WORKING PAPER NO. 2013-08

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WORKING PAPER SERIES

UNIVERSITY OF DELAWARE | Alfred Lerner College of Business & Economics

DEPARTMENT OF ECONOMICS

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This paper is based on Ozdogan's doctoral dissertation at the University of Delaware. We acknowledge the helpful comments of Burton Abrams, Robert Schweitzer and Siyan Wang.

Abstract

Turkey experienced a financial crisis in 2000-2001 that led to significant financial reforms. The reforms resulted in a switch to a floating exchange rate, granted greater central bank independence and pursuit of a more credible monetary policy. Investigation of the channels of monetary policy in both periods finds that monetary policy's output effects have been strengthened considerable by the reforms. In the pre-crisis period monetary policy was highly inflationary, while in the post-crisis period, monetary policy targets low inflation and has become a tool for output stabilization. These results support the importance of central bank independence and a credible policy.

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1. Introduction

Turkey has historically suffered from a number of economic problems: high and persistent inflation, widespread use of foreign currency, an oligopolistic banking sector, volatile and shallow financial markets, and a central bank that lacked credibility. These many problems culminated in a financial crisis in 2001.

This crisis provided the impetus for a number of economic reforms. Central bank independence was increased. An authoritative and independent Monetary Policy Committee was created concomitant with the increased role given to monetary policy. The fixed exchange rate was abandoned and monetary policy adopted an inflation target.

These reforms were followed by a dramatic drop in the inflation rate, from the 60-90% range in the 1990s to single digit levels. Output fluctuations stabilized. Maintaining this hard-earned stability became the focus of economic policy in Turkey.

Credible policy reforms may enhance the impact of monetary policy on output in the post-crisis period, since monetary policy was highly inflationary prior to the crisis. Thus, analysis of the channels of monetary transmission will demonstrate whether the reforms have successfully enhanced the effectiveness of monetary policy as a stabilization tool.[1]

Most empirical analyses of the monetary transmission mechanism (MTM) focus on industrialized countries. There are a limited number of studies of Turkey's MTM, but none investigates the possibility of changes due to the financial reforms. Previous studies only investigate a subset of the potential channels of monetary policy. This paper contributes to understanding of the MTM in Turkey by examining all potential channels of monetary policy, and investigating whether the reforms have changed the MTM.

The main findings are that compared to the pre-crisis sample period, a number of monetary policy channels were stronger in the post-crisis sample period. Specifically, the response of output to interest rates was larger, faster and more persistent in the post-crisis sample period. The exchange rate and credit channels also strengthened in the post-crisis period, while the asset channel was weak during both sample periods.

The next section of this paper reviews the general literature on the MTM. The following section summarizes the salient features of the crisis and subsequent reform in Turkey and studies of the MTM in Turkey. The fourth section presents estimates of a baseline model of monetary transmission in Turkey. The fifth section examines the channels of monetary transmission. The final section concludes the paper.

2. Review of the Monetary Transmission Mechanism Literature

Monetary policy affects the real economy and inflation by changing either a monetary aggregate or an interest rate target, working through a number of potential channels. The traditional channels of monetary policy include changes in real interest rates, changes of exchange rates, and changes in asset prices. Recent research has also focused on the impact of monetary policy on credit, both through changes in bank lending and changes in borrowers' balance sheets.

The interest rate channel, the primary MTM in traditional models of monetary policy, may be weak in developing countries with shallow financial markets and state-owned banks. In such countries, limits on interest rates are binding, and banks have limited incentive to lend based on commercial criteria (Horvath and Maino, 2006).

The work of Fleming (1962), Mundell (1963), and Dornbusch (1976) on the Uncovered Interest Parity (UIP) condition brought attention to the exchange rate as a channel of monetary policy. The

change in the exchange rate affects the domestic economy via both aggregate demand and aggregate supply.

A monetary tightening increases domestic real interest rates, appreciating the real exchange rate. Domestically produced goods and services become relatively more expensive than imports, decreasing net exports and reducing domestic output (Obsfeld and Rogoff, 1995, Taylor, 1993). On the supply side, a real appreciation decreases the domestic price of imported goods, which decreases domestic inflation via the exchange rate pass through effect (McCallum and Nelson, 2001). The level of pass through to the overall inflation rate depends on the import share, the magnitude of the appreciation and its timing, and the macroeconomic characteristics of the economy (Alper 2003; Campa and Goldberg 2004; Kara, Tuger, Ozlale, Tuger, Yavuz and Yucel, 2005). Devereux, Engel and Storgaard (2003) argue that countries with a low volatility of money growth experience low rates of exchange rate pass through whereas countries with highly volatile money growth have higher pass through.

Alternatively, the ability of the monetary authority to affect real output via the exchange rate channel is limited under fixed exchange rates because the domestic interest rate is determined by the world interest rate. However, if domestic and foreign assets are imperfect substitutes, possibly due to capital controls, domestic interest rates may deviate from international levels providing monetary authorities with some room to maneuver (Kamin, Turner and Van'tdack, 1998). Moreover, Taylor (1999) finds that the exchange rate channel remains a very important transmission channel in small open economies.

Monetary policy affects asset prices such as bonds, equity shares, and real estate, changing firms' stock market values and household wealth. Changes in stock market values and household wealth in turn affect aggregate demand.

Tobin's *Q* (1969) is defined as the ratio of the market value of a firm to the replacement cost of capital owned by that firm. Following a monetary tightening, equity prices fall, decreasing *Q*. A lower *Q* makes investment more costly for the firm, reducing investment and aggregate output (Ireland, 2005).

In Ando and Modigliani's (1963) life-cycle theory of consumption, a policy-induced interest rate increase reduces the value of a household's long-term assets. This decrease in financial wealth reduces consumption expenditure, decreasing output.

Meltzer (1995) asserts a wider impact of monetary policy through asset prices. Monetary policy actions affect the markets for durable goods, real estate, equities, and financial assets along with interest rates. Changes in all of these asset prices affect aggregate demand and output.

However, the impact of the asset price channel in emerging markets is more unpredictable (Kamin et al., 1998). Asset markets are shallower and less competitive in emerging markets, and macroeconomic performance can be more volatile, increasing uncertainty. These factors may reduce the impact of asset prices in emerging countries.

The interest rate channel implicitly assumes competitive financial markets so that interaction between monetary policy and the real sector can be reduced to interactions between interest rates and real variables (Ozturkler, 2002). Yet, all financial markets suffer asymmetric information problems, especially for medium and small borrowers for whom information is costly to obtain. In emerging economies financial markets are often so poorly developed that the quantity of the credit, as well as its price, becomes an important instrument of monetary policy (Kamin et al., 1998).

Bernanke and Gertler (1995) define the credit channel of monetary policy as an "enhancement mechanism" amplifying and transmitting interest rate effects. They identify two channels through which central bank policy influences credit markets: the bank lending channel and the balance sheet channel.

If some of the borrowers are bank dependent (i.e. they do not have other forms of external financing) and bank loans are imperfect substitutes for other assets, monetary policy may operate through a bank lending channel. A monetary tightening decreases the supply of bank reserves reducing bank lending. Bank-dependent firms are forced to cut back their investment spending. The reduction in output following a monetary tightening results from financial market imperfections (Ireland, 2005).

The strength of the bank lending channel depends on size of the lending contraction for a given monetary policy shock[2] (Bean, Larsen and Nikolov, 2002), as well as on balance sheet conditions (Gibson, 1997). The empirical evidence for the lending channel is ambiguous. Kamin et al. (1998) find that the bank lending channel is weaker in emerging economies due to limited competitiveness and limited flexibility of financial markets. In contrast, the evidence for Korea, an emerging country, indicates that the bank lending channel remains significant (Bank of Korea, 1998). Edwards and Mishkin (1995) argue that banks' diminishing role in credit markets has weakened the bank lending channel in industrialized economies.

The balance sheet channel, also known as the "financial accelerator" or "broad (credit) channel", focuses on "the potential impact of changes in monetary policy on borrowers' balance sheets and income statements, including variables such as borrowers' net worth, cash flow and liquid assets" (Bernanke and Gertler, 1995). Interest rate increases reduce asset values, adversely affecting borrowers' balance sheets and creditworthiness. A change in net worth affects the borrower's ability to obtain loans for investment and consumption. A reduction of net worth increases adverse selection and moral hazard, since borrowers with low net worth have an incentive to take greater risks. The balance sheet channel affects both investments and consumption expenditures.

3. Crisis and Monetary Reform in Turkey

From the 1970s through the 1990s Turkey suffered chronic and rising inflation. Monetary policy changed frequently and by the 1990s targeted the real exchange rate. The nominal rate was depreciated in line with inflation to keep the real rate constant and maintain the competitiveness of exports. However, the policy was not transparent. The frequent policy changes, lack of transparency of the exchange rate policy, and an associated scandal hurt the credibility of the Turkish central bank.[3]

In November 2000 Turkey experienced rapid financial outflows due to a loss of investor confidence. Restrictions on capital flows had been removed in 1990, but the financial system remained vulnerable to speculative attacks. The capital outflow created a banking crisis and a large budget deficit, resulting in rapid monetary growth and currency devaluation. Unable to maintain an exchange rate target, the currency was floated.

Following the crisis, policies were adopted to restructure and reform the Turkish economy. In addition to floating the exchange rate, institutional reforms aimed to increase the role of markets, restructure state banks, reduce the public sector burden on the economy, grant independence to the Central Bank, and transition monetary policy toward an inflation targeting regime (Yilmaz, 2006). The transition to inflation targeting began in 2002 and was completed in 2006. An additional goal of the reforms was to more closely harmonize the Turkish economy with European Union standards.

The 2001 reforms may have affected the monetary transmission mechanism in Turkey. Prior to the reforms, entrepreneurs' incentives were to secure state contracts and monopoly positions. Increased transparency since the reforms reduces the scope for corruption and rent seeking, subjecting firms more to market forces (Airado, Dervis, Gros, Ozatay, Bayar, and Isik, 2004). Increased credibility and predictability provide a stable environment attracting more foreign direct investment. Basci, Ozel, and Sarikaya (2007) report that the increased capital inflows into Turkey have had a substantial effect on

Turkish monetary policy and the monetary transmission channels. For example, the asset price channel has been stronger in post-2001 period than in the pre-2001 period.

Switching to a floating exchange rate regime has reduced exchange-rate-pass-through to prices, and weakened the dominance of dollarization. This change has also enhanced the effectiveness of monetary policy (Ozatay, 2005). In addition, in a small open economy, switching to a floating exchange rate regime changes the monetary transmission mechanism by strengthening the interest rate and credit channels and weakening exchange rate pass-through (Basci et al., 2007). This expectation is supported by theory showing that floating exchange rates provide more flexibility for the state to focus monetary policy on domestic issues such as shocks to the domestic economy (Calvo and Mishkin, 2003).

As part of the 2001 reforms the Central Bank of Turkey (CBT) gained instrument independence, isolating it from political decisions. Also, the new law requires that the CBT cut off credits to public institutions including the Treasury (Yilmaz, 2006). The reforms move the CBT's short term interest rate to the forefront by redefining its primary role for shaping expectations. This policy strengthens the interest rate channel of monetary transmission (Basci et al., 2007).

State banks were restructured during the process of structural reform. Redundant state banks, their branches and employees were eliminated; capital adequacy ratios were increased; and a new Banking Regulatory and Supervisory Institute was created to monitor all banks in Turkey (Ozatay, 2005). Similarly, all other state institutions have undergone a process of reformation in line with EU standards. These reforms include elimination of redundant positions and branches, redesign of the agricultural support system, setting new hiring limits for state agencies; and public sector budgetary discipline and increased accountability. New laws have reformed the regulation and supervision of private enterprise, seeking to increase competition and efficiency.

In the first five years following the reforms real growth has averaged over 7% and inflation has fallen to single digit levels. Public and external debts have both declined substantially. Airado et al. (2004, 1) note that "the assessment of both private market actors as well as of international institutions is that the program has been successful in re-establishing macroeconomic stability, reducing the debt ratio and laying the ground for a durable acceleration of growth in an environment of drastically reduced inflation and much lower real interest rates."

The task of preserving sustained growth and low inflation rests primarily with monetary policy. Thus, it is important to understand the MTM link between monetary policy actions and both the real economy and inflation. However, the existing empirical literature examining the monetary transmission mechanism in Turkey fails to explore the possibility of a structural break in 2001 and reports several contradictory findings. Sahinbeyoglu, (2001) finds that the interest rate channel is weak while Ozturkler (2002) using data covering almost the same period finds that the interest rate channel is one of the two strongest channels.[4] Other recent studies demonstrate that the interest rate channel is strong.[5]

Empirical studies examining the exchange rate channel also report contradictory findings (Ozturkler, 2002). While Aslan and Korap (2007)[6] and Sahinbeyoglu, (2001) note that the exchange rate channel dominates the Turkish monetary transmission mechanism, Basci et al. (2007) reports that the importance of exchange rate channel has been attenuated in the post-2001 period due to the inflation targeting regime combined with a floating exchange rate regime, and the disinflation policies in the post-crisis period which have enhanced the effectiveness of monetary policy.

Aslan et al. (2007) provide evidence of a strong asset price channel in combination with the exchange rate channel. Several studies (Aydin, 2007; Basci et al., 2007) demonstrate the importance of the credit channel (i.e. bank lending channel) in the post crisis period. Alternatively, Ozturkler's (2002) study of the pre-crisis period finds that the bank lending channel is weak.

In sum, the limited literature examining the monetary transmission mechanism in Turkey reports inconsistent findings. A structural break following the 2001 reforms is a possible reason for the disparate findings.[7]

4. Monetary Transmission in Turkey – A Baseline Model

Sims (1980) developed and first used the Vector Autoregression (VAR) framework for the analysis of monetary policy. Since his seminal work, numerous studies have used the VAR methodology to analyze the monetary transmission mechanism (Bernanke, 1986; Bernanke and Blinder, 1992; Bernanke and Mihov, 1998; Christiano, Eichenbaum and Evans, 1999; Mojon and Peersman, 2003; Peersman and Smets, 2003). Christiano, Eichenbaum, and Evans (1999) and Leeper, Sims, and Zha (1998) review the MTM literature for the United States. Their methodological discussions demonstrate that VAR is an appropriate method for the analysis of the monetary transmission mechanism in Turkey.

The baseline VAR model used to analyze the Turkish MTM is:

$$Y_t = C + \sum_{i=1}^{p} \Phi_i Y_{t-i} + \varepsilon_t \qquad (1)$$

In Equation (1), Y_t denotes a vector of endogenous variables, C denotes a vector of constants, Φ_i denotes the matrices of autoregressive coefficients, Y_{t-I} denotes a vector of lags of the endogenous variables and ε_t is a vector of white noise processes; the error terms are assumed to be serially uncorrelated with zero mean and constant variance with a variance-covariance matrix E ($\varepsilon_t \varepsilon_t'$) = Σ_ε. The constants and the autoregressive coefficients (i.e. C and $\Phi_1, \Phi_2 \ldots, \Phi_p,$) are estimated by Ordinary Least Squares (OLS) for each part of Equation (1) separately. The sample covariance matrix of the OLS residuals is used to estimate Σ_ε.

The data[8] used in the baseline estimate are the domestic nominal short term interest rate (interbank money market rate denoted as *INTRATE*), the log of the Consumer Price Index (*LCPI),* the

log of Industrial Production Index (*LINDPROD*), and the log of a monetary aggregate (*LM1*).[9] Thus the *Y* vector of the baseline VAR is

Y= [INTRATE, LM1, LCPI, LINDPROD] (2)

The sample consists of monthly observations from 1996:07 through 2007:06. Due to the structural break in 2001, the data series are divided into two sub-samples and the model is estimated separately for each sub-sample.[10] The pre-crisis sub-sample includes 42 observations for the period 1996:7 - 1999:12. The pre-crisis data ends at the end of 1999 although the crisis hits in 2001. The 1996-2001 period covers two different monetary policy regime. From 1996 to the end of 1999 Turkey witnessed a so called "real exchange rate" policy, where as in the entire 2000, Turkey had fixed exchange rate regime.

The post-crisis sub-sample includes 66 observations for the period 2002:01 -2007:06 The 12 months after crisis period is excluded. The two sub-sample periods also separate the different exchange rate regimes: real exchange rate policy in the pre-crisis period and floating exchange rates after the crisis.

Sims (1980) suggests ordering the variables from the most pervasive to the least pervasive, so that variables contemporaneously affecting the other variables are ordered first, and the variables with less or no contemporaneous effect on the others are ordered last. Following Bernanke and Blinder (1992) and Bernanke and Mihov (1998), the policy variable is ordered first. They point out that for high frequency data, the policy variable should be ordered first implying that policy makers know only lagged values of the non-policy variables. The underlying assumption is that policy shocks have a contemporaneous impact on all of the endogenous variables, while the endogenous variables have no contemporaneous impact on the policy variable. The price measure (LCPI) is ordered before the real

output measure (LINDPROD) due to rapid price adjustment that typically occurs in high inflation countries (Ball, Mankiw and Romer, 1988).[11]

Tests find unit roots in all variables except LM1 in the first sub-sample and unit roots for all variables in the second sub-sample.[12] Johansen's cointegration test is performed for the variables which are integrated of order 1 in each subsample.[13] The results find that there exist cointegrating relationships between the variables that are I (1) in each of the sub-samples.

When a cointegrating relationship between the variables exists, the literature suggests using both a Vector Error Correction model and a VAR in levels. This study uses a VAR in levels for several reasons. For models with non-stationary and cointegrated variables, the parameters and the impulse responses of a VAR in levels are estimated consistently (Hamilton, 1994, Sims, Stock and Watson, 1990). Secondly, estimating a VAR in levels facilitates interpretation of the results relative to more complicated (i.e. Vector Error Correction) models .A third reason for estimating VARs in levels is that the cointegrating vectors for both periods indicate inconsistent behavior of output. Specifically, output increases following a positive interest rate innovation. Fourth, since most empirical studies estimate a VAR in levels, comparison with the existing literature is straightforward. Finally, since the data samples cover short periods, the MTM is analyzed as a short-term phenomenon, similar to other relevant empirical studies (Peersman and Smeets, 2001; Favero 2001; Al-Mashad and Billmeier, 2007).

The VAR model in levels is estimated for the ordering INTRATE, LM1, LCPI and LINDPROD. The Schwartz-Bayesian Information Criteria determines the optimal lag length as two periods for the pre-crisis period, and one lag for the post-crisis period.[14] The impulse response functions of the baseline model for the pre-crisis and post-crisis periods illustrate the findings. Monetary policy is analyzed through a one-time positive shock to the policy variable, INTRATE by one unit (1 percentage-point, i.e. 100 basis points). The results for the pre- and post- crisis periods are displayed in Figure 1.[15]

Since a positive innovation to the interest rate is a contractionary monetary policy shock, the impulse response patterns shown in the Figure 1 are consistent with the empirical evidence for the USA, the Euro Area, and many other countries (Christiano, et al., 1999; Gerlach and Smets, 1995; Peersman and Smets, 2001).[16] An unexpected temporary increase in the interest rate causes negative deviations of output from its long-run value in both periods. An unexpected one unit shock (1% increase) to the interest rate increases output slightly in the first two months after which output decreases in the pre-crisis period. The output response bottoms out after five months in the pre-crisis period with a decrease of 1.4 % of industrial production. Output reacts faster in the post-crisis period. It decreases very sharply in the first month. The magnitude of the decrease is about 0.3 % which is much smaller than that in the pre-crisis period. Then it starts to stabilize. The reaction of output to policy shocks is more persistent and faster in the post-crisis period, although the magnitude of the effect is smaller.

As shown in Figure 1, the price level (LCPI) responds positively to interest rate innovations for the first three months and then turns negative in the pre-crisis period. The price level (LCPI) responds positively to interest rate innovations in the post-crisis period. But, the effect is small. This result, known as the "price puzzle", is consistent with the empirical literature on the MTM in the US and in many other countries. One explanation of the price puzzle is that an unexpected increase in the interest rate increases inflationary expectations thereby increasing the price level (Morsink and Bayoumi, 2001). A second explanation for the price puzzle for emerging economies such as Turkey is the existence of a "cost channel" of monetary transmission (Barth and Ramey, 2000; Ozturkler, 2002; Sjuib, 2003). An increase in the interest rate increases firms' borrowing costs resulting in an increased price level, especially "if the firms depend on short term borrowing for their working capital needs" (Ozturkler 2002

The effect of an interest rate shock on the monetary aggregate variable (M1) is negative as expected in the pre-crisis period. The effect is strong which is 3% when it bottoms out. It is much smaller (0.3% at peak) and positive during the fifty month period after a shock in the post-crisis period.

Variance decompositions are computed for each variable at forecast horizons of one to three years. The results indicate that after three years in the pre-crisis period, interest rate shocks account for around 30 % of the fluctuations in output, with own shocks accounting for most of the rest (65%). In the post-crisis period, monetary factors (both interest rate and M1 shocks) account for only 15% of the variance of the forecast error in output after three years.

5. The Channels of Monetary Policy in Turkey

Analysis of the effectiveness of each monetary transmission channel (i.e. interest rate, exchange rate, asset price, and credit channels) in Turkey is conducted using the Vector Autoregression (VAR) framework. Each of the four channel variables is added to the baseline model in turn both endogenously and exogenously. Adding each channel variable one at a time as an endogenous variable, the extended baseline model (i.e. the endogenous model) is specified as follows[17]:

$$Y_t = C + \sum_{i=1}^{p} \Phi_i Y_{t-i} + \varepsilon_t \qquad (3)$$

where Y_t denotes the vector of endogenous variables, C denotes a vector of constants, Φ_i denotes the matrices of autoregressive coefficients, Y_{t-i} denotes the vector of lags of the endogenous variables and ε_t is a vector of white noise processes. More specifically;

Y= *[INTRATE, LM1, CHANNEL, LCPI, LINDPROD]* (4)

where the variable CHANNEL denotes one of the monetary transmission channel variables. The endogenous variables are ordered based on economic theory as in the Y vector above. The next step is to estimate another model where the channel variable is added to the baseline model as an exogenous variable. The model is as follows:

$$Y_t = C + \sum_{i=1}^{p} \Phi_i Y_{t-i} + BX_t + \varepsilon_t \qquad (5)$$

where Y_t denotes the vector of endogenous variables, C denotes a vector of constants, Φ_i denotes the matrices of autoregressive coefficients, Y_{t-I} denotes the vector of lags of the endogenous variables, X_t denotes the exogenous monetary transmission variable and ε_t is a vector of white noise processes.

To estimate the effectiveness of each channel, the relevant variable is added to the baseline model as an endogenous variable, and Equation (3) is estimated. The impulse responses of the baseline model and the endogenous model are compared. Then the exogenous VAR model is estimated (Equation 5). The impulse response functions of this model are compared with the former model in terms of the size of the responses to a policy shock (Alwani 2006; Kuttner and Mosser 2002; Morsink and Bayoumi, 2001; Poddar, Sab and Khachatryan, 2006). This method is applied to each transmission channel one at a time by changing the relevant variable representing that channel to assess its impact and size.[18]

Exchange Rate Channel

To measure the strength of the exchange rate channel in Turkey, the variable, LEXCRATE, the log of the average nominal monthly exchange rate between the Turkish Lira and US Dollar, is added to the baseline model.[19] The three models are estimated with lag lengths of two periods for the pre-crisis sample and one period for the post-crisis sample.[20]

Figure 2 shows impulse responses of output (industrial production) after a one unit interest rate innovation using the baseline, endogenous and exogenous exchange rate models for both periods. The impulse responses for the pre-crisis period (Figure 2A) suggest that the exchange rate channel worked exogenously. The impulse responses for the baseline and endogenous models are almost the same for the first five months. The output response is larger (a greater increase in the output) for the first two months for the exogenous model.[21]

The impulse response for the post-crisis period (Figure 2B) shows a stronger endogenous channel and supply side effects dominating demand side effects.[22] The demand side effect is the reduction of output from higher interest rates. The supply side effect is the exchange-rate pass through effect (McCallum and Nelson, 2001) that leads to an increase in output. This result indicates that output still depends substantially on imports in Turkey, especially imports of energy used in industrial production. Overall, the results indicate a strong exchange rate channel in the post-crisis period, consistent with the literature (Disyatat and Vongsinsirikul, 2003). Of course, the switch to a floating exchange rate should increase the strength of this channel.

For the impulse responses for prices (not shown), adding the exchange rate channel does not eliminate the price puzzle in the post-crisis period, but shortens the positive period to fifteen months. It does not have a significant effect in the pre-crisis period which is a period that The Central Bank of Turkey tried to keep the real value of Turkish Lira constant.

Asset Price Channel

Asset prices are measured by the log of the monthly average of the Istanbul Stock Exchange price index *(LISEINDEX*) with the base year set to 1986, as in Alwani (2006), and Poddar et al. (2006).[23] The model specification is the same as the previous estimate.

The impulse responses (Figure 3) for both periods display only minor differences between the baseline model and the models including an asset price channel. Comparing the endogenous and baseline models, the initial response of output is similar for both models in the pre-crisis period. The initial response in the exogenous model is slightly higher from the other two models. In the post-crisis period, the effect on output are similar for all three models. It seems that the effect of asset price channel is very limited for both periods.

However, the variance decompositions of output for the endogenous asset price channel model reveal that asset price shocks make an important contribution to the variability of output in the pre-crisis period. At a three-year horizon, asset price shocks account for around 40% and interest rate shocks account for 18% of the fluctuations in output, with own shocks accounting for 25% in the pre-crisis period. In the post-crisis period, movements of asset prices does not have a significant effect on output.Variance decompositions of output reveals that asset prices does not work endogenously in the post-crisis period.[24]

The price level responds positively to an interest rate innovation for the exogenous model in the pre-crisis period, only adding asset prices to the model endogenously solves price puzzle. The price level responds positively to an interest rate innovation in each of the three models in post crisis period, suggesting a price puzzle.

Credit Channel

Credit is measured by the log of the outstanding amount of total banking system loans (*LLOAN*), a la Disyatat et al. (2003) and Alwani (2006).[25] Specifications are the same as for previous estimates.

As seen in Figure 4 for the pre-crisis period, in the short run, output responds very quickly in the endogenous and exogenous models relative to baseline model, but the medium and long-run responses of output are similar in both the endogenous and baseline models. The exogenous effect of credit appears to be more effective in the medium and long run. The credit channel is weak in the pre-crisis period.

In the post-crisis period, the initial effect of the policy shock on output is the same for both the baseline, exogenous and endogenous credit channel models. Output decreases sharply in the first month and then begins to stabilize. Although the initial short run effect of the shock on output is the same in three of the models, the medium and long run effects are slightly different. For the endogenous and

exogenous models, output stabilizes more quickly relative to the baseline model in long run. The effect of the shock on output is more persistent for the endogenous model in post-crisis period relative to the pre-crisis period.

The impulse responses of output for both the endogenous and exogenous models indicate the existence of a stronger credit channel in the post-crisis period. The behavior of output in the endogenous model differs from the exogenous model in the medium run. These results suggest that the credit channel is stronger in the post-crisis period relative to the pre-crisis period, as expected.[26] The reforms following the crisis strengthened credit markets (Basci et al., 2007).

Adding bank loans to the model endogenously or exogenously does not solve the price puzzle in the post-crisis period (results not shown). In the pre-crisis period, adding bank loans to the model endogenously or exogenously does not have any effect on prices different than the baseline model.

Interest Rate Channel

Estimating the effectiveness of the interest rate channel in MTM is slightly different from the estimation of the effectiveness of the other channels because the baseline model already includes the central bank interest rate. Adding another interest rate variable to the baseline model may not accurately reflect the effect of interest rates on the economy. Thus, based on the empirical literature, two different approaches are used to examine the effectiveness of the interest rate channel.

The first approach adds a real bank lending rate to the baseline model as in Poddar et al. (2006), and Al-Mashat and Billmeier (2007), and proceeding as above with the other channels. The second approach assumes that the central bank's interest rate in the baseline model captures the effect of the interest rate (Disyatat and Vongsinsirikul, 2003; Alwani, 2006). Including the other three channel variables exogenously captures the effect of all four channels. Then, the effect of the interest rate is isolated by "holding constant" the other three channels simultaneously (Disyatat and Vongsinsirikul,

2003). This is done by estimating the baseline model with the three other channel variables added exogenously. When these three channel variables are exogenous, the output effect of interest rate changes is isolated.

Data for bank lending rates could not be obtained, so they are proxied by bank deposit rates, which do vary with bank loan interest rates. The interest rate variable is a weighted average of one-month deposit rates.[27] Deposit interest rates are weighted by the quantity of deposits and the number of days to maturity. One-month deposit rates provide better information about the reaction of financial markets after an unexpected monetary policy shock, but are collinear with the Central Bank's money market rate. Therefore, three-month deposit rates are also used in estimates of the interest rate channel.

The estimated results (not shown) obtain a very weak effect for deposit interest rates for both periods. However, the price puzzle disappears in the post-crisis period when the deposit interest rate variable is included in the model as an exogenous variable. Variance decompositions indicate that the deposit interest rate explains almost none of the variation in output. Overall, this approach finds very little support for a strong interest rate channel.

The second approach to estimating the interest rate channel includes all channel variables as exogenous variables in the model. The Y vector is:

Y= [INTRATE, LM1, LEXCRATE, LLOAN, LISEINDEX, LCPI, LINDPROD] (6)

In this model the central bank's interest rate reflects the interest rate channel. Then, another VAR is estimated with the three other channel measures (i.e. exchange rate, credit, and asset price channels) treated as exogenous variables. Holding constant the three exogenous variables, the output effects of a policy shock represent the interest rate channel.

Figure 5 displays the impulse responses of output following a 1 % interest rate innovation for both the endogenous and exogenous models in both periods. The endogenous model includes all

channels and the exogenous model shows the effects of the interest rate channel. The impulse response of output to a one unit (100 basis point) interest rate innovation in both endogenous and exogenous models in the pre-crisis period (left panel in Figure 5) reveals that output increases for the first month and then starts to decrease in the following months. In the exogenous model the initial increase in output (almost 0.3 % in the first month) is greater than the response of output when all the channels are include in the model in the pre-crisis period. In exogenous model output stabilizes very slowly relative to the endogenous model. These results indicate the existence of an interest rate channel in the pre-crisis period.

In the post crisis-period (right panel of Figure 5) an interest rate innovation decreases output in both models but more sharply in the exogenous model. The decrease is about 0.15 % in the endogenous model and about 0.57% in the exogenous model. Output increases to its initial level after two years. Also, the effect of the interest rate channel on output is larger in the post-crisis period than in the pre-crisis period (an initial decrease of 0.57% compared to an increase of 0.3%). This evidence indicates the existence of a stronger interest rate channel in the post-crisis period.

This result is consistent with the policy change of the Central Bank of Turkey in the post-crisis period. The Turkish Central Bank began targeting interest rates as a policy tool in the second period, so the interest rate channel is expected to be stronger in this period.

For the impulse responses for prices (not shown), holding constant the channels except for interest rates (i.e. the exogenous model) does not eliminate the price puzzle in the post-crisis period, but it decreases the inflationary effect on prices. In the pre-crisis period, adding all channels endogenously does not change the effect of the shock on output. Prices increase initially for four months and then decrease. Exogenous model eliminates this positive effect on prices. Prices decrease after an interest rate innovation and does not stabilize for a long period.

In sum, these results provide further evidence in support of central bank independence and the choice of policy regime. The post-crisis policy reforms in Turkey have increased the effectiveness of monetary policy. In the pre-crisis period, the inflationary policy resulted in relatively weak channels of monetary policy on real output. In the post-crisis period, the policy reforms appear to have considerable strengthened monetary policy.

6. Conclusion

Turkey adopted a number of structural reforms following its 2000-2001 financial crisis. Key features of these reforms are a change in the conduct of monetary policy and greater central bank independence. This study investigates the impact of these reforms on the monetary transmission mechanism in Turkey through 2007. The results demonstrate that the monetary transmission mechanism gains strength following the structural break in 2001 through the end of the post-crisis sample period in 2007.

Estimates of a baseline model indicate that an unanticipated increase in interest rates affects aggregate economic activity both before and following the crisis in the expected way. However, the impact of an unexpected interest rate shock is larger, faster and more persistent in the post-crisis period. A policy shock increases prices in the post-crisis period. This result, known as the "price puzzle," is widely found in empirical studies for many other countries. The price puzzle for emerging countries such as Turkey may also be due to a "cost channel" of monetary transmission. Increases in interest rates increase costs for firms that depend on short term borrowing for working capital needs. Firms pass on these cost increases in their prices. In other words, the existence of the persistent price puzzle in the pre-crisis period suggests that firms adjust their prices rather than output in response to interest rate shocks.

Exchange rates are an important channel of monetary transmission both before and after the crisis. The strength of the exchange rate channel has increased following the crisis and the switch to a

floating exchange rate, while exchange rate pass-through decreased at the same time.[28] Policy shocks affect output more quickly and stabilize more quickly in the post-crisis period when exchange rates are added to the model. The asset price channel is weak in both periods. The responses of output and asset prices to interest rate shocks are not intuitive in the pre-crisis period, as output and asset prices increase after a policy shock. In the post-crisis period the results are as expected.

The credit channel is found to be weak and working only in the short run in the pre-crisis period. Although the short data span after the structural reforms limits the analysis, the effect of the credit channel appears to have increased the post-crisis period. It was expected that improved operation of credit markets would strengthen the credit channel following the reforms, a result that is confirmed by the empirical results (Basci et al., 2007).

Two approaches are used to test the strength of the interest rate channel. The first approach includes an additional interest rate variable in the model. The impact of the additional interest rate variable is weak, but somewhat stronger in the post-crisis period. The second approach assumes that the effect of the interest rate channel is the effect of the policy interest rate when holding constant the effects of the other channel variables. This methodology finds a much stronger interest rate channel, and the strength increased considerably following the monetary reforms.

The results strongly support the importance of central bank independence and a credible monetary policy. The policy reforms following the financial crisis granted the central bank greater independence and allowed the pursuit of a credible monetary policy using a short-term interest rate. The reforms increased the ability of the central bank to stabilize output during the post-crisis sample period, since the effects of monetary policy on output, especially interest rates and exchange rates, strengthened considerably following the reforms. Whereas monetary policy affected prices more in the pre-crisis period, policy had strong and persistent effects on real output in the post-crisis sample period. Turkey's

policy reforms appear to have been successful, making monetary policy more credible and a more effective stabilization tool in the post-crisis sample period.[29]

Response to Cholesky One Unit INTRATE innovations

Pre-Crisis Period (1996:7- 1999:12) Post-Crisis Period (2002:01 – 2007:06)

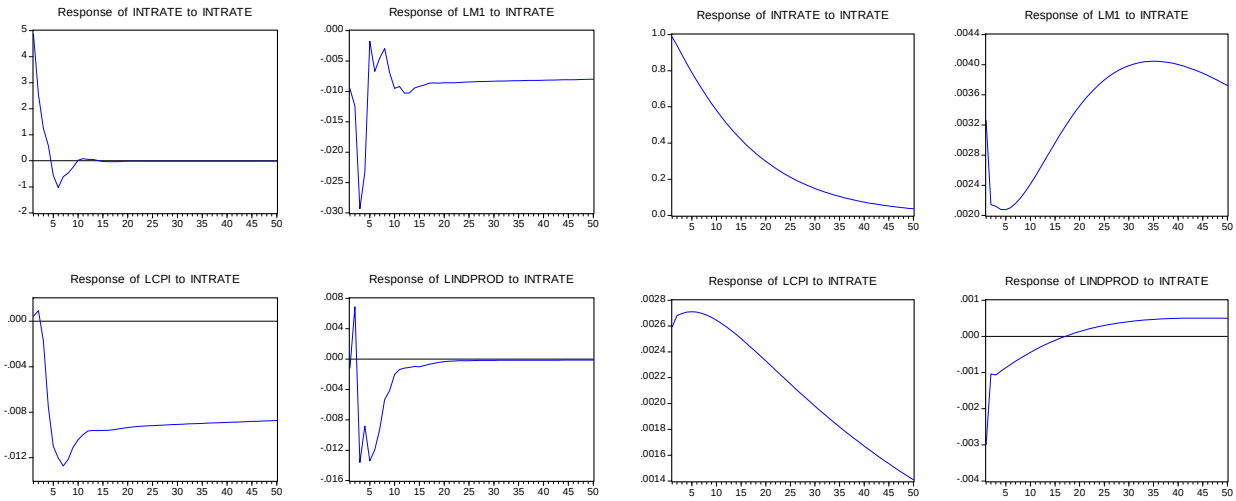
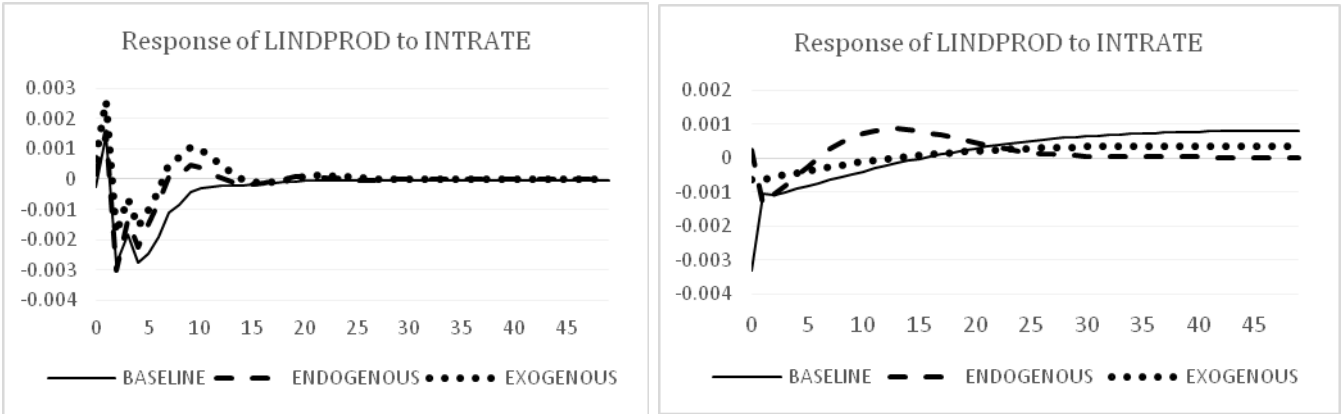
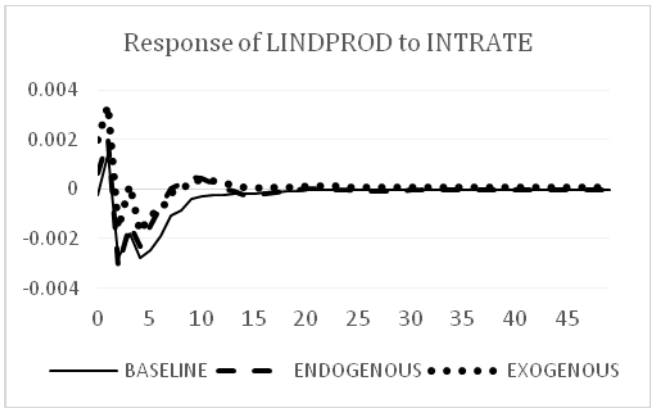


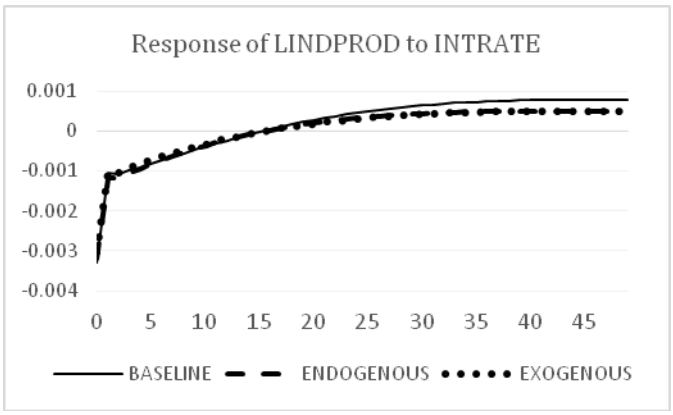
Figure 1- Selected Impulse Responses of the Baseline VAR



A. Pre-crisis Period B. Post-crisis Period

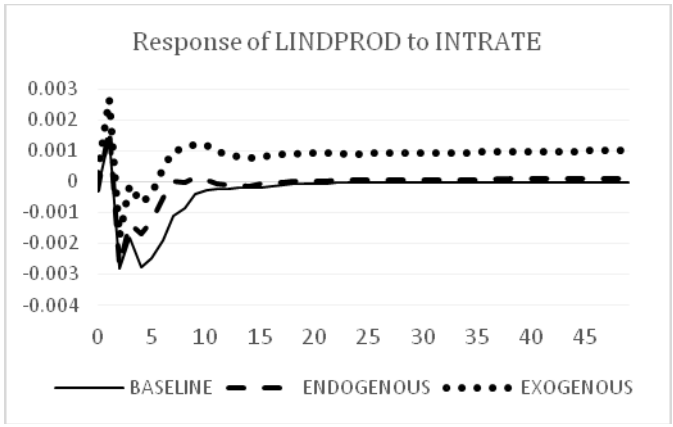
Figure 2: Impulse Response Functions of Output to Interest Rate with an Exchange Rate Channel

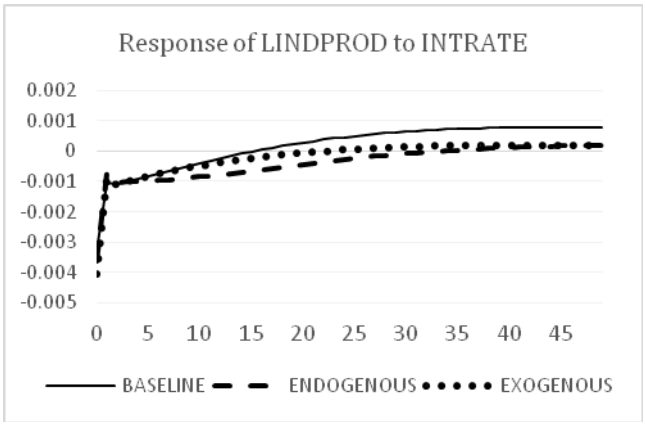




A. Pre-Crisis Period B. Post-Crisis Period

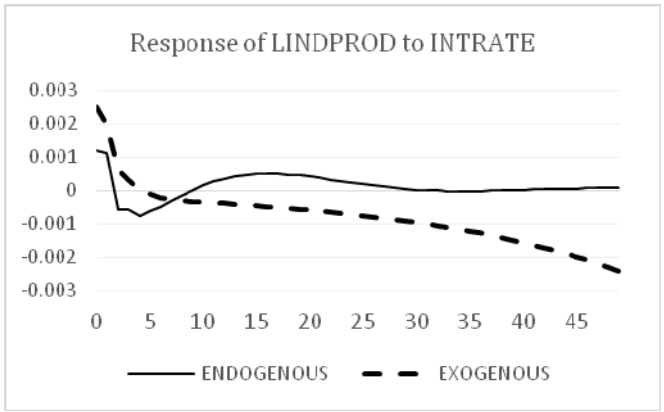
Figure 3: Impulse Response Functions of Output to Interest Rate with an Asset Price Channel

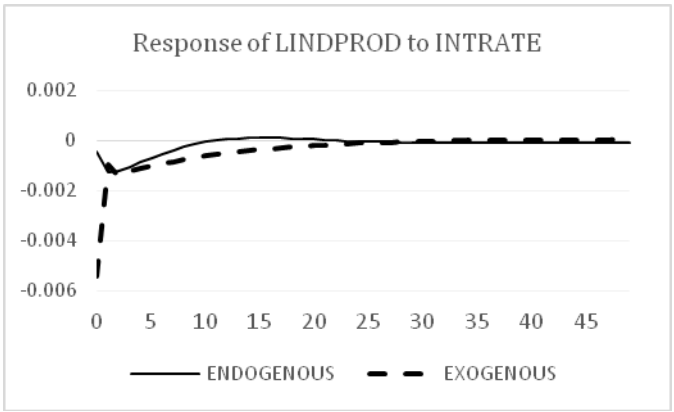




A. Pre-Crisis Period B. Post-Crisis Period

Figure 4: Impulse Response Functions of Output to Interest Rate with a Credit Channel





A. Pre-Crisis Period B. Post-Crisis Period

Figure 5: Impulse Response Functions of Output to Interest Rate for Endogenous (All channels) Model and Exogenous (Interest rate channel) Model for pre and post-crisis periods

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[1]Research has established that policy reforms have important economic impacts. Lucas (1976) established that a regime switch changes behavior within an economy. Barro and Gordon (1983) emphasize that a regime change solves the time consistency problem (Kydland and Prescott, 1977). Alesina and Summers (1993) demonstrate that central bank independence results in less inflationary monetary policy.

[2]The contraction is directly proportional to the interest elasticity of money demand (Bean et al., 2002).

[3]The exchange rate was not publicized, but was known in advance by high level bureaucrats who sold the information to currency traders including bank owners. Currency traders bought the currency from the central bank when it was cheap, and sold it back when it was expensive.
[4]Sahinbeyoglu (2001), using a small aggregate macroeconomic model for the period 1987 to 1999, concludes that the monetary transmission mechanism is weak when fiscal and monetary policies are uncoordinated. Ozturkler (2002) estimates a VAR for the period 1986 through 2001and finds a strong interest rate channel but a weak bank lending channel.
[5]Basci, Ozel and Sarikaya (2007), based on studies conducted by the central bank's staff, report that the interest rate and credit channels have strengthened, while the exchange rate channel has weakened in the recent years. Cifter and Ozun (2007) use a vector error correction model based causality test to analyze the data from 1997 through 2006. They find that the interest rate channel is relatively stronger in Turkey. This study does not investigate the possibility of a structural break in 2001.
[6]Aslan and Korap (2007) analyze the monetary transmission mechanism in Turkey for the 1992-2004 period using Vector Autoregressions, while ignoring the possibility of a structural break.
[7]Empirical studies examining the MTM before and after crisis periods in emerging economies similar to Turkey find that post-crisis reforms have changed the MTM in these economies. These studies examine the MTM in Mexico (Sidoui and Ramos-Francia, 2008), Chile (Betancour, De Gregorio and Medina, 2008), and Argentina (Gomez-Gonzalez and Grosz, 2007).
[8] The data are from the International Financial Statistics Database of the International Monetary Fund.
[9] Historically money developments have played an important role in Turkish monetary policy strategies.
[10]Fung (2002) and Hesse (2007) conducted their analyses using the sub-sample data: pre- crisis and post-crisis.
[11]The Likelihood Ratio Test is used to test whether the error covariance matrix is diagonal for the baseline model for both pre- and post-crisis periods. The test fails to reject the null hypothesis that the error covariance matrix is diagonal at the 5 % level of significance for both periods. If the error covariance matrix is diagonal, which is the case for the baseline model, the estimated impulse response functions are not sensitive to the ordering of the endogenous variables in the VAR model.
[12]Test results are available upon request. Both the Augmented Dickey-Fuller (ADF) test and the Augmented Dickey-Fuller-GLS test based on the Schwartz-Bayesian Information Criteria are used to test for unit roots. The five percent level of significance is used for all tests.
[13] Test results are available upon request.
[14] Test results are available upon request.
[15] Since the VAR in levels includes nonstationary variables, the confidence intervals with impulse responses would be incorrect. Confidence intervals are not reported with the impulse responses in these graphs.
[16] In Figure 1 the horizontal axis denotes the number of months elapsed after the shock, and the vertical axis denotes the deviation from the baseline level of the target variable in response to a one time unit shock to the policy variable (INTRATE).
[17]Another method of analysis would be to include all four channel variables simultaneously, but data limitations preclude this approach.
[18] The likelihood ratio test is used to assess the robustness of the results. The null hypothesis of an exogenous channel is tested against the alternative hypothesis of an endogenous channel. If the null is not rejected, the null of no effect of a channel (the baseline model) is tested against the alternative of a non-zero effect.
[19] Data are from the International Financial Statistics database.
[20] The lag length tests are discussed above.
[21] Likelihood ratio tests indicate an exogenous exchange rate channel in the pre-crisis period and an endogenous channel in the post-crisis period.
[22]Basci et al. (2007) also find that the supply side effect is dominant.
[23] The data are from the Central Bank of Turkey.
[24] Likelihood ratio tests indicate the asset price channel works exogenously in both periods.
[25] Data are from the Central Bank of Turkey.
[26] Likelihood ratio tests support the existence of an exogenous credit channel in the pre-crisis period and an endogenous channel following the crisis.
[27] Deposit rate data are from the Central Bank of Turkey.
[28]Ca'Zorzi, Hahn and Shanchez, 2007; Kara et al., 2005; Leigh and Rossi, 2002 all find that pass through decreases with the adoption of floating exchange rates.
[29] Investigation the effects of monetary policy since the adoption of explicit inflation targeting in 2006 is a topic for future research.