INVESTIGATING THE TIME VARYING NATURE OF THE LINK BETWEEN INFLATION AND CURRENCY SUBSTITUTION IN THE TURKISH ECONOMY

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Abstract
This study investigates the relationship between the rate of inflation and the degree of the currency substitution for Turkey during 1986-2006. Our results show that the correlation coefficient between the two variables has not been constant over time. The results of the Multivariate GARCH model estimated to obtain the correlation coefficients indicate that there is a nonlinear relationship between the inflation rate and the degree of currency substitution. The main policy implication of our study is that it is difficult to stop or to reverse the currency substitution unless a confidence in the domestic currency is established.

Keywords: Currency substitution; M-GARCH

JEL: F31; C32
I. Introduction

1980s and 1990s had witnessed successful efforts in decreasing inflation rates almost all over the world. This fact is usually attributed to the adoption of a new monetary policy framework, which is called inflation targeting regime, in 1990s.\(^1\) Reduction in inflation rates as a result of successful stabilization policies are expected to decrease the degree of currency substitution (CS) or dollarization, which is the phenomenon occurred by hedging behaviour of economic agents against high and variable inflation, and macroeconomic instability.\(^2\) Currency substitution has important implications for conducting monetary policy because it restricts the possibility of having an independent monetary policy and the effectiveness of exchange rate policies (Miles, 1978; Boyer and Kingston, 1987; Bergstrand and Bundt, 1990). It also contributes to higher levels of inflation by restricting the ability of government to generate a certain amount of income from the creation of money, which is called seigniorage.\(^3\) In order to reduce inflation to an acceptable rate for maintaining price stability and to make any inflation targeting regime work, confidence in monetary policy and inflation target should be established and maintained in a country with a history of high inflation coupled with high degree of CS.

The main prediction of the traditional literature on CS is that inflation rates and the degree of CS move in the same direction. An empirical reflection of this theoretical argument is that a positive correlation coefficient should be estimated between the level of inflation and the level of CS.\(^4\) However, in contrast to the expectation of the traditional literature, dollarization has not decreased in several emerging market economies despite the successful stabilization programs.\(^5\) In recent
years a number of studies have been conducted in developing countries in an effort to explain this paradoxical observation called “dollarization hysteresis”.

The main focus of the related studies has been on the determinants of the persistence or hysteresis in the CS. Guidotti and Rodriguez (1992) and Sturzenegger (1997) have argued that there are some costs of switching from the use of one currency to another as a source of irreversibility of CS. They assume that there is an equilibrium inflation band within which switching between currencies has not been occurred due to switching costs. To achieve dedollarization, inflation rate may fall below the band to compensate the switching costs. Uribe (1997) postulates a model in which the network externalities are the main source of irreversibility of CS. He argues that an increase in the degree of dollarization results an externality that reduces the transaction costs faced by private agents. Hence, it produces multiple equilibrium and irreversibility in velocity of money. An alternative explanation for non-linearities in the relationship between the degree of CS and inflation comes from public perceptions regarding anti-inflationary stabilization programs. Tandom and Wang (2003) present a CS model in which domestic money suffers from lack of confidence. They argue that this lack of confidence in domestic money leads to demand for foreign money as an alternative store of value, despite the higher costs associated with transacting in foreign money. In this setting, agents’ subjective beliefs and expectations play a key role in determining the degree of CS.

Although a number of empirical studies have been conducted on dollarization in Turkey, the time varying nature of the relationship between inflation and dollarization has not been explored. This paper contributes to the literature by presenting the time-varying correlation coefficients between inflation and currency substitution. The paper utilizes the Turkish data because Turkey is a good laboratory
for several reasons. First of all, it has plagued by high and volatile inflation rates together with various structural changes for more than two decades. For example, the GNP-deflator averaged increases of 71.2% over the period of 1990-2000, with a low value of 50.9% in 2000 and a high value of 107.3% in 1994. In line with inflation, the degree of CS defined as the ratio of foreign currency to broad money (M2) plus foreign currency has also fluctuated widely, between 0.21 in 1990 and 0.64 in 1994, with an average of 0.44. After several unsuccessful stabilization programs, inflation could have been controlled and decreased by a stabilization program based on inflation targeting strategy with which achieving price stability has been established as the primary objective of monetary policy in 2001. After the launch of the anti-inflationary program in 2001 the inflation rate has fallen down gradually to 9.3% in 2006, but the degree of CS has only fallen down the value of 0.37 in 2006. Therefore, the Turkish data gives us an opportunity to analyze not only the relationship between inflation and the degree of CS while inflation is rising but also the effect of a successful anti-inflationary program on the degree of currency substitution.

We find that the inflation-currency substitution correlation coefficient is sample dependent, i.e., the correlation coefficient is not fixed over the sample period. The study, therefore, estimates the time-varying correlation coefficients. The advantage of using time-varying correlation coefficients is to help us to understand the dynamics of the comovements between inflation and the CS over the analyzed period. Following den Haan (2000) and Cover and Hueng (2003), we define the inflation-currency substitution correlation to be the contemporaneous correlation coefficient between unanticipated changes in the levels of CS and inflation. To obtain the time-varying correlation coefficients, the paper estimates a two-variable vector autoregression (VAR) model with a bivariate generalized autoregressive conditional
heteroskedasticity (GARCH) disturbances process. The time-varying conditional variance-covariance matrix of residuals is used to estimate the (contemporaneous) correlation coefficients between considered variables.\(^8\)

Section II presents the methodology and the results. Section III concludes.

### III. Methodology and Results

In this study, Turkish monthly data from 1986:1 to 2006:10 are utilized, which are obtained from the Central Bank of Turkey. Since there is no reliable measure of foreign currency in circulation, we use foreign currency deposit as a proxy for the total foreign currency. The degree of CS is defined as the ratio of foreign currency to broad money (M2) plus foreign currency. Inflation is defined by monthly difference of the logarithm of Consumer Price Index (CPI). To show that the inflation-currency substitution correlation coefficient is not constant over the period, following the approach of Cover and Hueng (2003), we estimate an unrestricted two-variable VAR model.\(^9\) Table 1 presents the results obtained from VAR model. The first row of Table 1 reports the estimated correlation coefficient for the entire sample period is positive and equal to 0.2066. We further divide the whole sample period into sub-periods by arbitrarily chosen cut-off points. It is observed that the sign and the size of the correlation coefficients are quite sensitive to the period considered. The correlation coefficients obtained from the VAR model indicate that there exits an unstable relationship between the degree of CS and the level of inflation. We now turn to a model allowing the correlation coefficient parameters to change over time.

(Table 2)
In order to estimate the time-varying correlation coefficients, the paper utilizes the multivariate GARCH model of Baba, Engle, Kraft and Kroner (1991) (BEKK). The multivariate GARCH model is given by

\[ \pi_t = a_0 + a_1 \pi_{t-1} + a_2 CS_{t-1} + e_{\pi,t} \]  

(1)

\[ CS_t = b_0 + b_1 CS_{t-2} + \pi_{t-1} + e_{CS,t} \]  

(2)

\[ e_t = \begin{bmatrix} e_{\pi,t} \\ e_{CS,t} \end{bmatrix} \right|_{t-1} \sim \text{N}(0,H_t) \]  

(3)

\[ H_t = W'W + C'e_t e_{t-1}'C + G'H_{t-1}G \]  

(4)

where \( \pi_t \) and \( CS_t \) denote inflation rate and the degree of CS at time t, respectively, \( \Omega_{t-1} \) is the information set available at time t-1; \( H_t \) is the variance-covariance matrix; \( W, C \) and \( G \) are symmetric 2x2 matrices. BEKK representation ensures a positive semi-definite conditional variance-covariance matrix, which is a necessary condition for the estimated variances being positive or zero.  

(Figure 1)

We estimate the system of Equation [1-4] using the numerical optimization algorithm of Bernt et al. (1974) (BHHH). The estimated series of correlation coefficients that are obtained using the error terms, which are one-step-ahead forecast errors, could be called one-step-ahead correlation coefficients. However, following Cover and Hueng (2003), we refer them as the correlation coefficients.

(Figure 2)

Figure 1 depicts the estimated time-varying correlation coefficients. It is seen that the correlation coefficient has fluctuated widely, between -0.6410 in 1995:06 and 0.7303 in 2001:03, with an average value of 0.2155. In order to make it easy to interpret the results, we present the annualized correlation coefficients in Figure 2.
The mean of the annual average value is 0.2152 over the period, with the lowest value of 0.038 in 1987 and the highest value of 0.507 in 2001. The Turkish economy had been exposed to two financial crises over the period, one of which occurred at the beginning of 1994 and the other in 2001. The average estimated values of the correlation coefficients are 0.426 in 1994 and 0.507 in 2001, which are the highest values over the period. It might be said that high inflation and high depreciation rates of currency were the major reasons for having high degree of currency substitution during these two periods. Sharp increase in dollarization after the crisis in 1994 could be attributed to the hedging behavior of private agents against unexpected increases in inflation and decreases in the value of home currency. During these crisis periods, inflation rates, i.e. the increases in the average GNP deflator, were 107.3 % in 1994 and 55.3 % in 2001, and the Turkish lira was depreciated 113 % in 1994 and 85 % in 2001. This finding is consistent with the traditional view pointing out the erosion of purchasing power of domestic money as the main determinant of the level of CS. Estimating high and positive value of the correlation coefficient for the period of 1999-2001 also supports the traditional view. Failure of the exchange rate-based stabilization program at the beginning of 2001 could be seen as the main determinant of this strong relationship between the level of inflation and CS.

However, the nature of the relationship between inflation rates and the degree of CS had changed in the sub-period of 2002-2006 during which inflation had been decreasing as a result of the adoption of the inflation targeting regime as a new monetary policy framework. The estimated annual correlation coefficient, as seen from Figure 2, decreased significantly indicating that the relationship between inflation rate and the degree of CS was weakened. This finding indicates that there is an asymmetric relationship between the degree of CS and the rate of inflation, where
the degree of CS increases with an increase in inflation, but does not seem to be irreversible when the inflation rate comes down. This result needs to be interpreted in line with the other economic developments besides inflation rates. The average inflation rate came down from 85.8 % during the period of 1994-1998 to the level of 15 % during the period of 2002-2006. In addition, the standard deviation of inflation, which is an indicator of uncertainty or volatility in the inflationary process, decreased from 12.7 % to 8.2 %. Similar developments had been observed with respect to the exchange rate. The growth rate of the exchange rate, defined as the price of foreign currency in terms of home currency, had been 34 % during the period of 1994-1998 and -1 % during the period of 2002-2006. The standard deviations of the growth rate of exchange rate were 39 % and 8 %, respectively, during the two periods.

It is interesting to note that the Turkish lira appreciated and remained overvalued after 2001 in which the floating exchange rate regime was introduced. Overvaluation of the Turkish lira for a long period of time has two major effects on the economy. One relates to the current account deficits which become chronic after 2002. The ratio of current account deficit to GNP increased from 3.1 % in 2003 to 8 % 2006. The other effect is related to the tendency of private sector to borrow in foreign currencies in order to take advantage of overvaluation of the domestic currency. The persistent widening of the current account deficits make economic agents to believe that the Turkish lira will have to be depreciated in the future to finance the growing external debt.

**IV. Conclusion**

This paper used a Multivariate GARCH model to estimate time-varying correlation coefficient between the rate of inflation and the degree of CS for Turkish economy.
over the period 1986-2006. The estimates suggest that the correlations are not constant over the period. These findings may be interpreted that there is a non-linear relationship between the inflation rate and the degree of CS. Although currency substitution is a phenomenon brought about switching behavior of economic agents from domestic currency to foreign currencies during high and variable inflation, we found that it might also prevail during low inflation. Specifically, we provide some evidence that an increase in inflation rate leads to increase the degree of CS. However, there is an evidence of dollarization hysteresis, despite the implementation of successful anti-inflation stabilization program in the case of Turkey. This might be the result of having a long history of dollarization, which makes it difficult for economic agents to abruptly abandon holding foreign currency as a store of value and/or medium of exchange. This finding shows that having a strong commitment to achieving price stability is an important precursor for eliminating the currency substitution in an economy. Therefore, we can conclude that unless confidence in the domestic currency is established, it is difficult to stop or to reverse currency substitution.
Table 1. Constant Conditional Correlation Coefficients

<table>
<thead>
<tr>
<th>Sample Period</th>
<th>Correlation Coefficient</th>
</tr>
</thead>
<tbody>
<tr>
<td>1986:01-2006:10</td>
<td>0.2066</td>
</tr>
<tr>
<td>1986:01-1994:10</td>
<td>0.1665</td>
</tr>
<tr>
<td>1994:01-1998:10</td>
<td>0.4047</td>
</tr>
<tr>
<td>1999:01-2002:10</td>
<td>0.4692</td>
</tr>
<tr>
<td>2002:01-2006:10</td>
<td>-0.0133</td>
</tr>
</tbody>
</table>
Fig. 1 Estimated values of time-varying correlation coefficients.

Figure 2. Average value of estimated correlation coefficients.
References


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1 See for details Mishkin (2000), Jones and Mishkin (2003), and Dotsey (2006).

2 We do not make a distinction between the currency substitution and asset substitution as in Calvo and Vegh (1993) and Agenor and Khan (1996), defining currency substitution as the process whereby foreign currency holdings substitute for domestic currency balances as a store of value, unit of account and medium of exchange.
For the studies focusing on the feedback effect of the degree of CS on the inflation rate see, for example, Chang (1994) and Levy-Yeyati (2004).

For a traditional literature review see, for example Giovannini and Turtelboom (1992) and Calvo and Vegh (1992).


The link between currency substitution and inflation for Turkey is analyzed in Bahmani-Oskooee and Domac (2003), Scacciavillani (1995), Selcuk (1994, 2001).

See, for example Agenor et al. (1997) and Telatar and Telatar (2003) for an overview of Turkish economy.

Cover and Hueng (2003) uses the time-varying forecast errors from a VAR to examine output and prices for USA.

den Hann (2000) shows that using VAR prediction errors to examine the correlation are efficient as long as model has sufficient lags so that errors are not integrated.

See Engle and Kroner (1995) for the important features of the BEKK model.

The Central Bank of Turkey had not intervened in the foreign exchange market during this period with the “fear of floating” as pointed out by Calvo and Reinhart (2002).