable: Δm_t

Method: two-stage least squares

Sample: 1997:02 2001:03

Instrumental variables: $[\Delta p_{t-1}\ \Delta y_t\ \Delta i_t\ \Delta p_t^*\ \Delta e_{t-1}]'$

Variable	Coefficient	Standard error	t – statistic	Probability
β_0	-0.062356	0.021797	-2.860773	0.0063
β_1	1.232562	0.479721	2.569334	0.0135
β_2	-2.250988	0.562860	-3.999194	0.0002
β_3	0.665967	0.202063	3.295844	0.0019

R^2 = -0.356483 Std. Error = 0.123086 DW = 2.0003

The estimates for domestic inflation equation are presented in Table 3:

Table 3 **Domestic inflation equation**

Depende: Δp_t

Method: two-stage least squares

Sample: 1997:02 2001:03

Instrumental variables: $\left[\Delta p_{t-1}\ \Delta y_t\ \Delta i_t\ \Delta p_t^*\ \Delta e_{t-1}\right]'$

Variable	Coefficient	Standard Error	t – statistic	Probability
α_0	0.013936	0.010671	1.305940	0.1981
α_1	3.321297	5.654110	0.587413	0.5598
α_2	0.422073	0.179391	2.352808	0.0230
α_3	0.314580	0.038121	8.252162	0.0000

R^2 = 0.763253 Std. Err. = 0.020645 DW = 1.571637

The estimates for the central bank reaction function are presented in Table 4:

Table 4 **Central bank reaction function**

Dependent variable: Δm_t - Δr_t

Method: two-stage least squares

Sample: 1997:02 2001:03

Instrumental variables: $\left[\Delta p_{t-1}\ \Delta y_t\ \Delta i_t\ \Delta p_t^*\ \Delta e_{t-1}\right]'$

Variable	Coefficient	Standard Error	t – statistic	Probability
γ_0	-0.023107	0.017169	-1.345862	0.1848
γ_1	-0.248645	0.225194	-1.104137	0.2752
γ_2	0.275546	0.057900	4.758992	0.0000

R^2 = 0.400264 Eroare std. = 0.092329 DW = 1.547760

5. The characterisation of the behaviour of the central bank in conducting foreign exchange policy

The estimation of the three equations allowed us to determine the coefficients needed to compute the conversion factor. These coefficients are:

$$\alpha_2 = 0.422073 ,\ \beta_2 = 2.250988 ,\ \gamma_1 = 0.24845 .$$

The conversion factor is:

$$\eta = -\frac{1}{(1+\gamma_1)\cdot\alpha_2 + \beta_2} = -\frac{1}{(1+0.24845)\cdot 0.422073 + 2.250988} = -0.35998$$

The values for exchange market pressure computed under the approach proposed by Weymark are presented in Table 5. The variable is denoted EMP_t^W .

For comparision, we have presented a measure of exchange market pressure in which the conversion factor is determined as:

$$\eta = -\left(\frac{\text{var}(\Delta e_t)}{\text{var}(\Delta r_t)}\right)^{1/2} \tag{25}$$

where $\text{var}(\Delta e_t)$ represents the variance of the exchange rate change and $\text{var}(\Delta r_t)$ represents the variance of the measure for central bank intervention. This measure was proposed by Eichengreen, Rose şi Wyplosz (1995)[3] and was based on the idea of equalising the standard deviations of exchange rate change and foreign reserve changes.

Using formula (25), the conversion factor gives:

$$\eta = -\frac{0.068532}{0.088751} = -0.772183 \tag{26}$$

The measure for exchange market pressure computed using the conversion factor proposed by Eichengreen, Rose and Wyplosz (1995) is denoted by EMP_t^{ERW} and is depicted in Table 5:

[3] Eichengreen, B., Rose, A.K. şi Wyplosz, C.(1995) – Exchange Market Mayhem, Economic Policy, Vol.21, 249 –312.

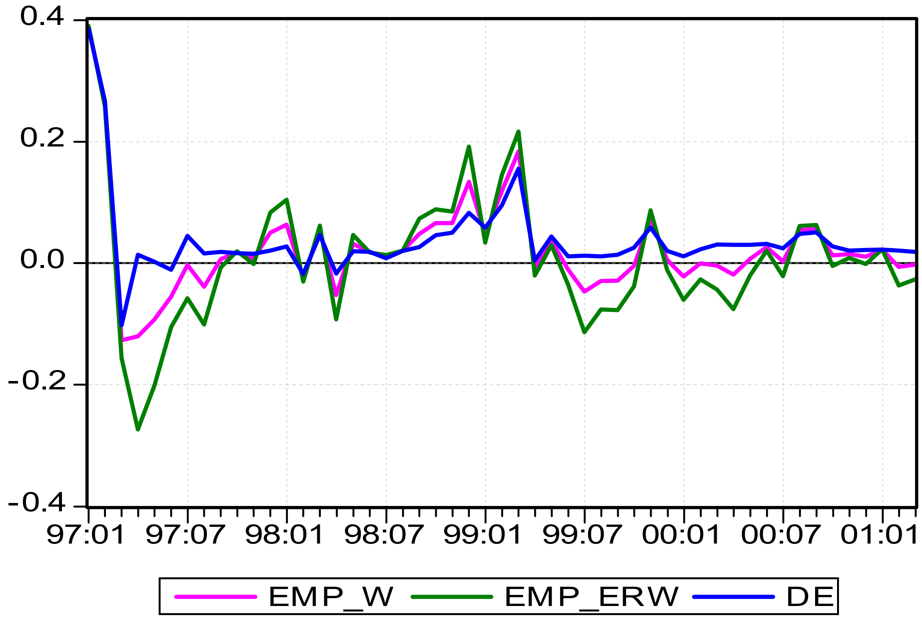
Table 5 **Indicators for exchange market pressure**

Date	EMP_t^W	EMP_t^{ERW}
1997:01	0.387559476	0.390083608
1997:02	0.262378934	0.257594856
1997:03	-0.126879973	-0.155850361
1997:04	-0.119989829	-0.273476354
1997:05	-0.092561631	-0.200969157
1997:06	-0.055033111	-0.105418359
1997:07	-0.003082611	-0.057880721
1997:08	-0.038660712	-0.101004073
1997:09	0.006766722	-0.007044763
1997:10	0.018023362	0.019568969
1997:11	0.007534689	-0.001306414
1997:12	0.04983506	0.083396099
1998:01	0.063471892	0.104480802
1998:02	-0.023525135	-0.030436233
1998:03	0.053647584	0.061937565
1998:04	-0.052339021	-0.092545256
1998:05	0.032091617	0.046284406
1998:06	0.017961454	0.017334081
1998:07	0.01057852	0.012959755
1998:08	0.020477726	0.020593606
1998:09	0.048238185	0.073335713
1998:10	0.065798831	0.088624482
1998:11	0.066291979	0.085150927
1998:12	0.133510359	0.191715507
1999:01	0.047158827	0.033851249
1999:02	0.118178891	0.144490576
1999:03	0.184025027	0.216544025
1999:04	-0.006988012	-0.02011858

Date	EMP_t^W	EMP_t^{ERW}
1999:05	0.037224819	0.029786637
1999:06	-0.010316982	-0.035070998
1999:07	-0.046411838	-0.113709689
1999:08	-0.029523789	-0.076322984
1999:09	-0.028570831	-0.077270132
1999:10	-0.004207942	-0.038034293
1999:11	0.072190656	0.087440627
1999:12	0.005315334	-0.011533295
2000:01	-0.022066941	-0.060432365
2000:02	-0.00033633	-0.026899392
2000:03	-0.003798924	-0.043244943
2000:04	-0.019050914	-0.075374086
2000:05	0.006957415	-0.019958834
2000:06	0.026415709	0.020665294
2000:07	0.003054237	-0.021621142
2000:08	0.054385258	0.061365076
2000:09	0.056222953	0.062488467
2000:10	0.012715462	-0.004542373
2000:11	0.015057691	0.008856695
2000:12	0.011150963	-0.001175125
2001:01	0.02248476	0.02259458
2001:02	-0.006052238	-0.036747143
2001:03	-0.002807621	-0.026855836

In order to better analyse the exchange market pressure indicators, we plot in the same graph the two measures of disequilibrium together with the change in the exchange rate:

Graph 1 **Exchange market pressure and change of the exchange rate**



In order to study the behaviour of the central bank in conducting the exchange rate policy, it is useful to compute the degree of central bank intervention. The indicators for the degree of intervention are shown in Table 6:

Table 6 **Indicators for the degree of central bank intervention**

Date	ω_t^W	ω_t^{ERW}
1997:01	0.005688	0.012122
1997:02	-0.01592	-0.03479
1997:03	0.199402	0.348222
1997:04	1.117108	1.051382
1997:05	1.022817	1.010509
1997:06	0.799556	0.895359
1997:07	15.52445	1.773543
1997:08	1.408282	1.156276
1997:09	-1.78251	3.672688
1997:10	0.074891	0.147959
1997:11	-1.02473	12.67756
1997:12	0.588125	0.753876
1998:01	0.564243	0.735278
1998:02	0.256557	0.425369
1998:03	0.13495	0.250732
1998:04	0.670868	0.813859
1998:05	0.38623	0.574438
1998:06	-0.0305	-0.0678
1998:07	0.196583	0.344204
1998:08	0.004942	0.010541
1998:09	0.45437	0.6411
1998:10	0.302952	0.48248
1998:11	0.248442	0.414895
1998:12	0.380729	0.568741

Data	ω_t^W	ω_t^{ERW}
1999:01	-0.24644	-0.73643
1999:02	0.194437	0.341129
1999:03	0.154323	0.28132
1999:04	1.640964	1.222633
1999:05	-0.1745	-0.46779
1999:06	2.095378	1.322232
1999:07	1.266315	1.108699
1999:08	1.384317	1.148664
1999:09	1.48857	1.18065
1999:10	7.020284	1.666057
1999:11	0.184483	0.326713
1999:12	-2.76824	2.736662
2000:01	1.518333	1.18927
2000:02	68.9734	1.849889
2000:03	9.068006	1.708748
2000:04	2.581907	1.399829
2000:05	-3.37859	2.526326
2000:06	-0.19011	-0.52128
2000:07	-7.05554	2.137939
2000:08	0.112081	0.213075
2000:09	0.097322	0.187831
2000:10	-1.18529	7.117273
2000:11	-0.35964	-1.3116
2000:12	-0.96534	19.64949
2001:01	0.004265	0.009105
2001:02	4.429142	1.564778
2001:03	7.480208	1.677468

As it can be seen from Table 5, during the first two months of 1997 there was a strong pressure on Leu depreciation on the foreign exchange market. The central bank did not undertake any measures to restore the equilibrium, as we can infer from the low values of the degree of intervention. Therefore, domestic currency depreciated from 4035 at the end of December 1996 to 7744 at the end of February 1997.

Following the liberalisation of the exchange rate and foreign exchange market, an increase of the capital inflows took place in the following months. As shown in Table 5, from March until August 1997 the exchange market underwent an appreciation pressure. Taking into account the NBR's desire to ensure a slow nominal depreciation, the release of the appreciation pressure was carried out through foreign currency purchases on the foreign exchange market. This enabled the NBR to strengthen its foreign currency reserves.

Starting with the last part of 1997, due to the general condition of the economy, certain pressures appeared on the foreign exchange market taking the form of a higher currency demand. Thus, the measures of the foreign exchange pressure are generally positive for this period. The NBR acted as a net foreign exchange buyer in September and November, amplifying the excess demand for foreign currencies. Hence, the value for the coefficient ω_t is negative for these months. During the months of October and December, the National Bank sold foreign currency on the interbank market, lowering the depreciation pressure.

During the first part of 1998, the foreign exchange pressure was negative, because of the capital inflows for this period. The central bank lowered this pressure through foreign exchange currency purchases. The degree of intervention was positive, but less than one. This situation can be explained through the central bank's desire to tame inflation by inducing a real appreciation of the exchange rate. Throughout this period the exchange rate served as "temporary and implicit objective for the monetary policy" (NBR(1998)). This policy proved successfully regarding the halting of the increase of the price level, but had a negative impact on the external competitivity of the economy.

The following months were characterised by a positive pressure on the foreign exchange market. The decreasing trend of the domestic currency has been determined by the capital outflows following the Russian crisis and the negative expectations regarding the ability to pay back the loans due in 1999. In the second half of 1998, the NBR intervened in order to avoid the steep depreciation of the domestic currency by selling foreign currency in the foreign exchange market. The degree of intervention is all through the second semester of 1998 positive and less than one.

The depreciation pressure of the domestic currency went on all the way through the first months of 1999, under the impact of an increased foreign currency demand generated by the expectations regarding the future evolution of the exchange rate. The central bank had to intervene in order to avoid a steep depreciation of the national currency which would have brought negative effects on the price level. If the central bank had restrained from intervening the national currency would have lost 11.8 percent of its value in February and a further 18.4 percent in March.

The foreign exchange market stance modified beginning with the month of June 1999, when, although the foreign debt peak had not been passed, the exchange market pressure became negative. The bank responded to the appreciation pressure with foreign currency purchases, which helped the elimination of the excess foreign currency and helped to keep the competitivity gains accumulated hitherto. The degree of intervention had values more than one, which indicates that the central bank induced through its intervention a movement of a different direction from that that would have happened hadn't it been for the intervention. The exception to this rule is November 1999, when a depreciating pressure was induced having the commercial banks' speculative market actions as background. The central bank sold foreign currency in order to release this pressure, but, nevertheless the exchange rate depreciated on a higher scale than in the previous months.

During the year 2000, as well, the foreign exchange market was characterised by an excess of foreign currency, which induced appreciating pressure on the national currency. This becomes more evident if we consider the measure of the pressure on the foreign exchange market using a conversion factor determined according to the method proposed by Eichengreen, Rose and Wyplosz (1995). Only the months of August and September failed to abide by this rule, because, following the central bank's decision to allow a higher depreciation tick, a depreciation pressure was induced on the market. The central bank became a net foreign currency seller in the following months, releasing the pressure on the exchange rate.

In the current year, after the depreciating trend of the exchange rate was according to the target established by the central bank in January, a fact proven by the low level of foreign exchange intervention a foreign currency excess began to appear on the market, caused mainly by the foreign currency purchases performed by banks from their clients. This appreciation pressure solicited the intervention of the central bank which went on to buy foreign currency from the foreign exchange market.

6. Conclusions

In this paper, we analysed the behaviour of the National Bank of Romania in the conduct of the foreign exchange policy and the way it acted in order to reduce or amplify exchange market pressure. We defined exchange market pressure as a combination between the change in the exchange rate and change in the foreign currency reserves of the central bank.

The main conclusions that can be drawn from the analysis are: in the most part of the months in the period considered there was a negative pressure on the exchange market, which without central bank intervention would have been resulted in a nominal appreciation of the domestic currency. The National Bank knew to take advantage from this situation, strengthening in this period its foreign currency reserves. In the most cases, the appreciation pressure was not only eliminated by foreign currency purchases, but the central bank induced a depreciation of the domestic currency. The positive pressure on the domestic currency was lowered by sales of foreign currency from the central bank's reserves.

Despite the fact that they explain quite well the behaviour of the central bank in the last four years, the indicators presented in this paper have some limits generated, mainly, by the assumptions made when the model was specified. Relaxing some of these assumptions would conduct to better results. We include here the explicit specification of the sterilisation of the effects of foreign exchange market intervention, the relaxation of the hypothesis of a constant monetary base multiplier and taking into account, separately, the interventions conducted with the aim of strengthening the foreign reserves.

Bibliography

1. Baillie, R., O. Humpage and W. Osterberg (1999), "Intervention as Information: A Survey", *Working Paper No. 9918*, Federal Reserve Baank of Cleveland

2. Dominguez, K. (1993), "Does Central Bank Intervention Increase the Volatility of Foreign Exchange Rates", *NBER Working Paper No. 4532*

3. Dominguez, K. (1999), "The Market Microstructure of Central Bank Intervention", *NBER Working Paper No. 7337*

4. Dominguez, K. and J. Frankel (1993), "Does Foreign Exchange Intervention Matter? The Portfolio Effect", *The American Economic Review*, Vol. 83, No. 5, 1356-1369

5. Eijffinger, S and W. Verhagen (1997), "The Advantage of Hidding Both Hands: Foreign Exchange Intervention, Ambiguity and Private Information", *CentER for Economic Research Working Paper*, Tilburg University

6. Frankel, J. and A. Rose (1994), "A Survey on Empirical Research on Nominal Exchange Rates", *NBER Working Paper No. 4865*

7. Greene, W. (1993), "Econometric Analysis", 2nd edition, *Macmillan Publishing Company*, New York, N.Y.

8. Kohlscheen, E-W. (2000), "Estimating Exchange Market Pressure and Intervention Activity", *Working Paper Series No. 9*, Banco Central de Brasil

9. Maddala, G.S. (1992), "Introduction to Econometrics", 2nd edition, *Macmillan Publishing Company*, New York, N.Y.

10. Spolander, M. (1999), "Measuring Exchange Market Pressure and Central Bank Intervention", *Bank of Finland Studies E:17*, Helsinki, Finland

11. Weymark, D. (1998), "A General Approach to Measuring Exchange Market Pressure", *Oxford Economic Papers*, 50, 106-121

12. National Bank of Romania, "Buletin lunar" din perioada 1999-2001, Bucureşti, România

13. National Bank of Romania, "Raport anual" din perioada 1997-1999, Bucureşti, România