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An Analysis of Exchange Market Pressure and Monetary Policy: Evidence from Turkey

Alpaslan AKÇORAOĞLU*

The present paper examines the interrelations between exchange market pressure (EMP) and monetary policy for the specific case of Turkey within a context of VAR. Employing the monthly data for Turkey during 1990s, this paper examines whether the data for Turkey supports the predictions of Girton-Roper monetary model of exchange market pressure (EMP). The evidence presented in this paper indicates that one measure of monetary policy, domestic credit growth by the central bank, has a significant and positive impact on EMP as predicted. However, the author finds no evidence of Granger causality from interest differential to EMP. This surprising result may be explained by the fact that interest rates contain both policy and market-determined elements. In fact, the signs of the impulse-response functions conform to the predictions of the Girton-Roper's monetary model. On the other hand, our evidence suggests that policy authorities respond to higher EMP by increasing domestic interest rates. However, the direction of the responses of domestic credit to higher EMP is mixed. Finally, our evidence reveals that Fisher effect dominates liquidity effect in Turkey during 1990s.

1. Introduction

This paper analyzes the relationship between exchange market pressure (EMP) and monetary policy in Turkey during 1990s. Exchange market pressure (EMP) is defined as the rate of depreciation of the exchange rate *plus* the rate of change of international reserves as a percentage of monetary base (Girton and Roper, 1977). EMP is more appropriate concept under a managed exchange rate regime as it captures the movements both in exchange rate and foreign reserves. Since the collapse of the Bretton Woods system and, a brief period of freely floating exchange rates that followed it, many countries have pursued a mixed exchange rate regime. These intermediate exchange rate systems are characterized by some degree of exchange rate flexibility and state intervention in markets with purchases or sales of international reserves.

The recent crises in East Asia and Latin America have indicated that the examination of external and internal factors affecting EMP is critical for policy

* Ph.D., Department of Econometrics, Faculty of Economic and Administrative Sciences, Gazi University

makers. As the experiences of these countries have showed, policy authorities, with few alternatives in the short term, attempt to reduce EMP by adjusting the domestic money supply and interest rates. The implementation of structural policies such as fiscal adjustment and financial sector reform necessiate a longer time period. On the other hand, some authors discussed whether contractionary monetary policy and specifically high interest rates will be sufficient to defend exchange rates (Radelet and Sachs, 1998). Corsetti, *et. al.* (1998) have claimed that a "Laffer" curve may exist under certain conditions. According to this view, a contractionary monetary policy may lead to a panic among investors and thus depreciation of the national currency.

Moreover, there is a controversy between some authors on the stance of monetary policy in East Asia and Mexico during and after the crisis. While some authors characterize monetary policy as loose in East Asian countries at least in the early stages of the crisis, some others have the opposite view. However, Calvo and Mendoza (1996) stress that foreign reserve outflows were initially sterilized with increases of domestic credit by the Central Bank during the Mexican crisis of 1994-95.

This paper tries to examine the interrelationships between EMP and monetary policy for the specific case of Turkey. In early 1994, Turkish economy confronted with a serious currency crisis. Therefore, Turkey provides a particularly good example for testing the relationship between EMP and monetary policy. First, we explore whether the effects of monetary policy on EMP conform to the predictions of the Girton-Ropers's monetary model of exchange market pressure. Second, this paper attempts to shed some light on whether the stance of monetary policy is itself a function of the exchange market pressure in Turkey.

This paper is organized into five sections. Section 2 provides the details of theoretical discussions. Section 3 contains the data and empirical methodology. In section 4, empirical results are presented. A brief summary and conclusion is found section 5.

2. EMP, Girton-Roper Monetary Model, and Some Recent Policy Issues

The Girton-Roper monetary model of exchange market pressure (EMP) is designed specifically for Canadian managed exchange rate regime during the period 1952-62. The basic aim of their model is to explain EMP when there exists an excess of domestic money supply over money demand in a managed exchange rate system. In this model, any excess supply of money can be relieved by an exchange rate depreciation, a decline in international reserves, or by some combination of the two under a managed exchange rate regime. More recently, some papers have used EMP indirectly to form a discrete crisis indicator. This indicator has been commonly used in some recent empirical work (e.g., Eichengreen, *et. al.* (1996); Kaminsky, *et. al.*

(1998)). On the other hand, Eichengreen, *et. al.* (1996) also have formed an EMP indicator that includes interest differential. However, the interest differential will be taken as a determinant of EMP in this paper.

Employing an exponential specification of the demand for monetary base function, Girton and Roper (1977) states the monetary equilibrium condition for any country i as follows:

$$(1) \quad M_i = F_i + D_i = P_i\, Y_i^{\beta_i} \exp(-\alpha_i\, \varphi_i), \qquad \beta_i > 0, \quad \alpha_i > 0$$

where H_i: supply of monetary base issued by the central bank of country i, F_i: monetary base created against the purchase of foreign assets, D_i: monetary base created by domestic credit expansion, P_i: price level, Y_i: real income, φ_i: index of interest rates, β_i: income elasticity, α_i: interest rate coefficient.

Formula (2) determines the division of M between its domestic, D, and foreign, F, sources.

$$(2) \quad F_i(t) = \int_{-\infty}^{t} E_t(t)\, R_i'(t)\, dt$$

where $R_i(t)$: stock of international reserves, $R_i'(t)$: time derivative of R_t (net purchases at time t), $E_i(t)$: the country's parity (or price of foreign exchange in the case of foreign exchange reserves).

If we substitute the time derivate of (2) in the differentiated version of (1), the following formula can be obtained (terms expressed in percent change form):

$$(3) \quad m_i = r_i + d_i = F_i + \beta_i\, y_i - \alpha_i\, \varphi_i'$$

where $m_i = M_i'/M_i$, $d_i = D_i'/M_i$, $\varphi_i'(t) = d\,\varphi_i/dt$, $F_i = P_i'/P_i$, $r_i = ER_i'/M_i$, $y_i = Y_i'/Y_i$

A real measure of the balance of payments r_i is acquired when the rate of change of international reserves valued in domestic currency $E_i\, R_i'$ is deflated by domestic monetary base M_i.

By substracting the monetary equilibrium condition (3) for country j from the equilibrium condition for country i, we can analyze the monetary interaction between countries.

$$(4) \quad r_i - r_j = -d_i + d_j + b_i\, y_i - b_j\, y_j + \Phi_i - \Phi_j - \alpha(\varphi_i' - \varphi_j')$$

and $(\alpha = \alpha_i = \alpha_j)$

If equation (4) is rewritten by a new notation, we can reach to equation (5).

$$(5) \quad r_i - r_j + e_{ij} = -d_i + d_j + \beta_i\, y_i - \beta_j\, y_j + \lambda_{ij} - \alpha\, \psi_{ij}$$

where e_{ij}: rate of appreciation of currency i in terms of currency j, $\lambda_{ij} = \Phi_i - \Phi_j + e_{ij}$: differential inflation rate adjusted for exchange rate changes, $\psi_{ij} = \varphi_i' - \varphi_j'$: change in the uncovered interest differential.

If one of the two countries is a center or key-currency country, this extreme asymmetry in the adjustment burden will justify the followig equation:

$$(6) \quad r_i + e_i = - d_i + m_j + \beta_i y_i - \beta_j y_j + \lambda_j - \alpha \psi_i$$

In that case, the center country will have the ability to force most of the adjustment burden on those countries who try to stabilize their exchange rates. If, on the other hand, the monetary authorities of two countries with comprable sizes intervene without a formal commitment to a fixed exchange rate, the variable $r_i - r_j + e_{ij}$ measures exchange market pressure (EMP).

This last equation implies that an increase in the domestic credit growth, for a given rate of growth of world prices and permanent income, will result in an equiproportionate loss in reserves with no change in the exchange rate, or an equiproportionate depreciation of the domestic currency, or some combination of the two.[1]

According to Girton and Roper, the term EMP refers to the magnitude of money market disequilibrium that must be removed either through reserve or exchange rate changes. The model specification used in their analysis and the assumption that policy makers do not use domestic credit changes to affect exchange rate ensures that EMP is the simple sum of the percentage change in the exchange rate and in international reserves.[2]

On the other hand, Roper and Turnovsky (1980) utilized a different model specification and relaxed the above mentioned assumption. Consequently, they concluded that the excess demand for money is equal to a linear combination of changes in the exchange rate and in the monetary base and that these two components are not equally weighted (Weymark, 1995).

Studies on 1994-95 Mexican crisis indicates that monetary authority sterilized the international reserve outflows at least in the early stages of a crisis. Tennar (1999) argues that an initial increase in EMP may result from a decrease in demand for money and the central bank may incorrectly perceive to be temporary. The same author also presents an alternative explanation such that the existence of a weak

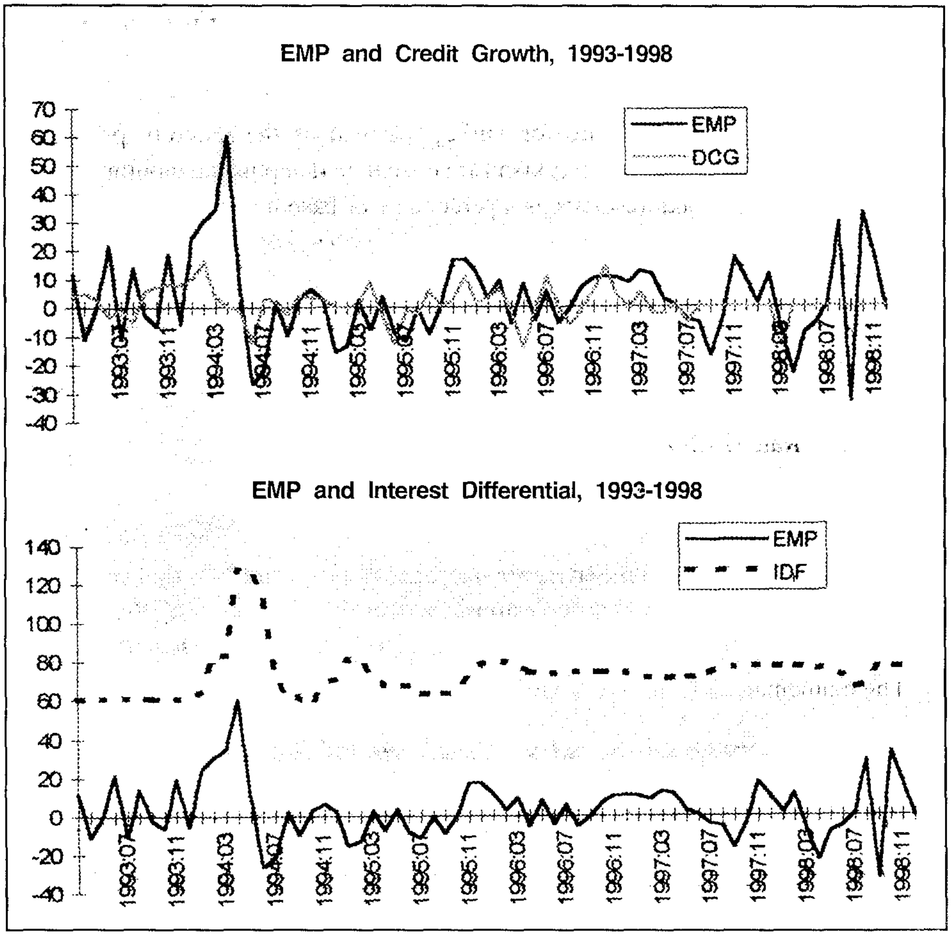
1. According to our definition of EMP (exchange rate depreciation plus reserve outflows scaled by monetary base), EMP is a positive function of domestic credit growth by the central bank. If e represents units of the national currency per U.S. Dollar and r is the reserve outflows scaled by monetary base, EMP equals e - r. See, for example, Tanner (1999).

2. Connolly and Da Silveria (1979) and Burkett and Richards (1993) are the two examples of empirical studies testing the revelance of monetary model of EMP for developing countries (Brazil and Paraguay, respectively).

financial system may lead to a such a policy reaction. In both Mexico and East Asia, policy authorities did not let unsound financial institutions fail during the crisis because of political constraints. In other words, policy authorities had a few options other than extending credit to such financial institutions.

In early 1994, Turkish economy underwent a serious currency crisis. In charts 1-2, exchange market pressure (EMP) is plotted against domestic credit growth by Turkish central bank and interest differential, respectively. Visual inspection of Charts 1-2 reveals that a currency crisis of this scale has never occured during 1990s.

Charts 1 and 2



In this paper, we include both central bank credit growth and interest differential as monetary policy variables. Some authors claim that the stance of monetary policy is best measured by an interest rate. However, another view argues that interest rates are also market determined variables with expected exchange rate depreciation and risk. On the other hand, several recent studies analyzing monetary policy in East Asia examined movements in the interest rate (e.g., Furman and Stiglitz (1998), Goldfajn and Gupta (1999))

3. Data and Empirical Methodology

All series used in empirical analysis are monthly and are taken from the Central Bank of Turkey (www.tcmb.gov.tr), and International Financial Statistics (IFS) database. The data set regarding the three-month London Inter-Bank Offer Rate (LIBOR) on $US deposits are sourced from IFS database.

The data cover the period 1990:03 to 1998:12 for all series. The variables in this paper are the following:

EMP exchange market pressure for Turkey, defined as the monthly percentage depreciation of the $US / Turkish Lira exchange rate plus the monthly change of net international reserves as a percentage of base money.

C monthly change of net domestic credit of the Central Bank of Turkey as a percentage of base money.

i_D domestic interest rate, proxied by the deposit rate on three-month Turkish Lira deposits[3]

i_{US} external (world) interest rate, proxied by the three-month London Inter-Bank Offer Rate (LIBOR) on $US deposits.

IDIF Interest Differential

To provide evidence on the dynamic interactions between EMP, domestic credit growth and interest differential, we estimate a vector autoregression (VAR) model for Turkish economy and perform the Granger (1969) causality tests.

The mathematical form of a VAR is

$$(7) \qquad Y_t = A_1 Y_{t-1} + \dots + A_n Y_{t-n} + \varepsilon_t$$

Here, $Y = (EMP_t, C_t, IDIF_t)$ is a matrix of variables, $A_1 \dots A_n$ is a vector of coefficients to be estimated and ε_t is a vector of innovations (see Hamilton (1994) for a detailed and technical discussion of VAR methodology).

3. We also experimented with proxies such as deposit rate on three-month $US deposits in Turkey and real interest rates for Turkey and United States, defined as nominal interest rate minus the inflation rate (measured by the percentage change of CPI index). But, when included, these variables did not change the basic nature of the results.

An impulse-response function (IRF) traces the response of an endogenous variable to change in one of the innovations. In other words, an IRF describes the effect on current and future values of the endogenous variable of a one standard deviation shock to one of the innovations.

If the innovations are not correlated with each other, the interpretation is straightforward. When the errors are correlated, they have a common component which cannot be identified with any specific variable. One method of dealing with this problem is to attribute all the effect of any common component to the variable that comes first in the VAR system. The errors are orthogonalized by a *Choleski* decomposition so that the covariance matrix of the resulting innovations is diagonal.

4. Empirical Results

We first established the order of integration of each series via the Phillips-Perron (P-P) tests. The results of Phillips-Perron (1988) tests indicate that all series are level stationary (results available upon request). Table 1 reports the Wald-F statistics constructed under the null hypothesis of non-causality. The test results of Granger-noncausality in Table 1 demonstrate that exchange market pressure (EMP) Granger-cause interest differential at the 99 percent level. Impulse response functions and their corresponding standard errors are reported in Tables 2 through 4. The IRFs presented in Table 2 show that shocks to EMP affect the interest differential positively. Because an increase in EMP generally implies an increase in either expected exchange rate depreciation, risk, or both, policy authorites respond by increasing the level of domestic interest rate. There are significant positive responses until the sixth period.

On the other hand, empirical model reject Granger causality from interest differential to EMP at conventional levels. This surprising result may be explained by the fact that interest rates contain both policy and market determined elements. As is seen from Table 2, the IRFs are all negative after the initial response. The signs of the estimated IRFs conform to the predictions of the monetary approach to EMP. However, all of the responses are insignificant.

Table1. Granger causality test results, Turkish Economy 1990:03-1998:12

H_0:	Wald-F statistic	Result	Probability
Domestic credit growth does not cause EMP	4.6228	rejected	(0.0018)
EMP does not cause domestic credit growth	1.1494	accepted	(0.3380)
Interest differential does not cause EMP	0.2204	accepted	(0.9264)
EMP does not cause interest differential	7.8386	rejected	(0.0000)
Domestic credit does not cause interest differential	2.7000	rejected	(0.0352)
Interest differential does not cause domestic credit	1.6542	accepted	(0.1673)

Note: For all estimates, 4 lags are used.

Our empirical evidence suggests that domestic credit growth Granger-cause EMP at the 95 percent level (see Table 1). The estimated IRFs in Table 3 reveal that shocks to domestic credit growth are positively associated with movements in EMP. There are positive and significant IRFs for at least one period. That is an expected result and conforms to expectations of the monetary model. On the other hand, the magnitude of the initial shock exceeds one (i.e., a one percent shock to credit growth causes a change in EMP more than one percent).

Table 2. Impulse Response Functions (1990-1998 Monthly Data)

Responses of:	**EMP**	**Credit growth**
Shock to:	Domestic credit growth	EMP
Period 1	1.96	0.00
	(1.07)	(0.00)
Period 2	3.90	0.30
	(1.09)	(0.42)
Period 3	2.36	-0.57
	(1.11)	(0.45)
Period 4	2.81	-0.37
	(1.11)	(0.46)
Period 5	1.20	-0.44
	(1.15)	(0.43)
Period 6	-0.95	-0.33
	(0.84)	(0.22)

NOTE: Standard errors in parantheses.

However, the author find no evidence of causality from EMP to domestic credit growth at conventional levels. The IRFs reported in Table 3, however, indicates that shocks to EMP affect domestic credit growth positively in the second period. However, there are negative responses after 2 months. The signs of the IRFs (though none of them are significant) suggest that the policy makers respond, initially, to increased EMP by increasing domestic credit of the central bank (i.e., sterilization).

Table 3. Impulse Response Functions (1990-1998 Monthly Data)

Responses of:	**EMP**	**Interest Differential**
Shock to:	Interest Differential	EMP
Period 1	0.00	1.86
	(0.00)	(0.50)
Period 2	-0.92	4.43
	(1.14)	(0.72)
Period 3	-0.44	5.28
	(1.14)	(0.96)
Period 4	-0.50	4.99
	(1.14)	(1.12)
Period 5	-0.28	2.61
	(0.63)	(1.20)
Period 6	-0.04	0.94
	(0.68)	(1.18)

NOTE: Standard errors in parantheses.

Table 4. Impulse Response Functions (1990-1998 Monthly Data)

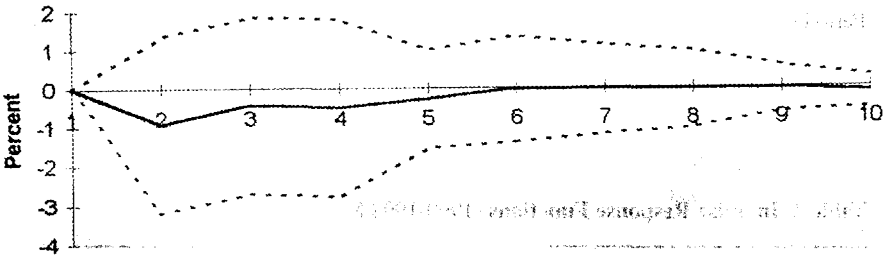
Responses of:	**D.Credit Growth**	**Interest Differential**
Shock to:	Interest Differential	Domestic Credit Growth
Period 1	0.00	0.41
	(0.00)	(0.56)
Period 2	-0.23	1.10
	(0.42)	(0.82)
Period 3	-0.88	2.73
	(0.44)	(1.04)
Period 4	0.06	3.23
	(0.42)	(1.13)
Period 5	-0.14	3.68
	(0.30)	(1.19)
Period 6	-0.13	3.09
	(0.29)	(1.19)

NOTE: Standard errors in parantheses.

We also examined the interrelations between domestic credit growth and interest differential for the specific case of Turkey. The empirical results from Table 1 indicate that domestic credit growth Granger-cause interest differential at the 95 percent level. In addition, shocks to domestic growth affect interest differential positively as suggested by the IRFs in Table 4. All responses are positive and several of them are significant. Such a finding implies that *Fisher effect* dominates the *liquidity effect* in Turkey where inflation rates are chronically high. However, the Wald-F statistics in Table 1 reveal that domestic credit growth does not respond to interest differential shocks. The IRFs reported in Table 4 show that the direction of the responses is mixed.

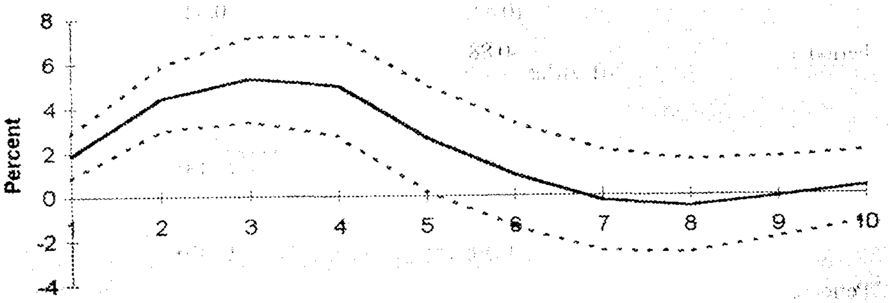
The IRFs are also presented visually, in Charts 3 through 8.

Chart 3: Response of EMP to Interest Differential



Months (Dotted lines are 2 times standart errors)

Chart 4: Response of Interest Differential to EMP



Months (Dotted lines are 2 times standart errors)

Chart 5: Response of EMP to Domestic Credit Growth

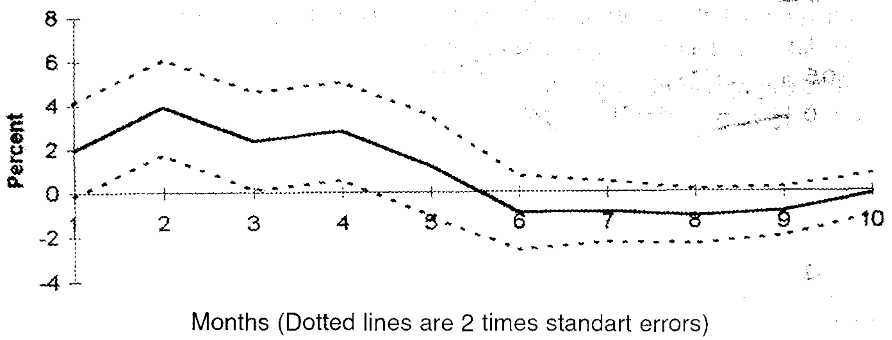


Chart 6: Response of Domestic Credit Growth to EMP

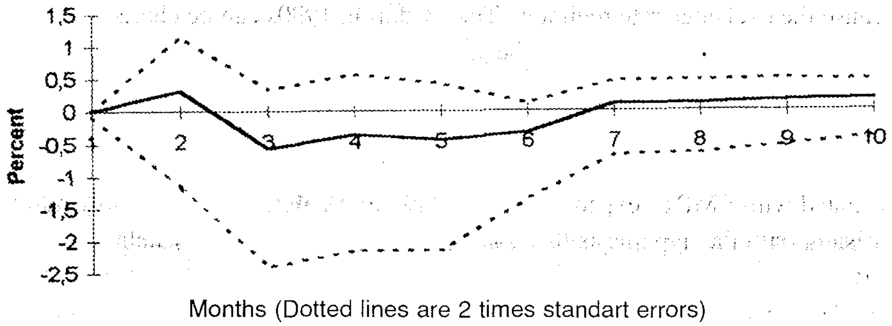


Chart 7: Response of Interest Differential to Domestic Credit Growth

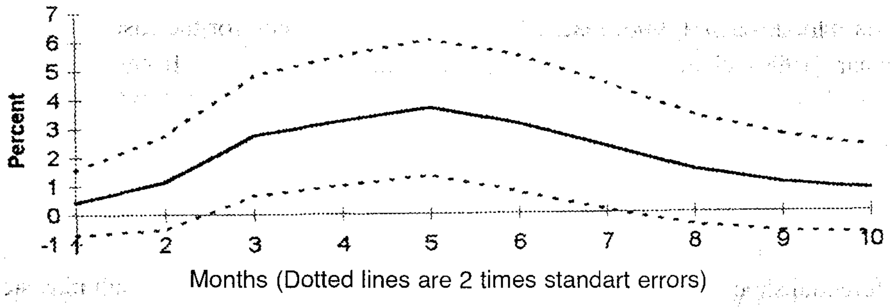
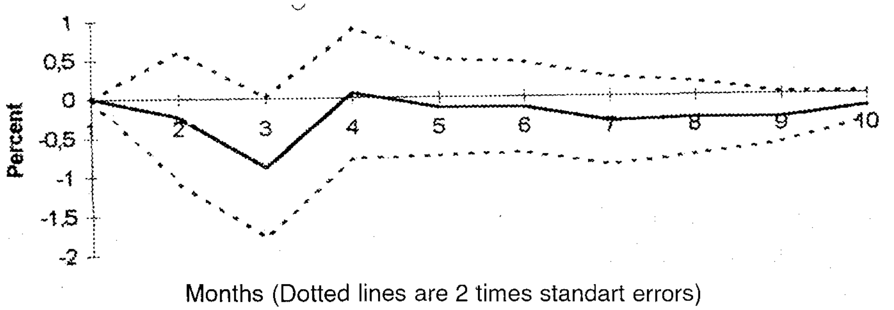


Chart 8: Response of Domestic Credit Growth to Interest Differential



5. Conclusions and Policy Implications

The present article investigated the interrelations between exchange market pressure (EMP) and monetary policy for the specific case of Turkey during 1990s. Because the exchange rate regime in Turkey during 1990s can be characterized as a managed floating regime, EMP is the approriate concept for our analysis.

In this paper, we first examined whether the data for Turkey supports the predictions of Girton-Roper monetary model of exchange market pressure (EMP). Our evidence suggests that domestic credit growth by the central bank are positively associated with EMP as expected by the monetary model. Therefore, this finding is consistent with the hypothesis that contractionary monetary policy helps reduce the EMP.

On the other hand, the signs of the impulse response functions suggest that EMP shocks affect domestic credit growth positively at least in the initial phase (Granger causality test statistics do not indicate a causality from EMP shocks to domestic credit growth at conventional levels). Some recent studies have argued that monetary authority sterilized the international reserve outflows at least in the early stages of the crises in East Asia and Latin America. Analyzing 1994-95 Mexican crisis, Flood, *et. al.* (1996) reached to a similiar conclusion for the case of Mexico. Tennar (1999) claims that such a policy reaction may stem from an error in perception by the monetary authority or from the existence of a weak financial system (see Section 2 for details).

Moreover, shocks to EMP affect the interest differential positively as expected because a high EMP is associated with exchange rate depreciation and risk. On the other hand, Granger causality test statistics do not indicate a causality from interest differential shocks to EMP at the conventional levels. This suprising result may stem from the fact that interest rates have market-determined as well as policy determined elements. Thus, such a result does not necessarily indicate the ineffectiveness of monetary policy for affecting EMP. However, the IRFs presented are negative as predicted by the monetary approach to EMP. Finally, our evidence indicates that domestic credit growth has positive and significant impact on the interest differential, suggesting that the Fisher effect dominates liquidity effect for the Turkish economy during 1990s.

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