Turkey's trilemma trade-offs

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Abstract

In this paper, we study the trilemma configuration of the Turkish economy. The paper starts by empirically testing the Mundell-Fleming theoretical concept of an "impossible trinity" (trilemma) for Turkey, following the Aizenman, Chinn and Ito (ACI) approach. This includes calculating the trilemma indices and investigating their evolution over the period of 1998Q1-2010Q4, which is split into sub-samples according to the Turkey's macroeconomic policies. We also introduce alternative empirical techniques in order to deal with possible misspecification problems detected in the ACI approach. These techniques include employing additional terms in the regression, Two Stage Least Squares and Kalman filtering. These analyses show how contributions of financial integration and monetary independence have increased from the first period to the last, with corresponding limitations on exchange rate stability. The analysis continues by exploring the implications of changes in the trilemma indices for inflation. Accordingly, it reveals evidence that trilemma indices have impacts on inflation for the period of 2003-2010. Finally, it finds that there is a key role for international reserves as trilemma trade-offs and their effects on inflation can be mitigated with their accumulation.

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Turkey's Trilemma Trade-offs: Is There a Role for Reserves?

1. Introduction

The macroeconomic policy "trilemma" for open economies, also known as the impossible trinity, states that a country simultaneously may choose at most two of the following three goals: monetary independence (MI), exchange rate stability (ES) and capital account openness (KO). The trilemma policy trade-offs are conveniently represented via a triangle, where each vertex of the triangle in Figure 1 represents full attainment of one of the three goals. Therefore, as shown, being at any side of the triangle represents attainment of two of the three goals, at the expense of abandonment of the third.

Clearly, an economy cannot be positioned on all three vertexes of the Figure 1 triangle at once. However, since each of the three goals is potentially desirable, it is conceivable that policy makers would attempt to meet all three partially, which is captured in Figure 1 as being at a point somewhere in the interior of the triangle.[1] For example, a country might have a managed float and some capital controls, sacrificing some monetary independence as well in the face of international capital flows.

In fact, the partial attainment of all three policy goals has seemed to characterize policy-making in practice, and has perhaps even been the dominant global policy stance, especially for emerging market economies. This "mixed" approach to the trilemma has been characterized by continual adjustment of policies in response to a rapidly changing global environment, as well as attempts to implement market-oriented economic reforms. At the same time, government policy makers have not always had clear guidance on how precisely to manage the trade-offs: in terms of Figure 1, what is the optimal position in the triangle at any given time? Or, even more fundamentally, what are the joint implications of a complex

[1] See Aizenman (2010), for example, for a more detailed discussion of the trilemma framework.

set of macroeconomic policy decisions for the policy stance of an economy, viewed from the lens of trilemma trade-offs? Can a country's policy-makers even know where they are positioned in the triangle?

Therefore, it is important to have a better understanding of how to characterize and measure various different mixtures of trilemma policy stances, and the present paper contributes to an emerging literature in this area. The underlying theoretical framework of the trilemma, namely the Mundell-Fleming model, is not very easily adapted to analyzing the partial attainment of all three goals in formal theoretical modeling. However, Aizenman, Chinn and Ito (ACI) recently developed a new methodology to empirically characterize the mixed approach to the trilemma in practical policy-making. In their approach, ACI (2008, 2010) initially measure each policy dimension via an empirical index. A higher value of one index represents greater closeness to that policy goal. In this case, the question of how trilemma-based policy trade-offs are managed becomes an empirical exercise.

The theoretical constraint of trade-offs between the three policy goals is then captured by estimating a regression equation in which the dependent variable is a constant (in their case, one), and the independent variables are the three trilemma indices (with the constant term excluded on the right hand side, of course). However, in this regression, the estimated coefficients alone will not provide sufficient information about "how much of" the policy choice countries have actually implemented even though they should give us some approximate estimates of the weights countries put on the three policy goals. Hence, following ACI, looking into the contributions using the estimated coefficients and the actual values for the variables (such as a*MI , b*ES , and c*KO) will be more informative. The coefficients multiplied by the values of the indices therefore indicate the ***relative contributions*** of the three variables to the overall trilemma policy stance.

The ACI methodology is applied by them to large cross-sections and time-averaged panels of countries, in order to discern patterns of trilemma policy stances in different groups of countries, and at different points

in time. That particular data analysis reveals how, for example, emerging market economies have adjusted to managing the trilemma as they have opened their economies while facing potentially severe global shocks. The ACI methodology provides an important new empirical approach to understanding the evolution of the global financial architecture and policy responses.

Cross-country analysis can also be useful for individual country policy-makers, if they believe that they can draw lessons from "average" experience across a relevant comparison group, but it will typically not be sufficient for understanding a single country's past policy choices and future policy options. Our focus in this paper is therefore on applying the ACI methodology to a single country, Turkey, with the objective of more specifically understanding the detailed evolution of the policy stance toward the trilemma trade-offs. Our analysis can provide policy-makers with a summary view of their past choices, including unintended consequences or unappreciated trade-offs, as well as serving as an input into analysis of future policy options.

Our focus on Turkey is driven by its relatively challenging experiences as an emerging market economy, including struggles with inflation, exchange rate management, and policies of financial liberalization. With this perspective, the resulting potential future impacts on macroeconomic policy making can be informed by a better understanding of how it has managed the trilemma trade-offs in the recent past.

Our single-country paper is similar to Hutchison, Sengupta and Singh (2011) who have applied the ACI methodology to India. However, we differ from them by testing the ACI methodology in terms of checking specification errors and searching for consistent contribution figures. This is because running a regression with a constant on the left hand side may, potentially, imply that the independent variables are correlated with the residuals, as we force the residuals and the weighted sum of the variables to add up to a constant. Such correlation would cause OLS coefficient estimates to be biased and inconsistent. In this context, we initially perform a specification test i.e. the Ramsey RESET test, to check the specification of

the regression. Next, we attempt to eliminate such a misspecification found in the OLS analysis by employing different techniques; two stage least squares (TSLS) and Kalman filtering. While no single estimation method can be considered definitive, our approach here allows us to examine the robustness of the estimated contributions across different estimation methods, each with its own assumptions about the underlying structure of the relationship between the trilemma indices and associated policy stances. In our analysis, however, the results obtained from Kalman filter analysis appear to be the most consistent with the actual behavior of the Turkish economy over the period considered.

An important additional feature of the ACI analysis has been to apply their empirical approach to assessing the role of foreign exchange reserves in softening (at least in the short run) the trade-offs inherent in the trilemma. Thus, this paper, following ACI again, specifically assesses the empirical role of reserves in modifying the trilemma trade-offs in practice for Turkey. The role of international reserves has also been discussed widely both in the literature and by central bankers. Central bankers of emerging markets usually assign reserves a buffer role against risks after experiencing several crises in a financially integrated environment. The reserves to GDP ratios in many emerging market economies increased dramatically after the East Asian crisis of 1997-98. Similarly, Turkey's reserve accumulation presented in Figure 2 indicates a substantial increase in international reserves over the last decade. Regarding empirical studies, several of them (e.g., Cheung and Ito, 2007; Obstfeld, et al. 2008) suggest structural changes in the patterns of reserves hoarding. Obstfeld, et al. (2008) also find that financial openness, the ability to access foreign currency through debt markets, and exchange rate policy are all significant predictors of international reserve stocks.

The paper proceeds as follows: Section 2 gives a brief description of Turkish macroeconomic policies during 1998-2010. Section 3 describes the methodology and the dataset used in this study. Section 4 and 5 conduct the econometric analysis and report the results on the trilemma-influenced policy configuration

over the period analyzed. Section 6 investigates macroeconomic impacts of the trilemma policy configuration, including the role of foreign exchange reserves. Lastly, Section 7 presents the conclusions.

2 Dealing with the Trilemma Trade-offs after Liberalization: Turkish Case

Liberalization of the Turkish economy started in the early 1980s with economic policies designed to encourage exports. This was followed by the liberalization of the foreign exchange regime early in 1984, allowing commercial banks to accept foreign currency deposits. In parallel to those changes, an interbank money market for short term borrowing facilities was enacted in 1986 and the Turkish Central Bank started its open market operations in 1987. Additionally, the Turkish Capital Market Board was established which later on initiated the opening of Istanbul Stock Exchange during the same period. Finally, with the recognition of full convertibility of the Turkish Lira and full liberalization of the capital account, financial liberalization was effectively completed in 1989.

Two decades of experience after liberalization have provided a basis for examination of Turkish economic policies with regards to the trilemma trade-offs. Since 1989 when Turkey became financially liberalized, the Turkish economy could not manage to achieve a solid economic performance at all times. In fact, two serious exchange rate crises hit the economy, in 1994 and in 2001, due to the vulnerability caused by financial liberalization and accompanying high current account and budget deficits. In the first crisis of 1994, the Turkish currency devalued by nearly 40 percent. With the later crisis, the devaluation rate reached 100 percent and the Turkish economy had to change its strategy in dealing with the trilemma trade-offs. Before 2001, exchange rate stabilization (via pegged exchange rate regimes) was crucial for the Turkish economy. However, after 2001, monetary independence took this place as the key policy goal, as the exchange rate was allowed to float freely. Hence, we next examine macroeconomic policy implementations of Turkey in two main periods: the pre-2001 period and the period from 2001 till today.

2.1. Pre-2001 Period

In terms of macroeconomic policies, the pre-2001 period can be further categorized into three sub-periods: pre-1980s, 1980-1988 and 1989-2001. In the pre-1980 period, international capital movements were severely restricted. Thus, there were not any partial policy trade-offs in this period, as Turkey could control both the exchange rate and interest rates in the absence of financial integration – it was at a side of the trilemma triangle.

The decade of the 1980s (more specifically, the 1980-1988 period) was the transition period for the liberalization of Turkish economy. In this period, the controls over foreign exchange transactions were removed in a gradual manner. However, there were still some restrictions on capital transactions in this decade; hence it was possible for the Turkey to implement a pegged exchange rate regime and also to control interest rates simultaneously.

Finally, with the recognition of full convertibility of the Turkish Lira in 1989, Turkey removed all controls over foreign exchange transactions. Thus, it initially faced the trilemma trade-offs in 1989 after having fully liberalized its capital account movements. Subsequently, Turkey made its choice and continued to implement the pegged exchange rate regime and (slowly) gave up controlling interest rates till 2001.

After the completion of capital account liberalization in 1989, there has been a relatively massive short term capital inflow -- rather than long term -- to Turkey whereas long term inflows including direct investment remained limited[2]. Given the lack of deep domestic financial markets, the productive sectors of the economy were harmed in an environment dominated by large movements of short-term capital, high interest rates, an overvalued currency and stagnant export markets. The situation was worsened

[2] The level of FDI inflows remained stable in Turkey in the 1990s, while FDI surged over the world. For Turkey, FDI increased in the 1980s following the liberalization measures implemented at the beginning of the decade, but growth in FDI stopped in the 1990s, with inflows averaging less than 0.5% of GDP. In the same time, Central European countries, which are considered as Turkey's main competitor in the region for attracting foreign investment, scored much higher inflows (OECD reviews of Regularity Reform in Turkey, 2002).

because the Turkish government was not 'fiscally disciplined' enough and unable to meet its budget and had to borrow from the domestic market at high interest rates. As a result, Turkey's macroeconomic performance soon became dependent on short-term capital inflows and Turkey lived through chronic fiscal imbalances and a high and chronic inflation. In order to overcome inflation and to achieve macroeconomic stability, Turkey has launched many stabilization programs, at the center of which lay the pegged exchange rate regime. However, as most of the exchange rate based stabilization programs were either interrupted or stopped, Turkey could achieve neither price stability nor high and sustainable growth rates. Therefore, the economy remained vulnerable to a vicious circle of bad macroeconomic performance causing costly capital inflows generating, in turn, higher public deficits (Central Bank of the Republic of Turkey, 2004).

On account of this risky position, Turkey experienced two severe crises, in 1994 and 2001, each of which ended with large devaluations, higher inflation rates and economic recessions. Besides, contagion effects of the Asian and Russian crises in 1997 and in 1998 increased the vulnerability of the economy. Living with such weaknesses for such a long period of time created a strong inertia in inflation dynamics and high volatility in growth rates. As a consequence, Turkey's inflation averaged over 70 percent in the period 1989 to 2001 while growth rates remained at a level of 3 percent on average.

As the economy has been trapped into high real interest rates together with an overvalued domestic currency, the monetary authority was bound to a passive role in this period. Hence, the Central Bank of the Republic of Turkey (CBRT) has been forced to hold significant foreign exchange reserves in order to accommodate to this process (Balkan and Yeldan, 2002). In line with this, Central Bank reserves reached 25 billion USD at the end of the 1990s starting from 5 billion USD in the beginning of the decade. In spite of this hoarding, Central Bank's reserves were not sufficient to defend the Turkish Lira in the crisis of 2001. Even though Central Bank reserves spent 25 percent of its reserves in this crisis, the Turkish Lira depreciated by 40 percent due to the huge short term capital outflows. In fact, net portfolio capital

outflows exceed 5 billion USD in just one quarter before this crisis. This is a huge outflow for Turkey as net portfolio investment flows stayed positive throughout the decade attaining an average of 1.5 billion USD per year[3].

2.2. Post 2001 Period

The 2001 crisis was an important watershed for the Turkish economy as it made clear that the pegged exchange rate regime was impossible to carry out due to the loss of confidence of economic agents in the sustainability of such a regime. Hence, on 22nd February of 2001, the Turkish Lira was allowed to float freely in order to prevent further damage to the economy. Accordingly, the Central Bank would intervene in the market only to compensate for the short-term excess volatility in the exchange rates in either direction. In practice, Central Bank carried out several interventions in the period of 2002–2006 amounting to a total of 27.5 billion USD. As presented in Table 1, a big portion of these interventions (around 25.5 billion USD) was in the form of foreign exchange purchases. As a result of this, Central Bank reserves rose from 20 billion USD to the level of 60 billion USD in just 5 years.

By implementing a floating exchange rate regime, Turkish Central Bank has gained an active role after 2001 in achieving price stability, thus a new monetary policy strategy, namely an inflation targeting (IT) regime, was designed. This regime was implemented implicitly during the period between 2002-2005 and explicitly thereafter. Under the inflation targeting regime, the Central Bank began to use its interest rate instrument, effectively indicating a significant move in positioning within the trilemma triangle. Thus, during this period, the CBRT faced the traditional trilemma problem of maintaining an independent monetary policy in the face of international capital inflows and a desire to stabilize the exchange rate.

With these new policies, the Turkish economy has entered into a structural transformation process through which macro-economic performance has improved considerably. In the period of 2002 - 2005, all

[3] Only exception is the year of 1998 when there was net portfolio investment outflow 6.7 billion USD. This was mainly a contagion effect of the Russian crisis.

inflation targets have been attained for four years in a row and the inflation rate was brought down to single digits, where it stayed thereafter. This performance in disinflation positively affected economic growth. Not only positive but also high growth rates were attained. Total cumulative economic growth in real terms surpassed 30 percent from 2002 to 2006.

In parallel to these macroeconomic improvements, the economy started witnessing sharp increases in capital inflows, especially in the years prior to the recent global financial crisis. Both net foreign direct (FDI) investment and net portfolio investment inflows rose to a larger extent. Between 2002 and 2007, net FDI inflows grew constantly and peaked at 20 billion USD level. On the other hand, net portfolio inflows continued to fluctuate even though these inflows attained an average over 5 billion USD each year during the same period.

Recently, with the beginning of the global financial crisis, the outlook of the economy changed somewhat as Turkey suffered from its spillover effects like most emerging market economies. Nevertheless, the Turkish economy has been one of the first to recover from the crisis in 2010. In the meantime, the inflation rate was kept in single digits despite the external shocks experienced during 2008-2010. On the other hand, regarding the growth, Turkish economy initially stabilized in 2008 and shrank later in 2009. Yet, the slowdown of the economy did not long last and Turkish economy recovered starting from the last quarter of 2009 and achieved a high growth rate of 9 percent in 2010.

These growth prospects have been accompanied by fluctuating capital flows. While FDI continued to remain strong with 15.7 billion USD in 2008 and 6.7 billion USD in 2009, net portfolio outflows amounted to roughly US$10 billion just in three quarters of 2008 Q3-2009Q1. This led to depreciation pressures and higher volatility in the foreign exchange market. However, even in the event of such large capital outflows, CBRT did not undertake foreign exchange direct intervention measures to limit pressures on domestic liquidity. As a result, the rapid reserve accumulation of 2002- 2006 has slowed

down after 2006 and Central Bank reserves reached a total of 70 billion USD in 2009 by increasing 10 billion USD since 2006. In contrast, capital inflows and net portfolio investments have gone up by US $15 billion just in 2010, boosting foreign exchange reserves another 10 billion USD during the year.

3 Data

Our approach of constructing the trilemma indices mainly follows Aizenman, Chinn and Ito (2008, 2010). Hence, we initially construct indices for each of the three policy objectives of the trilemma: monetary independence, exchange rate stability and capital account openness (or financial integration). Nevertheless, our study has two departures from Aizenman, Chinn and Ito (ACI). First of all, instead of using cross-country data and time-averages of annual data, we use data for a single country, Turkey. Secondly, we use a different measure of capital account openness than the preceding authors, this last departure being dictated by the needs of a time series analysis of trilemma policy stances. In this respect, our study follows Hutchison, Sengupta and Singh (2011).

The data we employ, being quarterly, is higher in frequency than employed by ACI, and subject to substantial time variation. Indeed, we find that there is variation in the results across sub-periods into which we divide our sample. The division into sub-periods is determined by changes in the institutional regime that was in force in the different sub-periods.

The main data constraint in this work is related with the capital openness. Firstly, quarterly data for capital flows is available starting from 1992. Nevertheless, since we describe capital openness as a ratio over GDP in the next subsection, our data extends from 1998Q1 to 2010Q4, covering 52 quarters. The reason for losing the period of 1992 to 1998 is mainly because the up-to-date GDP series for Turkey starts from 1998. The previous series covering the period of 1987 to 2007 is also used for robustness and cross

checks. Moreover, in our analysis performed with the latter data, we have found out that there is a structural break for 1998.

For composing the trilemma indices, we obtain quarterly data on GDP, exchange rate, interest rates and capital flows from the CBRT website. We use the nominal Lira-to-US dollar exchange rate series to construct a quarterly index of exchange rate stability, as described in the next subsection. For calculating the monetary independence index, we use interbank overnight interest rates for Turkey and for the US. For the latter, we use effective Federal fund rates which we obtain from Federal Reserve System database. The correlations between these two are used to create a quarterly index of monetary independence, again as described in the next subsection. To examine the impact of international reserves, we again use data from the CBRT website where the data is weekly. We average reserves figures for each quarter to construct a quarterly series for international reserves of Turkey[4]. For the policy outcome of inflation, we use the monthly CPI index from the CBRT database. The inflation series is quarterly averages of monthly inflation figures.

3.1 Construction of Indices

The key constructs for examining the policy configuration with respect to the trilemma are indices of monetary independence (MI), exchange rate stability (ES) and capital account openness (KO). These indices are constructed as follows.

[4]Since reserves are a stock, and GDP is a flow variable, one can calculate the reserves-to-GDP ratio using quarterly data after annualizing the GDP figure by multiplying it by four. However, this will not change any of our results in our analysis.

ES Index

Following ACI (2008), we construct this index by calculating the quarterly standard deviations of the change in the log of the Lira-US dollar exchange rate, and the index is then constructed according to the formula below:

$$\frac{1}{1+\frac{stdev(exch\_rate)}{\left|d\log E_t / dt\right|+0.01}}$$

where |*d log Et/dt*| is the absolute value of the quarter-on-quarter depreciation rate.

Again, the scaling ensures that the index lies between 0 and 1, with the highest value indicating the greatest degree of exchange rate stability. In the calculation of this index, we depart from ACI (2008) by employing daily series in order to be more precise. The evolution of this index for the sample period is shown in Figure 3.

MI Index

We again follow Aizenman, Chinn and Ito (2008) in measuring MI as the reciprocal of the correlation of interest rates in the home country (here Turkey) and the base country (here the United States). Quarterly correlations are calculated using daily interest rate data whereas ACI (2008) used monthly interest rates. As mentioned earlier, the interest rates are overnight interbank rates. The formula used for constructing this index is:

$$MI = 1 - \frac{corr(i_H, i_B) - (-1)}{1 - (-1)}$$

The scaling ensures that the index lies between 0 and 1, with the highest value indicating the greatest degree of monetary independence. The plot of the MI index is shown in Figure 4.

KO Index

For construction of the KO index, we differ from the ACI approach of employing a de jure control. Instead, we use simple de facto measure of capital account openness, the ratio of the sum of inward and outward foreign investment flows to GDP. A critical point should be noted at this stage is that the KO index is not theoretically constrained to lie between 0 and 1 – the upper bound cannot be imposed. However, for the sample period, it is easily met as shown in Figure 5.

The lack of data with sufficient frequency on de jure controls dictates our approach. This can also be justified by the fact that de facto capital openness is not only driven by de jure restrictions on capital flows but also those on current account transactions as well as export proceeds and exchange rates. Within this context, a country like Turkey, while having an open capital account, may still restrict the flow of capital by limiting transactions on the current account or controlling exchange transactions.[5] Hence, a country with capital controls can still be financially more open as private sector can circumvent such controls in most cases.

3.3.3 Dividing into Sub-periods

We divide the entire period into sub-periods as the period under consideration covers dramatic changes in external conditions and policy stances. Doing so will allow us to see how policy differences affected the trilemma configuration in different sub-periods.

As described earlier, Turkey switched from the pegged exchange rate regime to floating in the first quarter of 2001. Hence, we divide our whole sample into two as 1998Q1-2001Q1 and 2001Q2-2010Q4[6].

[5] Taxing imports for some specific goods and a restricted exchange rate regime are examples of these kind of restrictions that Turkey implemented from time to time during 1998-2010.

[6] This is consistent with the results of the Chow test employed in order to search for a structural break.

According to this separation, our first period includes only 13 observations. However, efforts aimed to extend this period before the year of 1998 does not change much as another structural break is captured for the year of 1998.

4 In Search of Consistent Contribution Estimates

Our methodology to analyzing Turkey's macroeconomic policies in the context of trilemma trade-offs again follows Aizenman, Chinn and Ito (2008, 2010) but with cross-checks by employing other econometric techniques, to explore the robustness of particular estimation methods. We initially estimate a model for the trilemma configuration that is revealed by the data, by regressing a constant on the three indices. We replicate this with other techniques in order to reach a method in which specification is attained correctly. Thus, apart from OLS, we employ different techniques, both linear and non-linear, in order to obtain consistent index contribution figures. Finally, we also examine the role of international reserves accumulation in affecting inflation.

4.1 Methodology

Following ACI (2008), we initially test the validity of the trilemma in a linear tradeoff for each sub-period. This reduces to examining the goodness of fit of this linear regression[7]:

$$2 = aMI_t + bES_t + cKO_t + \varepsilon_t \qquad \textbf{(1)}$$

The contributions obtained from equation (1) for the subsamples are reported in Table 2. This table reports the means, coefficients and contributions of the three indices for all three periods and R-squared figures. The overall fit is extremely good, reflected in the very high R-squared numbers.

[7] For this regression, we detect heteroskedasticity and autocorrelation in our robustness checks in several cases, even though the significance of our coefficients is affected only in a limited manner. Hence, we employ Newey-West standard errors in our regressions in order to be more precise and consistent in the presence of both heteroskedasticity and autocorrelation. The constant term on the left hand side of the regression is set equal to 2, since policy configurations on the vertices of the trilemma triangle would correspond to two indices equal to 1 and the third index equal to zero. Of course, this is just a normalization, and following ACI in using 1 on the left hand side would simply double the estimated coefficients.

Furthermore, we also examine the robustness of the contribution estimates as the basic analysis may possess specification problems. Ramsey and Alexander (1984) showed that the **Ramsey Regression Equation Specification Error Test (**RESET) test could detect specification error in an equation which nonetheless gives satisfactory values for traditional test criteria (goodness of fit, high t-ratios etc). Thus, as a next step in our analysis, we examine our OLS analysis by performing the Ramsey RESET test, in order to see whether specification errors exist or not.

4.2 Testing the Specification: Ramsey RESET Test

The Ramsey RESET test developed by Ramsey (1969) is a general specification test for the linear regression models. More specifically, it tests whether non-linear combinations of the explanatory variables have any power in explaining the endogenous variable. Technically, Ramsey (1969) proposed to fit the initial regression and generate new regressors that are functions of fitted values $\mathbf{y=x\beta}$, such as $\mathbf{w= (x\beta)^2, (x\beta)^3 \ldots (x\beta)^n}$. The next step in the test is to estimate the model $\mathbf{y=x\beta+w\gamma+u}$ and the test the nonlinearity as the Wald test of *n* restrictions, H_o: $\gamma=0$ against H_a: $\gamma\neq0$. Typically a low value of 2 (or 3) is used for *n*.

In our trilemma regression, Ramsey RESET test indicates the possibility of specification error despite the attractive results. Accordingly, the OLS analysis may have at least one of the following types of specification errors:

- Omitted variables
- Endogeneity problem as a result of measurement error
- Incorrect functional form

In all these cases, the OLS estimates become biased and inconsistent. Below, we discuss and attempt to overcome those different types of specification errors.

4.3 First Potential Problem: Omitted Variables

This problem occurs if the OLS analysis does not include all relevant variables. However, as we are constrained with three indices theoretically, we can not add any other variables into our regression. On the other hand, we can still *add* quadratic and/or cubic (or even higher power) terms of the same indices into our regression equation. Adding these new terms does not violate linearity in the parameters, although the expression on the right hand side becomes non-linear in the independent variables. In the rest of the paper, we name this new regression as "***enhanced***" which is obtained by adding new terms to the standard one. Regarding these models, main disadvantage stems from adding too many extra terms into the regression as some of the coefficients become insignificant and contribution figures become imprecise. Hence, we obtain our enhanced model by adding only square terms.

4.4 Second Potential Problem: Endogeneity

Endogeneity, i.e., correlation between the disturbance and explanatory variables, can arise as a result of omitted variables and measurement error[8]. Given that we deal with the omitted variables case in the previous section, here we focus on measurement error.

Measurement error occurs when the variable cannot be precisely measured. We are faced, therefore, with using an approximate measure, including some error of measurement. The standard approach to deal with measurement error is to estimate the equation using *instrumental variables* regression. The idea behind this approach is to find a set of variables, termed *instruments*, that are both correlated with the explanatory variables in the equation, and uncorrelated with the disturbances. These instruments are used to eliminate the correlation between right-hand side variables and the disturbances.

[8] Simultaneity and sample selection errors are other problems that give rise to endogeneity.

In our analysis, we treat the capital openness index as the variable that is measured with error. This is due to the fact that we cannot observe capital openness precisely.[9] "Net errors and omissions" item in Turkey's balance of payments amounts to non-negligible figures. Furthermore, for our time series data, we cannot calculate capital openness according to the commonly used measures. Hence, our capital openness definition (of the ratio of the sum of inward and outward foreign investment flows to GDP) is likely to depart from its true value and we need to use an instrumental variable instead of the capital openness index.

As measurement error of capital openness has no structure in our case, meaning that it is independent of the true capital openness (named as "classical measurement error"), use of lagged variables as instruments becomes legitimate. In line with this, we employ lagged capital openness index as the instrumental variable in a two stage least squares (TSLS) analysis as a first version. Alternatively, in a second version, we use lagged indices as instrumental variables and perform a TSLS analysis accordingly.

4.5 Third Potential Problem: Incorrect Functional Form

Regarding the incorrect functional form problem, the linearity assumption of OLS might have caused the specification error. To address this issue, some or all of the variables should be transformed to logs, powers, reciprocals, or in some other way. Hence, there is a wide range of alternatives in the form of ***non-linear least squares***.

5 Trilemma Contributions: Findings

In this section we assess different techniques discussed so far; OLS, enhanced OLS, non-linear models TSLS, enhanced TSLS. In our assessment, our guide is the Ramsey RESET test. We employ this test in

[9] Regarding other two indices, we assume no measurement errors as exact values of both interest rates and exchange rates are observable.

order to evaluate specifications of each model for different sub-periods in which we determine our confidence level as 95 percent. First, we start with OLS and enhanced OLS. We find out that Ramsey RESET test rejects both of these specifications for any sub-periods. As they are misspecified, our contribution figures are biased and inconsistent. This is a crucial finding as it indicates that it is misleading to apply the ACI approach for Turkey. Next, we perform TSLS, enhanced TSLS regressions which are confirmed by Ramsey RESET test for the periods of 1998Q1-2001Q1 and 2001Q2-2010Q4. Regarding the non-linear models, none of the specifications we attempt gives reasonable results, hence we do not report these analyses performed in the context of non-linear least squares.

5.2 Assessment

In Table 3, we report contributions calculated from the regressions approved by the Ramsey RESET test together with the benchmark case of OLS. Accordingly, all regression results indicate that exchange rate stability is the highest contributor in the first period. For the second period, OLS regression and second version of TSLS (where lagged variables of all indices are implemented as instruments) indicate that exchange rate stability is again crucial for policy makers during this period. On the other hand, TSLS regressions of first version show that the contribution of capital openness dominates in the second period of 2001Q2-2010Q4. Within the context, findings of TSLS analysis should be considered with caution even though such specifications are confirmed by Ramsey RESET Test. This is due to instrumenting methodology of TSLS, which can make the outcome highly sensitive to the chosen instrumental variable(s).

6. Introducing an Alternative Technique

In this section, we employ an alternative technique in order to explain Turkey's trilemma trade-offs. This alternative technique we employ is State Space Modeling i.e. Kalman filter. In choosing this technique,

we aim to eliminate potential misspecification problems by taking our methodology into a more general framework in which OLS remains as a particular case in the analysis.

6.1 State Space Modelling: The Kalman Filter

State space modeling is a general and powerful representation. A wide range of time series models, including the classical linear regression model and ARIMA models, can be written and estimated as special cases of a state space specification. One of the main benefits of representing a dynamic system in state space form is that it allows unobserved variables to be incorporated into, and estimated along with, the observable model. Second advantage of employing state space models is its flexibility. They allow for known changes in the structure of the system.

In the context of state-space specifications; we specify our measurement and transition equations as below. The measurement equation shows the evolution of the observed variables described as a function of the unobserved variables. The transition equation shows how the unobserved variables evolve.

Measurement equation:

$$2 = C(1)_t * MI_t + C(2)_t * ES_t + C(3)_t * KO_t + \delta_t$$

Transition equations:

$$C(1)_t = \rho_1 C(1)_{t-1} + v_t \ ,$$

$C(2)_t = \rho_2 C(2)_{t-1} + \eta_t$ and $C(3)_t = \rho_3 C(3)_{t-1} + \varepsilon_t$ where $\delta, v, \eta, \varepsilon$ are assumed to drawn from zero mean and normal distribution.

Regarding the transition equations, we treat the parameters of the trilemma indices as unobserved and allow them to vary over time, evolving based on the transition of the economic state. We expect that such a set up can also catch the ***non-linear relations*** (if any) inherent in the trilemma configuration. Besides,

we do not need to divide the whole sample into sub-periods as Kalman filter is able to catch such (structural) breaks by allowing the parameters change over time. However, in order to make comparisons among the different techniques, we still present our results of Kalman filter in the form of other techniques (i.e. dividing the whole sample).

The general representation shown above constitutes our main Kalman filter approach (Kalman, 1960). A filter in this context is simply a term used to describe an algorithm that allows recursive estimation of unobserved, time varying parameters or variables in the system. Nevertheless, the Kalman filter is different from forecasting in that forecasts are made for the future, whereas filtering obtains estimates of unobservables for the same time period. The basic idea behind this filter is to arrive at a conditional density function of the unobservables using Bayes' Theorem together with the functional form of its relationship with observables and an equation of motion. The filter uses the current observation to predict the next period's value of unobservable and then uses the realization of the next period to update that forecast. The Kalman filter is optimal, i.e. Minimum Mean Squared Error estimator, if the observed variable and the noise are jointly Gaussian. Additionally, as Watson (1983) argues, the Kalman filter can always provide optimal estimates whenever OLS does and is also capable of doing so even when OLS does not.

6.3 Results

Table 4 presents the contributions obtained from Kalman filter analysis. These contribution figures, on one hand, have similarities with contribution figures of previous techniques as it also agrees that stabilizing exchange rate plays a crucial role in the first period. On the other hand, contributions of Kalman filter analysis differ from the contributions of the previous techniques with regard to its intensity and how its reduction is compensated in the next period. This decreasing tendency of exchange rate stability is compensated by both increasing tendency of monetary independence and capital openness

whereas the monetary independence has a greater role in comparison to the capital openness. This relocation from first to the second period is shown in Figure 6. We argue that the behavior of the Turkish economy is most consistent with the contributions of Kalman filter approach, in particular to the first version, which imposes fewer restrictions in terms of functional form of the relation. Moreover, as mentioned earlier, the Kalman filter technique employs the whole sample to reach its results which eliminates the problem of small sample for the period of 2001Q2-2010Q4. With such an advantage, while reporting our results, we can further divide the second period of 2001Q2-2010Q4 into two as 2001Q2-2006Q2 and 2006Q3-2010Q4. The rationale for choosing 2006Q2 is because Turkey can be considered to experience the famous concept of fear of floating during 2001Q2-2006Q2 as CBRT continued to directly intervene to the foreign exchange markets. This continued till 2006Q2 as shown in Table 1. Hence, in the period of 2001Q2 to 2006Q2, CBRT has directly intervened to the foreign exchange market from time to time. After 2006Q2, Turkey has not performed any direct interventions in the foreign exchange market although it has performed FX buying and selling FX auctions. Contributions of the trilemma indices regarding these two sub-periods are also shown again in Table 4. Interestingly, contributions of all indices rise from 2001Q2-2006Q2 to 2006Q3-2010Q4. This is mainly because trilemma tradeoffs become more binding in the period of 2006Q3-2010Q4.

7. Macroeconomic Impacts of Trilemma Policy Configuration: Role of Reserves

In this section, we analyze how the trilemma policy configuration and its interaction with the level of reserves affect inflation. Hence, following ACI (2008), the basic model we estimate is given by:

$$\inf_{it} = \alpha_0 + \inf_{it-1} + \alpha_1 TLM_{it} + \alpha_2 TR_{it} + \alpha_3 (TLM_{it} x TR_{it}) + \varepsilon_t \qquad \textbf{(2)}$$

inf_{it} is the measure for macroeconomic variables, TLM_{it} is the trilemma index, namely, *MI*, *ES*, and *KO,* included individually and TR_{it} is the level of gross international reserves as a ratio to GDP. (TLM_{it} x TR_{it}) is an interaction term between the trilemma index and the level of international reserves. We choose to

include only lagged value of inflation as a control variable given the limited degrees of freedom as the whole sample is reduced to 2003Q1-2010Q4 due stationary issues.

7.1 Findings

Results of the regression are presented in Table 5. According to the table, greater monetary independence is likely to lower inflation as expected. Furthermore, ES has also a negative effect on inflation indicating that higher exchange rate stability leads to experience lower inflation. In the literature, Ghosh et al. (1997) and many others have shown that pegged exchange rate regimes tend to experience lower inflation. On the other hand, greater capital openness, in tandem with loss of monetary independence and exchange rate stability, comes at the cost of higher inflation. Additionally, lagged inflation has a positive and highly significant effect on inflation indicating to a robust persistence in this macroeconomic variable.

Regarding the impact of reserve accumulation, its direct effect is usually insignificant although it tends to have a positive effect on inflation. However, as we suspect that international reserves may complement or substitute for other policy stances, we are particularly interested in the effect of those interaction terms (TLM_t x TR_t) in addition to the direct effect of reserves. The coefficient of the interaction terms, in general, measures the amount by which the change in response with one predictor is affected by the other predictor. If this coefficient is not statistically significant, then the data have not demonstrated the change in response with one predictor depends on the value of the other predictor. Within this context, our only statistically significant interaction term is between reserves and monetary independence. To interpret this result which is given in the third column of the Table 5, we can rewrite it as below:

$$\inf_t = -12.264 + 0.826 * \inf_{t-1} - 3.79 * ES_t + 8.87 * KO_t + 40.5 * TR_t + (23.92 - 65.026 * TR_t) * MI + \varepsilon_t$$

In such a case, impact of monetary independence varies with the value of reserves to GDP ratio. Given the level of gross international reserves as a ratio to quarterly GDP is above the threshold value of 0.368, monetary independence has a negative impact on inflation. Otherwise MI has a positive effect. Within this framework, monetary policy aimed to reduce inflation becomes credible. For Turkey, this level of reserves holding is below the average figure of 40 percent during the sample period; hence the impact of monetary independence is more likely to be negative on inflation. For other trilemma indices, same

argument is valid but not statistically significant. Accordingly, we conclude that *the reserve accumulation can relax the impact of the Turkish trilemma policy stance on inflation depending on its level*.

8 Conclusion

In this paper, we investigate Turkey's macroeconomic policies of the last two decades in the context of trilemma trade-offs. In this investigation, we also try to get an answer to the question whether there is a role for accumulating international reserves for Turkey. In line with this aim, we start with searching the point Turkey stands with respect to the trilemma triangle.

Our methodology starts with following ACI (2008) approach. Using quarterly data from 1998Q1 to 2010Q4, we construct trilemma indices for each of the three policy objectives: monetary independence, exchange rate stability and capital account openness. Considering Turkish macroeconomic policies, we split the whole period into sub-periods to explore.

Next, we employ different regression techniques (TSLS, Kalman filtering and adding higher power terms into the regressions) to examine trilemma trade-offs in addition to ACI approach of OLS estimation. At first cut, the results of our empirical analysis indicate that trilemma trade-offs are binding for Turkey in most cases and Turkish macroeconomic policies have been in a transformation with respect to trilemma trade-offs in particular from 1998Q1-2001Q1 to 2001Q2-2010Q4. The most remarkable change is the decrease of exchange rate stability contribution although it dominates others in the trilemma configuration throughout the entire period. Naturally, this reduction on exchange rate stability was accompanied by increases in other two indices, namely monetary policy independence and capital openness.

Nevertheless, there is no consensus among different techniques with regard to how monetary policy independence and capital openness contribute to the economy in the later period. While one technique (TSLS with lagged capital openness as instrument) favors capital openness and attributes all the

compensation to this index, Kalman filter exhibits balanced increases in these two indices. Among all, the Kalman filter approach has contribution figures that are the most consistent with the behavior of the economy. According to this approach, reduction on exchange rate stability is compensated mainly by monetary independence. Furthermore, Kalman filter is a more general technique imposing fewer restrictions in terms of linearity and degrees of freedom.

We also show that this transformation among the trilemma indices has influenced the economic outcome of inflation for the period of 2003Q1-2010Q4. Accordingly, monetary independence and exchange rate stability have diminishing effects on inflation while capital openness has an increasing effect. Finally, we investigate the role played by international reserves in mitigating the intensity of the trilemma trade-offs faced by Turkey. Our examination verifies that indeed there is a role for international reserves in softening Turkey's trilemma trade-offs. Such reserve management contributes to inflation while helping monetary policy to regain control of it after a threshold level.

Table 1 Direct Foreign Exchange Interventions under the Floating Exchange Rate Regime

Date	Amount Purchased	Amount Sold
July 2002		3
December 2002	16	9
May 2003	579	
June 2003	566	
July 2003	938	
September 2003	2.146	
February 2004	1.283	
May 2004		9
January 2005	1.347	
March 2005	2.361	
June 2005	2.056	
July 2005	2.366	
October 2005	3.271	
November 2005	3.164	
February 2006	5.441	
June 2006		2.105
TOTAL	**25.534**	**2.126**

Table 2 Trilemma Indices, OLS Coefficients and Contribution Estimates

		1998Q1-2001Q1	2001Q2-10Q4
	MI	0.492	0,503
MEANS	**ES**	0.885	0,618
	KO	0.064	0,065
	MI	0.061	0.718***
COEFF.	**ES**	2.034***	2.21***
	KO	2.596**	3.215*
	MI	0.030	0.361
CONTRIB.	**ES**	1.800	1.365
	KO	0.166	0.209
Adj. R Square		**0.99**	**0.96**

*, **, *** denote statistical significance at 10%, 5% and 1% levels respectively.

Table 3 Trilemma Indices, OLS Coefficients and Contribution Estimates

		OLS	TSLS-1	Enhanced TSLS-1	TSLS-2
	MI	0.030	0.051	0.12	0.19
1998Q1-	**ES**	1.800	1.561	2.06	1.47
2001Q1	**KO**	0.166	0.383	-0.18	0.33
	MI	0.361	-0.16	0.12	0.867
2001Q2-	**ES**	1.365	-0.67	0.215	2.387
2010Q4	**KO**	0.209	2.819	1.658	-1.27

Table 4 Contribution Estimates of Kalman Filter

	MI	0.064
1998Q1-	**ES**	1.83
2001Q1	**KO**	0.032
	SUM	**1.926**
	MI	0.298
2001Q2-	**ES**	1.410
2010Q4	**KO**	0.154
	SUM	1.862
	MI	0.264
2001Q2-	**ES**	1.387
2006Q2	**KO**	0.147
	SUM	1.798
	MI	0.338
2006Q3-	**ES**	1.437
2010Q4	**KO**	0.163
	SUM	1.938

Table 5 Inflation, 2003Q1-2010Q4

	(1)		(2)		(3)		(4)		(5)	
	Coefficients	*Standard Error*	*Coefficients*	*Standard Error*	*Coefficients*	*Standard Error*	*Coefficients*	*Standard Error*	*Coefficients*	*Standard Error*
Intercept	4.096**	1.725	3.709	3.255	-12.264	10.03	-3.789	11.097	4.25	4.32
Lagged Inflation	0.821***	0.065	0.821***	0.066	0.826***	0.062	0.819***	0.067	0.820***	0.067
MI	-1.861**	0.876	-1.802	1.124	23.921*	12.482	-1.789*	1.019	-1.78	1.204
ES	-4.469*	2.447	-4.503*	2.462	-3.792	2.424	8.526	21.16	-4.447	2.69
KO	14.826**	6.541	14.446*	7.234	8.869	6.315	14.789**	6.88	5.64	62.45
Res/GDP			0.991	6.148	40.50*	23.035	20.639	29.41	-0.43	11.20
MI*Res					-65.02**	31.487				
ES*Res							-33.924	55.08		
KO*RES									20.97	143.25
Adj. R^2	**0.9034**		**0.899**		**0.9037**		**0.897**		**0.895**	

Figure 1 The Trilemma Framework

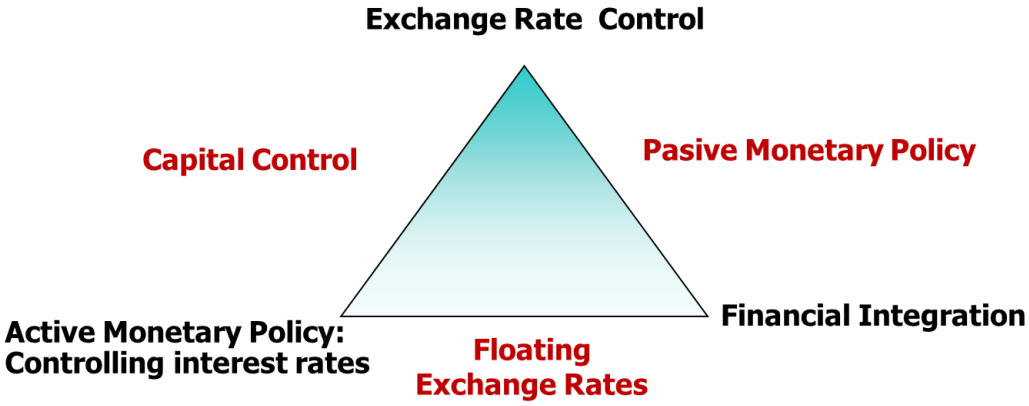


Figure 2 Reserves-GDP Ratio

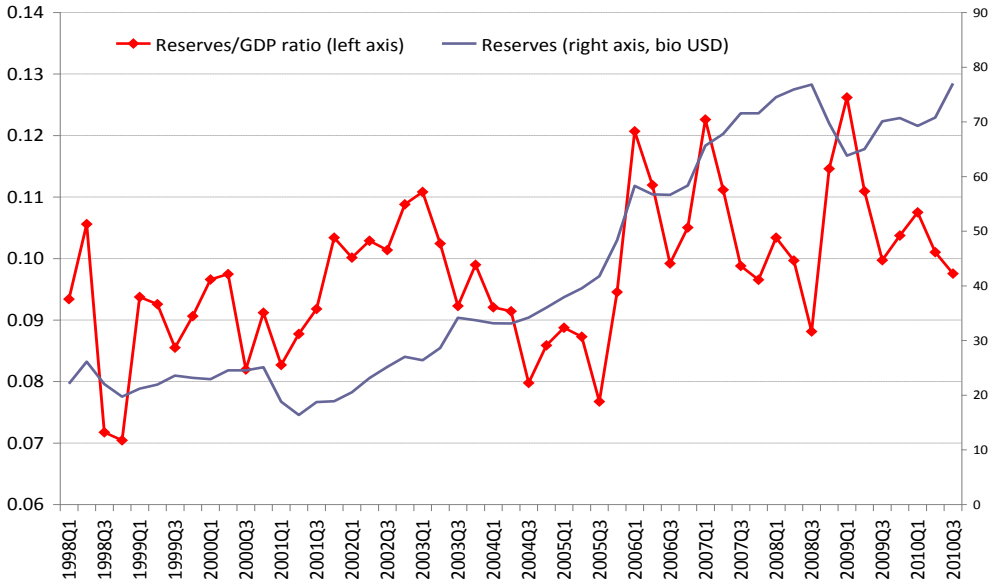


Figure 3 Exchange Rate Stability (ES) Index

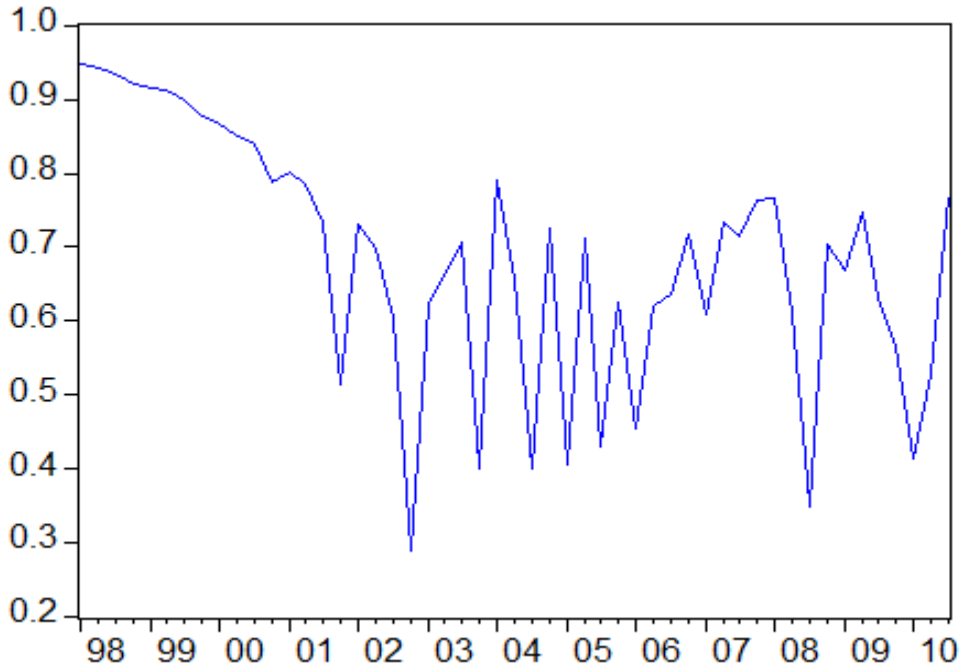


Figure 4 Capital Openness (KO) Index

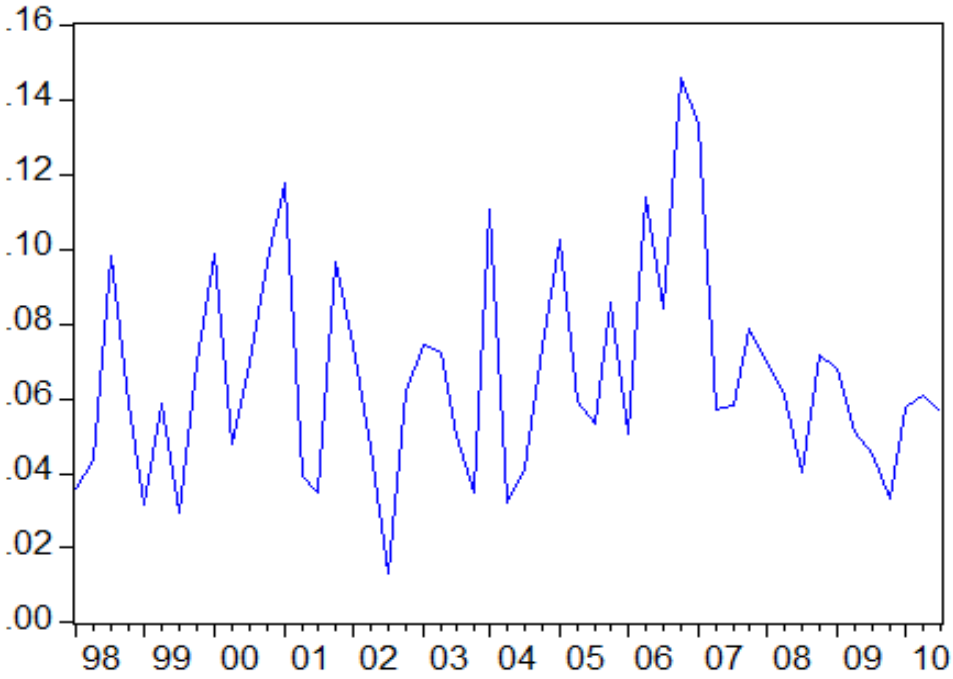


Figure 5 Monetary Independence (MI) Index

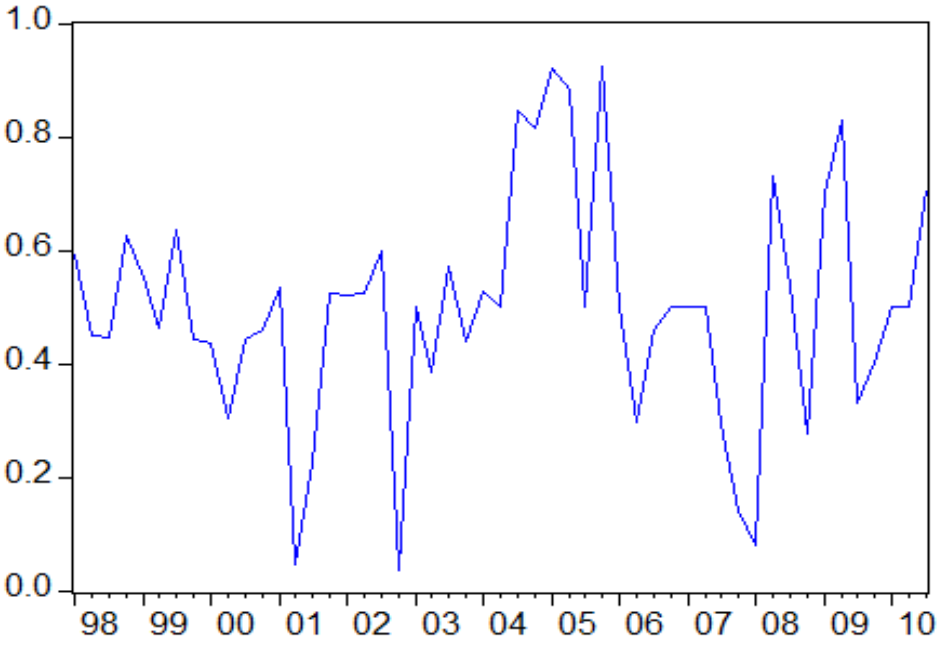
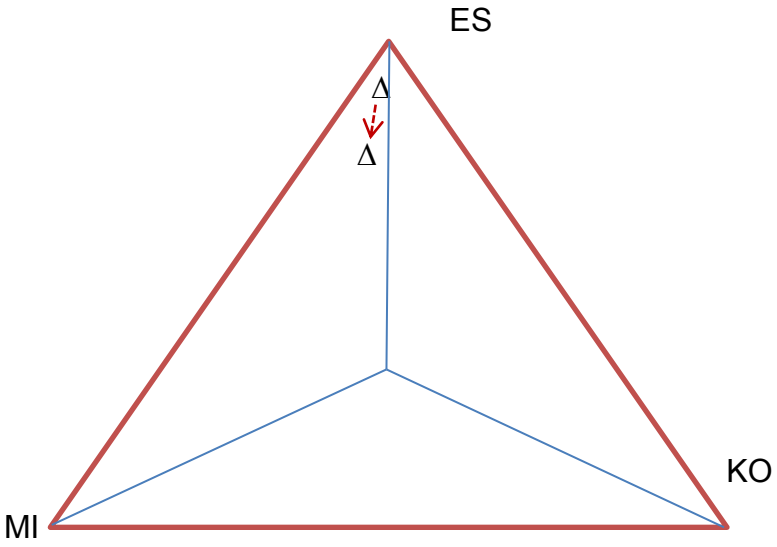


Figure 6:



APPENDIX: Data Sources

Turkish data obtained from the CBRT website, available at the address:

http://evds.tcmb.gov.tr/yeni/cbt-uk.html

US data obtained from the Federal Reserve System database, available at:

http://research.stlouisfed.org/fred2/categories

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