The Role of Monetary Policy during the Global Financial Crisis

The Turkish Experience

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Abstract

Turkey was one of the hardest hit countries by the crisis, with a year-over-year contraction of 14 percent during the first quarter of 2009. At the same time, anticipating the fallout from the crisis, the Central Bank of the Republic of Turkey (CBRT) decreased policy rates by an astounding 1025 basis points over the November 2008 to November 2009 period. Furthermore, the Turkish banking system was quite resilient to the episode of financial distress in contrast to many other countries, and in contrast to the 2001 crisis. In this context, this paper addresses the follow: If the post-2001 financial reforms, the adoption of the flexible exchange rate regime, and implementation of active countercyclical monetary policy were not carried out, how much deeper would the recent recession been? Counterfactual experiments indicate that these policies taken altogether seem to have added a growth contribution of up to about 10 percent on average. The counterfactual experiments are based on an estimated structural model which along with standard nominal and real rigidities employed, jointly incorporates a real stochastic trend, allows for a nonstationary inflation target, and includes a financial accelerator mechanism in an open-economy framework.

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I. INTRODUCTION

The recovery of the global economy seems to be gaining traction after the worse crisis in recent memory. Distinct features of the recent crisis include a sharp slowdown in economy activity worldwide—including severe recessions across many countries—along with an episode of acute financial distress. Another departure from past global downturns was the coordination of unprecedented counter-cyclical policy responses to the crisis, which seem to have facilitated the ongoing rebound in economic activity.

In this context, Turkey was one of the hardest hit countries by the crisis. While the latest growth rates indicate a healthy upswing, real GDP contracted sharply for four quarters, reaching a year-over-year contraction of 14 percent during the first quarter of 2009. At the same time, anticipating the fallout from the crisis, the Central Bank of the Republic of Turkey (CBRT) decreased policy rates by an astounding 1025 basis points over the November 2008 to November 2009 period. Another interesting development that makes the Turkish experience an interesting case study is that despite the occurrence of a severe crisis, the Turkish banking system was quite resilient to the episode of financial distress in contrast to many other countries.

The recent Turkish experience differs from the past in several dimensions. As discussed in further detail in the next section, Turkey suffered from an intense financial crisis in 2001. During the run-up to the 2001 crisis, the risk profile of the banking systems had increased markedly, which was a factor that put into question the viability of the implemented fixed exchange rate regime. As the crisis unfolded, the fixed exchange rate regime was eventually abandoned, capital fled the country, the banking system nearly collapsed, and economy entered a severe recession.

While the 2001 crisis was certainly harsh, it also presented an opportunity. Important lessons were learned in the aftermath of the crisis, and—for the purposes of this paper—at least three important reforms were implemented. First, the banking system was practically overhauled. Second, the pegs and heavily managed exchange rate regimes of the past were replaced by a free float. Third, and relatedly, the policy framework of the CBRT gradually transitioned into a full-fledged inflation targeting regime.

These reforms seem to have increased the resilience of the Turkish economy to shocks. It could be argued that the decreased risk profile of the economy, the flexible exchange rate regime which is now available to serve as a shock absorber, and the inflation targeting regime which is the new nominal anchor have all heightened the robustness of the economy.

In this context, this paper will focus on the macroeconomic implications of these three broad facets of monetary policy (which includes the financial reforms because they are an important element of the monetary transmission mechanism), particularly during the recent global financial crisis. The principle question of the paper is as follows: What was the role of these (monetary) policy changes in mitigating the severity of the recent recession? More specifically, we seek to address the following set of questions: (1) What role did the financial reforms play in alleviating the severity of the crisis? (2) In contrast to a peg, what was the role of the floating exchange regime in helping insulate the economy from the crisis? (3) Relatedly, consistent with the attainment of the inflation targets, what was the role of the CBRT's interest rate policy in soften the impact of the crisis?

This paper seeks to provide quantitative answers to these questions. To this end, we develop and estimate a dynamic stochastic general equilibrium (DSGE) model of the Turkish economy. The model, which is discussed in detail in Section 3, builds upon the literature and incorporates various features improving its ability to capture important dynamics of emerging markets—we choose the Turkish economy as our case study. For example, the model includes a time-varying endogenous external finance premium which is linked to the risk profile of the economy. As entrepreneurs, who are responsible for wholesale production, increase their leverage to finance larger projects, the external finance premium increases proportionately. Further, the model can easily allow the possibility that in order to finance these projects, entrepreneurs must borrow in foreign currency—liability dollarization is thus is an important vulnerability in line with the "original sin" hypothesis of Eichengreen and Hausman (1999).

The model also posits that prices and nominal wages are sticky, motivating active monetary policy. Exacerbating the persistence stemming from stick wages and prices, it is also assumed that indexation is prevalent across the economy. As shown in **Figure 1**, Turkey was plagued with high and persistent levels of inflation which became entrenched. These nominal rigidities clearly capture an important aspect of the Turkish economy and their important is determined through the estimation of the model. Furthermore, given the large swings in key nominal variables (interest and inflation rates), the model allows for a time-varying inflation target that is nonstationary. To enhance model fit, real frictions and other features are included which we compile from various studies to be discussed further below. Lastly, we assume monetary policy is conducted via an interest rate rule. This rule incorporates interest smoothing, and can be made responsive to the output gap. While the inflation target is the baseline policy objective, the rule can model a fixed exchange rate regime. Overall, one of the key modeling innovations of this paper is that it provides a framework that includes a real stochastic trend, allows for a nonstationary inflation target, and incorporates a financial accelerator mechanism in an open-economy setup.

Using the estimated DSGE model we can address the main question of the paper reformulated as the following: If the post-2001 financial reforms, the adoption of the flexible exchange rate regime, and implementation of active countercyclical monetary policy were not carried out, how much deeper would the recent recession been? The short answer is much deeper.

As discussed in further detail below, the four facets of monetary policy, namely the (1) reduced financial vulnerabilities, (2) adoption of a flexible exchange rate regime, (3) reaction to the output gap, and (4) discretionary departures from the interest rate rule (consistent with the achievement of the inflation target) all seem to have had clearly beneficial implications in terms of softening the impact of the crisis on economic activity. In fact, these policies taken together seem to have added a growth contribution of up to about 10 percent on average.

It may be useful to clarify that the our definition of discretionary departures from the interest rate rule includes the "pure" monetary policy shock as well as the shock to the time-varying inflation target. However, even if we exclude the inflation target shock, monetary policy still contributed markedly to Turkish growth during the recent crisis episode. Specifically, our counterfactual simulations indicate that the average contribution of the pure monetary shocks to output growth was around one percent, which lies in between the values found by Christiano and others (2007) for the U.S. (0.75 percent) and the euro area (1.27 percent).

As a byproduct of our estimated model, we can shed light on the monetary transmission mechanism in Turkey during the inflation targeting regime. As discussed in further detail below, a one-time monetary policy shock takes six quarters to fully feed through the inflation rate, while the effects on output taper off only after several years.

Our findings can be linked to the classical issue of the most appropriate exchange rate regime, which can be traced back to at least to the seminal contributions of Mundell and Fleming. In fact, we find that the flexible exchange rate seemed to have acted as a shock absorber in mitigating the harsh consequences of the crisis. Our work also builds on a tradition of small open economy DSGE models starting with Mendoza (1991). Over time, these real models were augmented with nominal rigidities to motivate and then explore the implications of monetary policy (for example, Obstfeld and Rogoff, 2000; Gali and Monacelli, 2002, among others). To capture financial frictions more appropriately, building on Bernanke and others (1999), a financial accelerator mechanism was also added on to these models (see for example, Cespedes and others, 2004; Devereux, and others, 2006; Gertler, and others, 2007; as well as Elekdag and Tchakarov, 2007). With the growing popularity and feasibility of Bayesian method, building upon the closed economy studies of Smets and Wouters (2003, 2007) as well as Christiano, Eichenbaum, and Evans (2006), small open economy models were estimated (Lubik and Schorfheide, 2007; Teo, 2006; as well as Christensen and Dib, 2006). Then, Elekdag, Justiniano, and Tchakarov (2006) estimated a small open economy model with a financial accelerator for an emerging market, which later motivated others do follow suit using richer modeling structures (see, for example, Garcia-Cicco, 2010). Against this backdrop, this paper takes Elekdag, Justiniano, and Tchakarov (2006) as a starting point, and augments their model with some of the features in Gertler and others (2007), Smets and Wouters (2007), Ireland (2007) to better capture model dynamics and improve model fit.

II. Economic Developments in Turkey: Some Stylized Facts

By way of background for the rest of the paper, the main objective of this section is briefly discuss some key developments regarding the Turkish economy over the last two decades. It will be useful to start off by highlighting the macroeconomic turbulence during the 1994 financial crisis shown in **Figure 1**. Taking the nomenclature of Calvo and others (2004) seriously, this could clearly be categorized as a sudden stop (of capital inflows). As capital ceased to flow into the economy, the trade balance-to-GDP ratio had to adjust by about eight percentage points of GDP, to over four percent from minus four percent. To effect this dramatic adjustment, the real effective exchange rate depreciated sharply and the real economy contracted severely. While the authorities attempted to defend the exchange rate by increasing interest rates (exceeding 200 percent even after accounting for the inherent smoothing of financial data when using quarterly time series), the eventual exchange rate depreciation cause an attendant rise in inflation rates.

Unfortunately, in turned out that the 1990s proved to be a very challenging period for the Turkish economy, in part because of crises in other regions of the world. The Mexican crisis that erupted in December 1994, the Asian crisis beginning in Thailand during July 1997, the Russian default in 1998, and the related collapse of Long Term Capital Management were all shocks that had global ramifications. Then in the late summer of 1999, Turkey was hit by a devastating earthquake. These developments clearly affected the Turkish economy, particularly output, consumption, and investment, as shown in **Figure 1**.

The start of the new millennium offered hope. Turkey was already engaged in an IMF-supported arranged, which among other objectives, sought to bring down the countries chronically high levels of inflation. One of the fundamental pillars of this macroeconomic stabilization plan was a quasi-currency board—in other words, a fixed-exchange rate regime would be the nominal anchor by which inflation would downtrend over time.

However, in the late fall of 2000, among other factors, fragilities in the banking system surfaced. With high leverage ratios and substantial currency mismatches, banks' risk profiles had increased dramatically over the years. Along with other issues, these vulnerabilities raised doubts about the resiliency of the economy, and after some political strife, there was a speculative attack on the fixed-exchange rate regime.

The quasi-currency board arrangement was abandoned in favor of a flexible exchange rate during February 2001. **Figure 1** reveals some similarities to the 1994 crisis, yet this downturn was to be much harsher. Once again, as capital outflows intensified, the trade balance-to-GDP ratio had to swing by about nine percentage points of GDP. The burden of adjustment had to be shouldered by the real exchange rate, which depreciated sharply, and output, which contracted severely. As before, interest rates shot up, but to no avail, and the inflation rate increased to levels which completely eliminated the disinflation gains from the stabilization program.

After the 2001 crisis, Turkey embarked on a new IMF-support arrangement. For the purposes of this paper, three major reforms that were implemented in the aftermath of the crisis are emphasized:

- First, there was nearly a complete overhaul of the Turkish banking system, which arguably decreased risk profile of the economy (as indicated by the lower leverage ratios shown in **Table 1**).
- Second, pegs (fixed exchange rates regimes) were abandoned in favor of floating exchange rates.
- Third, and relatedly, the CBRT started its transition, and in 2006 starting to officially implemented a full-fledged inflation targeting regime which would serve as the economy's nominal anchor.

Over the next 26 quarters, from the first quarter of 2002 to mid-2008, the Turkish grew by over five percent (year-over-year). While global economic and financial conditions were also extremely favorable, it is hard to argue that the reforms mentioned above did no contribute positively toward achieving these growth rates. In fact, the resiliency of the economy was vindicated after successfully coping with the turbulence during mid-summer of 2006 caused by a sell-off across many emerging economies.

Enter the global crisis. Synchronized downturns coupled with financial stress affected the global economy and international capital markets. In this context, the Turkish economy was hit directly by at least two major disturbances: a foreign demand shock and a financial shock. In fact, the contraction in world demand hit Turkish exports with severe implications for the rest of the economy. The financial shock resulted in a collapse of asset prices (including the currency), an increase in spreads, and sizeable capital outflows.

As a result, Turkey suffered one of the worst contractions during the recent crisis. The CBRT quickly grasped the implications of this dire situation. Anticipating substantially reduced levels of resource utilization, and in an attempt to mitigate the impact of the crisis on the economy, the CBRT cut interest rates by an astounding 1025 basis points over the November 2008 to November 2009 period. But to what end? Furthermore, what were the roles of the financial reforms implemented after the 2001 crisis in softening the recent downturn? These are some of the questions we seek to address below.

III. THE MODEL

This section presents a detail presentation of the DSGE model including households, entrepreneurs, capital producers, retailers, the foreign economy, and the monetary authority.

Households

There is a continuum of households, which attain utility from aggregate consumption, C_t, and leisure, L_t. Aggregate consumption is assumed to be given by a CES index of domestically produced and imported goods according to:

$$C_t = \left[(\gamma)^{\frac{1}{\rho}}(C_t^H)^{\frac{\rho-1}{\rho}} + (1-\gamma)^{\frac{1}{\rho}}(C_t^F)^{\frac{\rho-1}{\rho}}\right]^{\frac{\rho}{\rho-1}}$$

where C_t^H and C_t^F are consumption of the domestic and imported good, respectively. Moreover, γ is the share of domestic good in consumption, and ρ is the elasticity of substitution between domestic and foreign consumption goods.

The intra-temporal problem of the household for the consumption implies that:

$$\frac{C_t^H}{C_t^F} = \frac{\gamma}{1-\gamma}\left(\frac{P_t^H}{P_t^F}\right)^{-\rho}$$

The corresponding consumer price index, P_t, is given by:

$$P_t = [\gamma(P_t^H)^{1-\rho} + (1-\gamma)(P_t^F)^{1-\rho}]^{\frac{1}{1-\rho}}$$

The households decide on their current level of consumption as well as their amount of domestic and foreign bond holdings under the following preference:

$$U_t = E_0 \sum_{t=0}^{\infty} \beta^t \left\{\varepsilon_t^c \ln(C_t - bC_{t-1}) - \frac{\varepsilon_t^l}{1+\sigma_l}(L_t)^{1+\sigma_l}\right\}$$

where ε_t^c and ε_t^l are preference and labor supply shock, respectively. They have the following time series representations:

$$\log \varepsilon_t^c = \rho_c \log \varepsilon_{t-1}^c + \epsilon_t^c$$

$$\log \varepsilon_t^l = \rho_l \log \varepsilon_{t-1}^l + \epsilon_t^l$$

In household preferences, we also allow for habit persistence in preferences by including the term bC_{t-1}.

The representative household is assumed to maximize the expected discounted sum of its utility subject to budget constraint:

$$C_t = \frac{W_t}{P_t} L_t + \Pi_t - \frac{B_{t+1} - i_{t-1} B_t}{P_t} - \frac{S_t B_{t+1}^* - S_t \Phi_{t-1} i_{t-1}^* B_t^*}{P_t}$$

where W_t denote the nominal wage, Π_t real dividend payments (from ownership of retail firms), S_t the nominal exchange rate, B_{t+1} and B_{t+1}^* nominal bonds denominated in domestic and foreign currency, respectively; and i_t and i_t^* the domestic and foreign gross nominal interest rate, respectively. In addition, Φ_t represents a gross borrowing premium that domestic residents must pay to obtain funds from abroad, specifically:

$$\Phi_t = \Phi(b_{t+1}^*/z_t, \varepsilon_t^{\Phi})$$

$$b_{t+1}^* \equiv \frac{S_t B_{t+1}^*}{P_t}$$

As in Gertler and others (2007), the country borrowing premium, depends on total net foreign indebtedness and a exogenous process, ε_t^{Φ}. The introduction of this risk-premium is needed in order to ensure a well-defined steady-state in the model (see Schmitt-Grohe and Uribe, 2003, for further details).

The solution of the household's utility maximization problem yields the following Euler equation:

$$E_t \left[\beta \frac{\lambda_{t+1}}{\lambda_t} \frac{i_t P_t}{P_{t+1}} \right] = 1$$

where λ_t, the marginal utility of the consumption index, is given by

$$\lambda_t = \frac{\varepsilon_t^c}{C_t - bC_{t-1}}$$

In addition, the optimality condition governing the choice of foreign bonds yields the following uncovered interest parity condition (UIP), where it is now clear that the exogenous process, ε_t^{Φ}, could be interpreted as a risk premium (UIP) shock:

$$E_t \left\{ \lambda_{t+1} \frac{P_t}{P_{t+1}} \left[i_t - \Phi_t i_t^* \frac{S_{t+1}}{S_t} \right] \right\} = 0$$

Wage setting

Each household is assumed to be a monopolistic supplier of a differentiated labor service desired by the domestic firms. This implies that each household has some pricing power over the wage it charges, $W_{j,t}$. After having set their wages, households inelastically supply the firms' demand for labor at the going wage rate.

Each household sells its labor, $l_{j,t}$, to a firm which transforms household labor into a homogeneous input good, L_t, using the following production function:

$$L_t = \left[\int_0^1 (l_t(j))^{\frac{1}{\mu^w}} dj\right]^{\mu^w}$$

where $\mu^w$is the wage markup. This firm takes the input price of the differentiated labor input as given, as well as the price of the homogenous labor services. The demand for labor that an individual household faces is determined by:

$$l_t(j) = \left[\frac{W_{j,t}}{W_t}\right]^{\frac{\mu^w}{1-\mu^w}} L_t$$

Following Kollmann (1997) and Erceg and others (2000), we assume that wages can only be optimally adjusted after some random "wage change signal" is received. Households that do not receive the "signal" update their previous period wage by indexing it to the current inflation rate target, π_t^T, the previous period's inflation rate, π_{t-1}, and the current growth rate of the technology level, ζ_t. More formally, a household who does not re-optimize in period *t* sets its wage as:

$$W_{j,t} = {\pi_{t-1}}^{\gamma_w} (\pi_t^T)^{1-\gamma_w} \zeta_t W_{j,t-1}$$

where γ_w is the degree of wage indexation, with $\pi_t = P_t/P_{t-1}$.

The j^{th} household that can re-optimize its wage according to the following optimization problem:

$$\max_{W_{new,t}} E_t \sum_{s=0}^{\infty} (\beta\theta_w)^s \left[-\frac{\varepsilon_{t+s}^l}{1+\sigma_l} (l_{t+s}(j))^{1+\sigma_l} \right.$$
$$\left. + \lambda_{t+s} (\pi_t \pi_{t+1} \dots \pi_{t+s-1})^{\gamma_w} (\pi_{t+1}^T \pi_{t+2}^T \dots \pi_{t+s}^T)^{1-\gamma_w} (\zeta_{t+1} \dots \zeta_{t+s}) W_{new,t} l_{t+s}(j)\right]$$

After inserting the relevant expressions for $l_{t+s}(j)$ in the optimization problem, the equation above yields the following first order condition:

$$E_t \sum_{s=0}^{\infty} (\beta\theta_w)^s l_{t+s}(j) \left[-\varepsilon_{t+s}^l (l_{t+s}(j))^{\sigma_l} \right.$$
$$\left. + \frac{W_{new,t}}{P_t z_t} \frac{z_{t+s}}{\mu^w} \lambda_{t+s} P_{t+s} \left(\frac{P_{t+s-1}}{P_{t-1}}\right)^{\gamma_w} (\pi_{t+1}^T \dots \pi_{t+s}^T)^{1-\gamma_w} \frac{P_{w,t}}{P_{w,t+s}}\right] = 0$$

where $-\varepsilon_{t+s}^l (l_{t+s}(j))^{\sigma_l}$ is the marginal disutility of labor.

Foreign Economy

In considering arbitrage in goods markets, we distinguish between the wholesale (import) price of foreign goods and the retail price in the domestic market by allowing for imperfect competition and pricing-to-market in the local economy. Let $P_{w,t}^{F}$ denote the wholesale price of foreign goods in domestic currency, P_t^{F*} the foreign currency price of such goods, and, S_t, the nominal exchange rate. At the wholesale level, the law of one price holds, which implies:

$$P_{w,t}^{F} = S_t P_t^{F*}$$

Following Gertler and others (2007), we assume that foreign demand for the home tradable good, C_t^{H*}, is given by:

$$C_t^{H*} = \left[\left(\frac{P_t^{H*}}{P_t^{F*}}\right)^{-\chi} Y_t^*\right]^{\varpi} (C_{t-1}^{H*})^{1-\varpi}$$

where Y_t^* is real foreign output (or equivalently, foreign demand), which is assumed to be an exogenous stochastic process. The term $(C_{t-1}^{H*})^{1-\varpi}$ represents inertia in foreign demand for domestic products, and $\mathrm{P}_t^{\mathrm{H}*} = P_t^H / S_t$.

Entrepreneurs

The set up for entrepreneurs is similar to the framework in Gertler and others (2007), who build upon the framework introduced by Bernanke and others (1999). Risk neutral entrepreneurs manage production and obtain financing for the capital employed in the production process. To ensure that they never accumulate enough funds to fully self-finance their capital acquisitions, we assume they have a finite expected horizon. Each survives until the next period with probability ϱ_t , which is time-varying, and subject to an exogenous shock. Intuitively, an adverse shock could be interpreted as an impairment of the entrepreneurs assets caused by heighted financial uncertainty. Variations of this shock have been used by Elekdag and others (2006), Curdia (2007), as well as Christensen and Dib (2008).

At time t, the entrepreneur starts with capital, K_t, acquired in the previous period. He then produces domestic output, Y_t, using labor, H_t, and capital services, $u_t K_t$, where u_t is the capital utilization rate. The labor input H_t is assumed to be a composite of household and managerial labor:

$$H_t = L_t^{\Omega} L_{e,t}^{1-\Omega}$$

where $L_{e,t}$ is managerial labor, which is assumed to be constant. The entrepreneur's gross project output, GY_t, consists of the sum of his production revenues and the market value of his remaining capital stock. In addition, we assume the project is subject to an idiosyncratic shock, ω_t, with $\mathrm{E}(\omega_t) = 1$, that affects both the production of new goods and the effective quantity of his capital.

$$GY_t = \frac{P_{w,t}}{P_t} Y_t + \left(Q_t - \frac{P_{I,t}}{P_t}\delta_t\right)\omega_t K_t$$

where $P_{w,t}$ be the nominal price of wholesale output, Q_t the real market price of capital with respect to household consumption index, $P_{I,t}$ the price of investment good, δ_t the depreciation rate. Y_t is denoted as the wholesale good production, which has the following technology:

$$Y_t = \omega_t A_t (u_t K_t)^{\alpha} (z_t H_t)^{1-\alpha}$$

where A_t is stationary productivity shock and z_t is permanent technology shock, which is exogenously given by :

$$\frac{z_t}{z_{t-1}} = \zeta_t$$
$$\log \zeta_t = \rho_\zeta \log \zeta_{t-1} + \epsilon_t^{\zeta}$$

Following Greenwood and others (1988), we endogenize the utilization decision by assuming that the capital depreciation rate is increasing in u_t. The depreciation, δ_t, is the following convex function of the utilization rate:

$$\delta_t = \delta + \frac{\tau}{1+\epsilon} u_t^{1+\epsilon}$$

The problem of the entrepreneur is to choose labor and the capital utilization rate to maximize profits, given the values of K_t, z_t, A_t and ω_t . The optimality conditions imply the following labor demand functions:

$$(1-\alpha)(1-\Omega)\frac{Y_t}{L_t} = \frac{W_t}{P_{w,t}}$$
$$(1-\alpha)\Omega\frac{\mathrm{Y_t}}{\mathrm{L_t^e}} = \frac{\mathrm{W_t^e}}{\mathrm{P_{w,t}}}$$

where $\mathrm{W_t^e}$ is the managerial wage. The optimality condition for capital utilization is

$$\alpha\frac{Y_t}{u_t} = \delta'(u_t) K_t \frac{P_{I,t}}{P_{w,t}}$$

The entrepreneurs also make capital acquisition decision. At the end of period t, the entrepreneur purchases capital that can be used in the subsequent period t +1 to produce output at that time. The entrepreneur finances the acquisition of capital partly with his own net worth available at the end of period *t*, N_{t+1}, and partly by issuing nominal bonds, B_{t+1}, which is purchased by the household. Then capital financing is divided between net worth and debt, as follows:

$$Q_t K_{t+1} = N_{t+1} + \frac{B_{t+1}}{P_t}$$

The entrepreneur's demand for capital depends on the expected marginal return and the expected marginal financing cost. The marginal return to capital, R^k_{t+1}, is given by:

$$R^k_{t+1} = \frac{GY_{t+1} - \frac{W_{t+1}}{P_{t+1}} H_{t+1}}{Q_t K_{t+1}} = \frac{\omega_{t+1}\left[\frac{P_{w,t+1}}{P_{t+1}} \alpha \frac{\bar{Y}_{t+1}}{K_{t+1}} - \frac{P_{I,t+1}}{P_{t+1}} \delta_{t+1} + Q_{t+1}\right]}{Q_t}$$

It is represented by next period's ex-post gross output net of labor costs, normalized by the period t market value of capital. Here, $\bar{Y}_{t+1}$ is the average level of output per entrepreneur ($Y_{t+1} = \omega_{t+1}\bar{Y}_{t+1}$). Then, the expected marginal return is simply:

$$E_t R^k_{t+1} = \frac{E_t\left\{\frac{P_{w,t+1}}{P_{t+1}} \alpha \frac{\bar{Y}_{t+1}}{K_{t+1}} - \frac{P_{I,t+1}}{P_{t+1}} \delta_{t+1} + Q_{t+1}\right\}}{Q_t}$$

The marginal cost of funds to the entrepreneur depends on financial conditions. As in Bernanke and others (1999), we assume a costly state verification problem. In this setting, it is assumed that the idiosyncratic shock ω_t is private information for the entrepreneur, implying that the lender cannot freely observe the project's gross output. To observe this return, the lender must pay an auditing cost—interpretable as a bankruptcy cost—that is a fixed proportion of the project's ex-post gross payoff. Since the lender must receive a competitive return, it charges the borrower a premium to cover the expected bankruptcy costs. The external finance premium affects the overall cost of finance, it therefore influences the entrepreneur's demand for capital.

In general, the external finance premium varies inversely with the entrepreneur's net worth: the greater the share of capital that the entrepreneur can either self-finance, the smaller the expected bankruptcy costs and, hence, the smaller the external finance premium. Then, the external finance premium, χ_t may be expressed as:

$$\chi_t(.) = \chi_t\left(\frac{N_{t+1}}{Q_t K_{t+1}}\right)$$

with

$$\chi'(.) < 0, \;\; \chi(1) = 1$$

By definition, the entrepreneur's overall marginal cost of funds in this environment is the product of the gross premium for external funds and the gross real opportunity cost of funds that would arise in the absence of capital market frictions. Accordingly, the entrepreneur's demand for capital satisfies the optimality condition:

$$E_t R^k_{t+1} = \chi_t\left(\frac{N_{t+1}}{Q_t K_{t+1}}\right) E_t\left[i_t \frac{P_t}{P_{t+1}}\right]$$

This equation provides the basis for the financial accelerator. It links movements in the borrower financial position to the marginal cost of funds and, hence, to the demand for capital. Note, in particular, that fluctuations in the price of capital, Q_t, may have significant effects on the leverage ratio.

The other key component of the financial accelerator is the relation that describes the evolution of entrepreneurial net worth, N_{t+1}. Let V_t denote the value of entrepreneurial firm capital net of borrowing costs carried over from the previous period. This value is given by:

$$V_t = R_t^k Q_{t-1} K_t - \left\{ \chi_{t-1}(.) E_t \left[i_{t-1} \frac{P_{t-1}}{P_t} \right] \right\} \frac{B_t}{P_{t-1}}$$

Then, net worth is expressed as a function of V_t and the managerial wage.

$$N_{t+1} = \varrho_t V_t + \frac{W_t^e}{P_t}$$

where the weight ϱ_t reflects the time-varying survival rate, which is a stochastic exogenous discussed above, specifically:

$$\varrho_t = \varrho \varepsilon_t^N$$
$$\log \varepsilon_t^N = \rho_N \log \varepsilon_{t-1}^N + \epsilon_t^N$$

Here, ε_t^N can be interpreted as a financial uncertainty shock since it has direct impact on the level of aggregate net worth and therefore the external financial premium.

Lastly, entrepreneurs going out of business at time *t* consume their remaining resources. Then the consumption of entrepreneur is given by:

$$C_t^e = (1 - \varrho_t) V_t$$

where C_t^e denote the amount of the consumption composite consumed by the exiting entrepreneurs.

Capital produces

We assume that capital goods are produced by a separate sector in a competitive market. Capital producers are price takers and owned by the representative households. At the end of the period *t*, they buy the depreciated physical capital stock from the entrepreneurs and by using total investment good, they convert them into capital stock, which is sold to entrepreneurs and used for production at period *t+1*. Capital production technology is described by the following equation:

$$K_t = (1 - \delta_t) K_{t-1} + \left[1 - \psi \left(\frac{I_t}{I_{t-1}} \right) \right] I_t \varepsilon_t^i$$

where ψ is the capital adjustment cost with properties :

$$\psi(\zeta) = \psi'(\zeta) = 0, \ \psi''(\zeta) = \psi > 0$$

and ε_t^i is stationary investment-specific technology shock. Note that only the parameter ψ'' is identified and will be used in the log-linearized model.

As with consumption, the total investment good is assumed to be given by a CES aggregate of domestic and imported investment goods ($I_t^H$and I_t^F, respectively):

$$I_t = \left[(\gamma_i)^{\frac{1}{\rho_i}}(I_t^H)^{\frac{\rho_i-1}{\rho_i}} + (1-\gamma_i)^{\frac{1}{\rho_i}}(I_t^F)^{\frac{\rho_i-1}{\rho_i}}\right]^{\frac{\rho_i}{\rho_i-1}}$$

where $\gamma_i$is the share of imports in investment, and ρ_i is the elasticity of substitution between domestic and imported investment goods. Because prices of the domestically produced investment goods coincide with the prices of the domestically produced consumption goods we have the following investment demand functions:

$$\frac{I_t^H}{I_t^F} = \frac{\gamma_i}{1-\gamma_i}\left(\frac{P_t^H}{P_t^F}\right)^{-\rho_i}$$

where the aggregate investment price, P_t^I, is given by

$$P_t^I = [\gamma_i(P_t^H)^{1-\rho_i} + (1-\gamma_i)(P_t^F)^{1-\rho_i}]^{\frac{1}{1-\rho_i}}$$

The problem of capital producer is to maximize its future discounted profit stream:

$$\max \sum_{t=0}^{\infty} E_0\left\{\beta^t\lambda_t\left[Q_t(K_t-(1-\delta_t)K_{t-1}) - \frac{P_{I,t}}{P_t}I_t\right]\right\}$$

subject to the evolution of capital.

The accompanying first order condition is:

$$\frac{P_{I,t}}{P_t} = Q_t\varepsilon_t^i\left[1-\psi_t-\psi_t^{'}\frac{I_t}{I_{t-1}}\right] + \beta E_t\left\{\frac{\lambda_{t+1}}{\lambda_t}Q_{t+1}\varepsilon_{t+1}^i\psi_{t+1}^{'}\left(\frac{I_{t+1}}{I_t}\right)^2\right\}$$

Retailers of Domestic Good

We assume that there is a continuum of monopolistically competitive retailers of measure unity. Retailers of domestic good buy wholesale goods from entrepreneurs/producers in a competitive manner at price $P_{w,t}$ and then differentiate the product slightly and then sell their output to households, capital producers, and the foreign country. Given that their output is differentiated, retailers have the monopolistic power to set prices of these final output goods. Let Y_t^H be the good sold by retailer *i*. Final domestic output is a CES composite of individual retail goods, given by:

$$Y_t^H = \left[\int_0^1 Y_t^H(i)^{\frac{1}{\mu_t^H}}di\right]^{\mu_t^H}$$

where $\mu_t^H$is a stochastic process determining the time-varying markup. This process is assumed to follow:

$$\mu_t^H = (1-\rho_{\mu^h})\mu^H + \rho_{\mu^h}\mu_{t-1}^H + \epsilon_t^{\mu^H}$$

Cost minimization implies that each retailer faces an isoelastic demand for his product given by:

$$,Y_t^H(i) = \left[\frac{P_t^H(i)}{P_t^H}\right]^{\frac{\mu_t^H}{1-\mu_t^H}} Y_t^H$$

where $P_t^H(i)$ is the price of retailer i and P_t^H is the corresponding price of the composite final domestic good, given by:

$$P_t^H = \left[\int_0^1 P_t^H\,(i)^{\frac{1}{1-\mu_t^H}} di\right]^{1-\mu_t^H}$$

Like in the wages case, the price setting decision in retailer sector is modeled as an indexation variant of the Calvo (1983) framework. Each retailer faces a random probability, $1-\theta_H$, that it can re-optimize its price in any period. With probability θ_H, the firm is not allowed to re-optimize, and its price in period *t+1* is then updated according to the scheme :

$$P_t^H(i) = \pi_{H,t-1}^{\gamma_H}(\pi_t^T)^{1-\gamma_H} P_{t-1}^H(i)$$

where $\pi_t^H = P_t^H / P_{t-1}^H$.

Under this assumption, the retailer of domestic good that hast the opportunity to set its price, $P_{new,t}^H$, faces the following optimization problem when setting its price:

$$\max_{P_{new,t}^H} E_t \sum_{s=0}^{\infty} (\beta\theta_H)^s \lambda_{t+s}\{[(\pi_{H,t}\pi_{H,t+1} \dots \pi_{H,t+s-1})^{\gamma_H}(\pi_{t+1}^T\pi_{t+2}^T \dots \pi_{t+s}^T)^{1-\gamma_H} P_{new,t}^H] Y_{t+s}^H(i) - MC_{t+s}^H(i)(Y_{t+s}^H(i) + z_{t+s}\kappa^H)\}$$

where κ^H is fixed costs, in real terms, ensuring that import profits are zero in steady state and $MC_t^H = P_{w,t}$.

Solving this problem, the following FOC is obtained:

$$E_t \sum_{s=0}^{\infty} (\beta\theta_H)^s \lambda_{t+s} \left[\frac{\left(\frac{P_{t+s-1}^H}{P_{t-1}^H}\right)^{\gamma_H} (\pi_{t+1}^T\pi_{t+2}^T \dots \pi_{t+s}^T)^{1-\gamma_H}}{\left(\frac{P_{t+s}^H}{P_t^H}\right)}\right]^{\frac{\mu_{t+s}^H}{1-\mu_{t+s}^H}} Y_{t+s}^H P_{t+s}^H \times \left[\frac{\left(\frac{P_{t+s-1}^H}{P_{t-1}^H}\right)^{\gamma_H} (\pi_{t+1}^T\pi_{t+2}^T \dots \pi_{t+s}^T)^{1-\gamma_H}}{\left(\frac{P_{t+s}^H}{P_t^H}\right)} \frac{P_{new,t}^H}{P_t^H} - \mu_t^H \frac{MC_{t+s}^H}{P_{t+s}^H}\right] = 0$$

From the aggregate price index (2.3) follows that the average price in period *t* is:

$$P_t^H = \left[\int_0^1 P_t^H(i)^{\frac{1}{1-\mu_t^H}} di\right]^{1-\mu_t^H} = \left[\int_0^{\theta_H} \left(P_{t-1}^H (\pi_{t-1}^H)^{\gamma_H} (\pi_t^T)^{1-\gamma_H}\right)^{\frac{1}{1-\mu_t^H}} + \int_{\theta_H}^1 \left(P_{new,t}^H\right)^{\frac{1}{1-\mu_t^H}}\right]^{1-\mu_t^H}$$
$$= \left[\theta_H \left(P_{t-1}^H (\pi_{t-1}^H)^{\gamma_H} (\pi_t^T)^{1-\gamma_H}\right)^{\frac{1}{1-\mu_t^H}} + (1-\theta_H)\left(P_{new,t}^H\right)^{\frac{1}{1-\mu_t^H}}\right]^{1-\mu_t^H}$$

where we have exploited the fact that all firms that re-optimize set the same price. Log-linearizing and combining equations previous two equations yields the following aggregate Phillips curve relation:

$$\hat{\pi}_t^H - \hat{\pi}_t = \frac{\beta}{1+\beta\gamma_H}\left(E_t\hat{\pi}_{t+1}^H - \rho_{\bar{\pi}}\hat{\pi}_t^T\right) + \frac{\gamma_H}{1+\beta\gamma_H}\left(\hat{\pi}_{t-1}^H - \hat{\pi}_t^T\right) - \frac{\gamma_H\beta(1-\rho_{\bar{\pi}})}{1+\beta\gamma_H}\hat{\pi}_t^T$$
$$+ \frac{(1-\theta_H)(1-\beta\theta_H)}{\theta_H(1+\beta\gamma_H)}\left(\widehat{mc}_t^H + \hat{\mu}_t^H\right)$$

Retailers of Imported Good

The import sector consists of continuum of retailers that buy a homogenous good in the world market, turn the imported product into a differentiated (consumption and investment) good and sell it to the consumers and capital producers. Different importing firms buy the homogenous good at price $S_tP_t^*$. In order to allow for incomplete exchange rate pass-through to the consumption and investment import prices, we assume local currency price stickiness. Similar to the domestic good retailer case, the importing firms follow Calvo (1983) price setting and are allowed to change their price only when they receive a random price change signal. The firms that are not allowed to re-optimize, update their prices according to the scheme similar to the domestic retailer's case.

The profit maximization problem, which is similar to the retail of the domestic good, yields the following log-linearized Phillips curve relations for imported good inflation;

$$\hat{\pi}_t^F - \hat{\pi}_t = \frac{\beta}{1+\beta\gamma_F}\left(E_t\hat{\pi}_{t+1}^F - \rho_{\bar{\pi}}\hat{\pi}_t^T\right) + \frac{\gamma_F}{1+\beta\gamma_F}\left(\hat{\pi}_{t-1}^H - \hat{\pi}_t^T\right) - \frac{\gamma_F\beta(1-\rho_{\bar{\pi}})}{1+\beta\gamma_F}\hat{\pi}_t^T$$
$$+ \frac{(1-\theta_F)(1-\beta\theta_F)}{\theta_F(1+\beta\gamma_F)}\left(\widehat{mc}_t^F + \hat{\mu}_t^F\right)$$

where $\pi_t^F = P_t^F/P_{t-1}^F$ and $MC_t^F = S_tP_t^*$.

Monetary Policy

In our model, we include a central bank that implements a general interest rate rule to achieve specific policy objectives. The interest rate rule takes the following (log-linear) form:

$$\hat{\imath}_t = \rho_i \hat{\imath}_{t-1} + (1-\rho_i)\left[\hat{\pi}_t^T + \tau_\pi (E_t \hat{\pi}_{t+1}^F - \rho_{\bar{\pi}} \hat{\pi}_t^T) + \tau_y \hat{y}_t + \tau_s (\hat{s}_t - \hat{s}_{t-1})\right] + \epsilon_t^i$$

where ϵ_t^i denotes an independent and identically distributed domestic ("pure") monetary policy shock. The policy rule implies that the monetary authority sets the nominal interest rate, taking into consideration the inflation rate deviation from the time-varying inflation target, the output gap, the rate of exchange rate depreciation, and the previous period's interest rate. The inflation target is assumed to be evolved according to the following stochastic process, which, in our framework allows for nonstationary dynamics as in Ireland (2007):

$$\hat{\pi}_t^T = \rho_{\bar{\pi}} \hat{\pi}_{t-1}^T + \epsilon_t^\pi$$

Market Clearing Conditions

Finally, good market equilibrium is defined by the following equation,

$$Y_t^H = C_t^H + C_t^{eH} + I_t^H + C_t^{H*} + G_t$$

where G_t is AR(1) exogenous spending process as in Smets and Wouters (2007).

IV. Estimation

The model is estimated using Bayesian methods primarily developed by Schorfheide (2000), and later popularized by Smets and Wouters (2003), and Christiano, Eichenbaum, and Evans (2005). In what follows, familiarity with these papers is assumed, limiting the scope of this section to a discussion of the data used, model parameterization, and fit.

Data

The model is estimated using quarterly data over the period 2002:1—2009:4 using both Turkish and U.S. time series shown in **Figure 2**. We have chosen to match the following set of twelve variables: the GDP deflator, core inflation, consumption, investment, the real exchange rate, the short-run interest rate, GDP, exports, imports, foreign output, foreign inflation and the foreign interest rate. As in Adolfson and others (2007), the non-stationary technology shock induces a common stochastic trend in the real variables of the model. To make these variables stationary we use first differences and derive the state space representation for the following vector of observed variables:

$$Y_t^{obs} = \{\pi_t^h, \pi_t, \Delta lnC_t, \Delta lnI_t, \widehat{rer}_t, \mathrm{i}_t, \Delta lnY_t, \Delta lnC_t^{H*}, \Delta lnM_t, \Delta lnY_t^*, \pi_t^*, i_t^*\}$$

As discussed above, the various regimes changes, structural breaks, and their attendant affects on the Turkish time series suggests that utilizing a longer time span could yield to spurious inference. In fact, the sample period under consider captures the episode when the CBRT was adopting inflation targeting (initially implicitly, and the explicitly starting in 2006).

Nonetheless, while the sample is clearly shorter than desired, other papers by prominent authors have used samples with similar length including Del Negro and Schorfheide (2008). Regarding the foreign variables, U.S. time series were used primarily because that is where the recent global financial crisis originated, as well as the fact that the U.S. dollar is still the global reserve currency. We intend to use Euro area data, as well as include a few other time series (including real wages and hours) as we refine the paper.

Calibrated parameters

Because our model is stationary around a stochastic trend, its strength lies in the ability to be able to parameterize the variables that affect the cyclical properties of the data, rather than the steady state values. To this end, as in many other studies (see, for example, Christiano and others, 2010), the parameters the pin down key steady state relationships are calibrated (which could be thought of an infinitely strict priors), as summarized in **Table 2**.

Prior distributions of the estimated parameters

The remaining 38 parameters, shown in **Table 3**, are estimated. These parameters determine the degree of the real and nominal rigidities, the monetary policy stance, as well as the persistence and volatility of the exogenous shocks. The table shows the assumptions pertaining to the choice of distribution, the means, standard deviations or degrees of freedom.

The choice of priors is in line with the literature. General principles guiding the choice of the distributions are as follows: For parameters bounded between zero and unity, the beta distribution was used. For those assumed to take on positive values only (standard deviations), the inverse gamma distribution was used. Lastly, for unbounded parameters, a normal distribution was chosen.

It may also be useful to compare some parameters choices across some selected papers. For the Calvo (1983) parameters, we set the mean to 0.5 as in Teo (2009). Similarly, the indexation parameter is set to 0.5 as well, as in Adolfson and others (2007). Turning to the baseline monetary policy rule, interest rate persistence takes a value of 0.7, which is in line with Elekdag and other (2006). In line with the Taylor principle, the responsiveness to inflation was set at 1.4, slightly lower than in other studies, including, for example, Garcia-Cicco (2010). The habit persistence parameter is chosen to be 0.7 as in Adolfson and other (2007), whereas the investment adjustment cost parameter is relatively lower. Turning finally to the shocks, the persistence parameter was set at 0.8, lower than in Adolfson and other (2007) who use 0.85, but higher than Elekdag and other (2006) as well as Garcia-Cicco (2010), both of which use 0.5. The standard deviations of the shocks are centered around 0.5 (with an uninformative prior), which lies in the 0.1—0.7 set out in Adolfson and other (2007) with the view that we are estimating the model using the data from an emerging market.

Posterior distributions of the estimated parameters

The posterior estimates of the variables are also shown in **Table 3**. In general, the parameter estimates are in line with those found in other studies. While comparing parameter estimates across studies is potentially useful, three important issues should be kept in mind. First, various studies consider distinct countries. For example, Garcia-Cicco (2010) considers Mexico (which exports a sizable amount of oil), Elekdag and other (2006) investigate Korea, Teo (2009) focuses on Taiwan, and Adolfson and other (2008) examine Sweden, not to mention closed-economy counterparts focusing on the United States and the euro area as done in Christiano and others (2008). Second, just as the structural features are the economies investigated are different, sample periods and choice of time series used also differ. For example, this paper deliberating includes the arguably most intense periods of the recent global financial crisis, while many other studies do not. Lastly, while most of the models build upon a common core, important differences still remain, most relevantly, for example, in the choice of the monetary policy rule used. In sum, country-specific, modeling, sample period, and data differences should be recognized when comparing posterior estimates across various studies.

We now compare some selected posterior estimates with those found in some other estimated open economy models. Starting off with nominal rigidities, we find the wage-Calvo parameter of 0.6, which implies that wages are adjusted on average every 2.5 quarters. Relatedly, the parameter dictating the degree of wage indexation is also found to be 0.6, implying that the wage Philips curve has a significant backward looking component. These findings are quite close to those presented by Adolfson and other (2007) and Teo (2009). As for the real rigidities, are estimates regarding habit formation and investment adjustment costs are 0.9 and 4.3, respectively. Regarding the former, Garcia-Cicco (2010) finds an estimate of 0.8, and as for the latter, Teo (2009) estimates the parameter to be 3.2.

Comparison of estimated policy rules is much more challenging because various studies focus on substantially different specifications. For example, Teo (2009) uses a money-based postulation, whereas Adolfson and others (2007) include the real exchange rate, as well as output growth and the change in inflation along with the more typical output gap and deviation of inflation from target. With these considerations in mind, we first discuss the interest smoothing parameter which is found to be 0.6, similar to that in Elekdag and other (2006). As for the responsiveness of inflation deviation from target, our estimate is 1.5 (in line with the original proposal by Taylor, 1993), which is close to the value of 1.6 found by Adolfson and others (2007). The responsiveness the nominal exchange rate depreciation is smaller, and responsiveness to the output gap takes on an even lower value of 0.1 echoing the findings of Elekdag and others (2006) as well as Adolfson and others (2007).

Turning to the exogenous shocks, we start off by discussing persistence. The persistence parameters of the stationary and unit root technology shocks are found to be 0.7 and 0.4, respectively. Regarding the former, Elekdag and others (2006) as well as Adolfson and others (2007) find a value closer to 0.9, and as for the latter, Teo (2009) presents an estimate of 0.5. While the standard deviations of the unit root technology and monetary policy shocks are found to be 0.1, similar to that in Adolfson and others (2007), our estimate of the preference shock, for example, is at least twice as large.

An initial assessment of model fit

In terms of assessing the fit of the model, we start off by comparing the data with the baseline model’s one-sided Kalman filter estimates of the observed variables, and then consider model robustness in the following section. The data and the filtered variables are shown in **Figure 2** indicating that the in sample fit is generally satisfactory. That said, the fit of the model deteriorates markedly for a few related variables. Specifically, real variables summarizing the external sector deviate from the model’s predictions significantly. Foreign output, exports, the real exchange rate, and imports, which are all interconnected seem to differ from what the model predicts, but this should not be too surprising for several reasons. First, these types of models have difficultly tracking the dynamics of the real exchange rate. Several authors note that exchange rates are a puzzle not just because they are volatile, but also because they seem to be 'disconnected' from the real economy, as discussed in by Devereux and Engel (2002), Duarte and Stockman (2005), and Obstfeld and Rogoff (2000). Second, our sample includes the most intense period of the recent global financial crisis including the attendant collapse in global trade (Blanchard and others, forthcoming). Intuitively, the model's external linkages seem to have difficulty replicating the unprecedented nature of this period. In contrast, the predictions of the model are remarkably close to the data for the rest of the variables. The model's consumption and investment predictions closely mimic that of the data (with correlation coefficients of 0.96 and 0.99, respectively). Model-generated output seems to capture the patterns in the data well (the correlation is 0.61), despite the discrepancies between the external-sector related variables as noted above. Lastly, the model and data track each other well with respect to the interest and inflation rate series, capturing the downtrend in these variables during the disinflation process in Turkey. As we refine the paper, we intend to complement the discussion above by comparing moments generated from the model with those in the data as well as appraising forecast performance against less structured vector autoregressions.

V. Sensitivity Analysis

After the initial appraisal of the model, we can investigate the importance of the various features of the model that differentiate it from its New Keynesian core. In what follows, we either reduces the degree of certain nominal and real frictions, omit a shock process, or evaluate another policy rule, all of which serve as another assessment of the robustness of the estimated model. The results are summarized in **Table 4**, which depicts the log data density of the various models, and the posterior odd ratio between the baseline specification versus the competing model.

Using the posterior odds ratio as are decision metric, the baseline model seems to outperform the other competing models. By way of interpreting the posterior odds ratios, we adapt the guidance provided by Jeffreys (1961) which suggests that a ratio in the 10–100 range provides strong to very strong evidence in favor of our baseline. In this context, several results are worth emphasizing. First, the exclusion of the financial accelerator mechanism is decisively rejected in favor of the baseline model, which underscores the importance of incorporating such financial frictions in models, particularly when investigating emerging markets, as result also discussed extensively in Elekdag and others (2006). The baseline is favored to models with low nominal and real rigidities as many of the ratios easily exceed 100. Second, turning our attention to the role of structural shocks, the table indicates the importance of technology shocks. Aguilar and Gopinath (2007) have argued for the importance of trend shocks and Justiniano and others (2007) for the critical role of investment-technology shocks in accounting the variability of output dynamics. Demand shocks also seem to be important, as models without preference of government spending shocks are rejected in favor of the baseline. As expected, the model is decisively chosen in contrast to a specification where the foreign output shock is eliminated. Financial shocks (financial uncertainty and the risk premium—UIP—shocks) are seem to be important but to a lesser degree. Also, a specification whereby the persistence parameter of the time-varying inflation target is set to unity is also rejected relative to the baseline. Third, we consider four alternative monetary policy rules, all which are less favorable with respect to the baseline specification. In each of these rules, the depreciation of the nominal exchange rate is dropped, and in some cases, other variables are included. The third and fourth rules—which are rejected by the data—consider an interest rate rule where the central bank focuses on year-over-year inflation and its lead. Finally, the last rule corresponds to a fixed exchange rate regime, which, intuitively, is also strongly rejected in favor of the baseline model. It should be underscored that these rules are empirical interest rate rules and do not represent the exact reaction functions of the monetary authority. That being the case, as in other studies (Lubik and Shorfheide, 2007, Elekdag and others, 2006, as well as Adolfson and others, 2007), it seems that an exchange rate term is preferred by the data, which may serve as a proxy capturing the forward-looking nature of monetary policymakers.

VI. MONETARY TRANSMISSION MECHANISM

This section seeks to further understand the dynamics of the estimated model. It starts off by considering the propagation of various shocks commonly examined in the literature, and then turns to the investigation of the monetary transmission mechanism in Turkey during the recent inflation targeting regime.

Model dynamics

In this subsection, examine the dynamics of what could be considered demand, supply, and external shocks under the baseline model specification, as well as under two alternative specifications, in particular, (i) in a model without the financial accelerator, and (ii) in a model that operates under a fixed exchange rate regime.

The main results are depicted in **Figure 3**, which is split into two columns, specifically, the left side considers the case with (baseline) and without the financial accelerator operational, whereas the right side contrasts the baseline specification to that of a model with a fixed exchange rate regime. In each case the baseline dynamics is represented with the black thick line, where as the other models are shown with the dashed lines. We consider a preference (demand), domestic markup (supply), and foreign interest and output (external) shocks, and at the moment focus on the dynamics responses of output to these shocks.

Two major themes are revealed upon closer inspection of the impulse responses. First, as expected, economic contractions are much more severe under the fixed exchange rate regime. The is standard textbook macroeconomics: the exchange rate acts like a shock absorber mitigating the degree of real adjustment the economy has to undergo when buffeted by the shocks. Second, for the most of the shocks, the financial accelerator amplified there impact, leads to sharper downturns. The shocks cause a deterioration of net worth, thus raising the external finance premium, thereby leading to a more acute contraction of investment

The monetary transmission mechanism in Turkey

It may be useful to start this subsection with a similar exercise conducted above, namely, a comparison of the baseline model with specifications without the financial accelerator. The impulse response to a one unit monetary tightening shocks are shown in **Figure 4.** A one unit increase in the policy rate brings about a slowdown in the economy without the financial accelerator primarily because the opportunity cost of investment and current consumption rises. Under the baseline economy (which incorporates the financial accelerator), higher interest rates depress asset prices bringing about a deterioration in net worth. Weaker balance sheet fundamentals cause an increase in the risk premium which raises the opportunity cost of investment above and beyond that generated by the monetary tightening. As indicated in the figure, the sharper contraction of investment which is the primary determinant of the deeper slowdown.

We now turn our attention the monetary transmission mechanism, which according to Taylor (1995), is the process through which monetary policy decisions are transmitted into changes in real GDP and inflation. Because the model is estimated over the 2002–2009 period, it is particularly well suited to appraise the current state of the monetary transmission mechanism during the (implicit and full-fledged) inflation targeting regime.

The implications on output, as well as the real and nominal interest and inflation rates to a one standard deviation contractionary monetary policy shock are shown in **Figure 5**. The 90 percent bands around the impulse response functions take into consideration the stochastic nature of the shock as well as parameter uncertainty. As shown in the figure, the nominal interest rate brings about a slowdown which generates deflation in the short run. In fact, inflation reverts back to its mean in about six quarters, which actually lies in the center of the CBRT's control horizon it presents in its inflation reports. However, while the impact of the monetary tightening dissipates after two quarters, because the persistent inflation series takes an additional year to converge back to equilibrium, the real interest rate remains in positive territory for about a year, continuing to act as a drag on growth. This is one of the important factors why the impact of the one-time monetary tightening seems to still have sizeable affects on output even after several years elapse. The main takeaway in this subsection is that a one-time monetary policy shock takes six quarters to fully feed through the inflation rate.

VII. HISTORICAL DECOMPOSITIONS

The main objective of this section is to understand the contributions of the exogenous shocks to output growth. There are too many shocks in the model to study the individual role of each on (year-over-year) output growth over the 2002–2009 period. To this end, **Figure 6** shows output growth along with three groups of shocks. The first group, "monetary policy," includes the "pure" monetary policy shock and the time-varying inflation target shock. The idea is that while the pure shock captures short-term deviations from the interest rate rule, the inflation target shock captures lower frequency changes. In other words, while the pure shocks might be thought of a discretionary deviation of the short-term nature, the inflation targets shocks might serve to capture more protracted changes in the stance that cannot be otherwise captured as the coefficient of the interest rate rule are fixed over the sample.

The second group includes the foreign demand, financial uncertainty, and risk premium shocks. These are the likely shocks most likely to be associated with the recent global financial crisis. Intuitively, the collapse in world trade is proxied with the foreign demand shock. The risk premium (UIP) is typically used to imitate a sudden stop shock (in parlance of Calvo and other, 2004), that is a shock that is causes large capital outflows (see, for example, Gertler and others, 2007). Such a shock would serve to capture the financial aspect of the recent crisis. Finally, this group includes a "financial uncertainty" shock. This shock directly affects entrepreneurial net worth and has been used in various forms by Elekdag and others (2006), Curdia (2007), Christiano and others (2010), and more recently by Ozkan and Unsal (2010). In a sense, the shock could be thought of capturing counterparty risk, a key consideration during the global financial crisis. For example, heightened uncertainty regarding the distribution of cash flows (the concept of Knightian uncertainty, formalized by Knight, 1921), could make valuation virtually impractical impair the value of collateral used to facilitate financial intermediation. The last group, "other demand and supply," includes the remaining shocks. Later below, we will highlight some of the individual shocks in the last two groups.

The main takeaway of this section, and of the paper, is shown in **Figure 6**. Specifically, we see that monetary policy (which includes the pure monetary policy and time-varying inflation target shocks) positively contributed to output growth during the crisis. The positive growth contributions of monetary policy really start gaining momentum in 2009Q1 when the CBRT cut interest rates by 450 basis points (which using quarterly data corresponds to a cut of 382 basis points). While not the main focus on the paper, its also notable that during the earlier part of the sample, monetary policy was suppressing growth in part of the disinflation process, but then seems to have supported economic activity during 2004–2006.

To better understand the effects of the second group of shocks (foreign demand, risk premium, financial uncertainty), each them is shown separately along with the (demeaned, year-over-year) GDP growth in **Figure 7**. To start off, however, note that the risk premium (UIP) shock does not seem to have an important affect on growth. A key reason could be that in contrast to Cespedes, Chang, and Velasco (2004) as well as Elekdag and Tchakarov (2007) we follow the initial specification of Gertler and others (2007) and posit that entrepreneurs borrow in domestic- rather the foreign-currency denominated debt. This arguable would reduce the role of risk premium (UIP) shocks, an important determinant of exchange rate dynamics. It is worthy to investigate how the contributions of the uncertainty and risk premium shocks are affected when debt is denominated in foreign currency.

The role of the shocks depicted in **Figure 7** could be analyzed in three phases. During the first two year of the sample, the lingering effects of the U.S. equity market crash and financial scandals related to the bankruptcies of Enron and WorldCom (the largest in U.S. history at the time) seems to be reflected in the uncertainty and foreign demand shocks. However, as we approach 2005, the positive contribution of the foreign demand shocks to growth starts gaining momentum. The healthy growth rate of the global economy that solidified in 2005 certainly is one reason why foreign demand seems to have supported Turkish growth during this period. Then, during the last quarter of 2008, emerging markets started feeling the brunt of the global crisis. According to the figure it was initially the financial uncertainty shock that negatively impacted Turkish growth, followed by the foreign demand shock.

Five of the remaining shocks seems to warrant further attention, and are therefore shown in **Figure 8** once again with the growth time series. Consider first the preference shock which is the last demand shock we investigate. The preference shock starts acting as a drag on growth during the last quarter of 2008. As the crisis intensified (with the collapse of Lehman Brothers), uncertainty seems to have increased. In line with precautionary savings models, this would cause a decline in consumption, which is what the preference shock seems to capture. This shocks discount future consumption by less and therefore current consumption is substituted by savings reducing domestic demand. The remaining shocks could all be classified as supply shocks in one way or another. In contrast to some other studies, there seems to be a limited role for the cost push and stationary technology shocks. By contrast, the unit root technology shock seems to be the most important of the supply shocks, echoing the result of Aguilar and Gopinath (2007) who argue that these types of trend shocks are key determinants of business cycle fluctuations across emerging markets. Lastly, there seems to be an important contribution by the investment-specific technology shocks, which is a point made by Justiniano and others (2007).

VIII. THE ROLE OF MONETARY POLICY DURING THE CRISIS

In this penultimate section of the paper, we conduct some counterfactual experiments with the goal of answering the following question: If the post-2001 financial reforms, the adoption of the flexible exchange rate regime, and implementation of active countercyclical monetary policy were not carried out, how much deeper would the recent recession been? As will be discussed below, that answer is that the recession would have been significantly more severe. In fact, these policies taken altogether seem to have added a growth contribution of up to about 10 percent on average

Before continuing it is useful to consider three important post-2001 reforms that we focus on in this section. First, and foremost, the CBRT starting implementing an inflation targeting regime—implicit initially, then explicitly as of 2006. Second, and relatedly, the fixed and heavily managed exchange rate regimes of the past were abandoned in favor of a flexible exchange rate. Third, with the financial reforms in wake of the virtual collapse of the banking sector, the risk profile of the Turkish economy decreased markedly in the aftermath of the 2001 crisis. In terms of a summary indicator, consider the leverage ratio in **Table 1**. The average leverage ratio across a cross section of firm decreased to 2 in 2007 from a value of 3 in 2000.

Therefore in what follows, we focus on four counterfactual simulations, and compare them with the actual realization which is our baseline. Under this baseline, the monetary policy framework operates under a flexible exchange rate regime, follows the estimated baseline interest rate rule which reacts to the output and allows for deviations from the rule (in the form of the monetary policy shocks discussed above). In this context, the four counterfactual experiments are as follows:

- **No monetary policy shock**: this counterfactual posits strict adherence to the baseline empirical interest rate rule. It is a simulation that excludes the monetary policy shocks (both the pure monetary policy and time-varying inflation target shocks). It serves to address the following question: What would the dynamic of output growth have been if the CBRT did implement any discretionary loosening (deviations from the interest rate rule) during the crisis?
- **No response to the output gap**: under this counterfactual, the output gap coefficient in the empirical interest rate rule is set to zero. Furthermore, as these counterfactuals are "cumulative," this scenario also sets the monetary policy shocks to zero. It serves to address the following question: What would the dynamic of output growth have been if the CBRT did implement any discretionary loosening *and* did not take into consideration the state of the output gap when formulating its policy decisions during the crisis?

- **Peg**: in this counterfactual, the CBRT is assumed to implement a strict fixed exchange rate regime. Intuitively, monetary policy does not react to the output gap, and there are no discretionary deviations from the rule (which solely focuses on stabilizing the nominal exchange rate). As before, this scenario preserves the "cumulative" nature of these counterfactuals. Here we seek to address the following question: What would the dynamic of output growth have been if the CBRT was implementing a fixed exchange rate regime?

- **Peg with heightened financial vulnerability**: under the last counterfactual, the CBRT is presumed to operate a fixed exchange rate regime as above, but the leverage ratio is calibrated to correspond to the case where it equals 3 in line with the value in **Table 1** during 2000. This final counterfactual serves to address the following question: What would the dynamic of output growth have been if the CBRT was implementing a fixed exchange rate regime *and* the economy was financially more vulnerable?

The (demeaned, year-over-year) growth rates under the baseline as well as those corresponding to the four counterfactuals as shown in **Figure 9**. As was to be expected, output growth declines the most under the last counterfactual (peg with heightened financial vulnerability). The lack of the exchange rate to serve as a shock absorber and the amplified effects of the financial accelerator mechanism owing to heightened financial vulnerability increase the susceptibility of the economy to the shocks that ensued during the global crisis.

The role of the other counterfactuals is more easily differentiated when we consider the level of output in contrast to the growth rates. **Figure 10** depicts the level of output to 100 during the first quarter of 2008 (the pre-crisis peak) allowing the reader to better distinguish the (cumulative) effects of each counterfactual on output. As shown in the figure, the four facets of monetary policy, namely the (1) reduced financial vulnerabilities, (2) adoption of a flexible exchange rate regime, (3) reaction to the output gap, and (4) discretionary departures from the interest rate rule (consistent with the achievement of the inflation target) all seem to have had clearly beneficial implications in terms of softening the impact of the crisis on economic activity.

The precise contributions to growth under the various counterfactuals are shown in **Table 5**. The table focuses on the arguable most intense period of the crisis, but this is still open to interpretation. Therefore we consider two crisis episodes that cover the period 2008Q4–2008Q4 or 2009Q1–2008Q4.

The values under columns [0] through [4] show either the average or cumulative contributions to growth during these two episodes. In particular, each column indicates the contribution to growth when as each one of the facets of monetary policy is implemented. For example, reduced financial vulnerabilities under column [4] add 2.4 percent to growth in the 2009Q1–2008Q4 sample. In addition to this effect, by adopting a flexible exchange rate regime as denoted under column [3], a 3.11 percent contribution to growth follows during the 2009Q1–2008Q4 sample. We also include the values calculated in Chrisitiano and others (2007) that consider the role of monetary policy shocks for the United States and the euro area. However, they only consider the pure monetary policy shocks (which exclude the inflation target shocks), and therefore, we also include these figures under column [0] for comparability. The last column summarizes the four counterfactuals and we also provide the cut in the Turkish policy rate (calculated using quarterly time series in line with the rest of the analysis).

It may be useful to first compare the results in **Table 5** with another study. Turning our attention to column [0], we see that the average contribution of the pure monetary shocks to output growth of around one percent (0.98 or 0.78 percent depending on the episode chosen) lies in between the values found by Chrisitiano and others (2007) for the U.S. (0.75 percent) and the euro area (1.27 percent). The four-quarter cumulative contribution of 3.14 percent is also remarkably close to the U.S. four-quarter cumulative contribution of three percent.

Add the time-varying inflation target shocks, intuitively raises the contributions of monetary policy to output growth. In fact, as portrayed in **Figure 9** and **Figure 10**, each of the facets of monetary policy results in positive contributions to growth, and taken altogether, yields a growth contribution of about 10 percent on average as indicated in the last column of **Table 5**.

As a final depiction of these counterfactuals, **Figure 11** summarized the findings of the table as well as the results in this section. The figure indicates that the average contributions of each the facets of monetary policy are important in terms of output growth. In sum, without the post-2001 financial reform, the adoption of the flexible exchange rate regime, and active countercyclical monetary policy, the impact of the recent global financial crisis would have been substantially more severe.

IX. Summary and Main Policy implications

This paper develops and estimates a structural model using Turkish time series over the 2002–2009 period corresponding to the CBRT's gradual transition to full-fledged inflation targeting. The main question this paper seeks to address is as follows: If the post-2001 financial reforms, the adoption of the flexible exchange rate regime, and implementation of active countercyclical monetary policy were not carried out, how much deeper would the recent recession been? The short answer is that the recession would have been significantly more severe.

Counterfactual experiments are conducted to investigate the growth implications of the following four facets of monetary policy, namely the (1) reduced financial vulnerabilities—a vital element for the monetary transmission mechanism, (2) adoption of a flexible exchange rate regime, (3) reaction to the output gap, and (4) discretionary departures from the interest rate rule (consistent with the achievement of the inflation target). All of these policy reforms seem to have had clearly beneficial implications in terms of softening the impact of the crisis on economic activity. In fact, these policies taken altogether seem to have added a growth contribution of up to about 10 percent on average.

As a byproduct of our estimated model, we can shed light on the monetary transmission mechanism in Turkey during this recent period. In sum, a one-time monetary policy shock takes six quarters to fully feed through the inflation rate, while the effects on output wane only after several years elapse.

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Table 1. Turkey: Financial Ratios Across Selected Industries

2007	Value added	Firms	CR	ATO	**Leverage**	NI/NS	ROA	ROE
All		7,352	140.2	1.0	**2.01**	5.3	5.1	10.3
Agriculture	7.3	48	174.6	1.0	2.21	5.1	4.1	7.1
Manufacturing	16.6	3,530	164.4	1.3	2.23	3.5	4.2	10.0
Construction	4.8	733	135.0	0.5	2.97	6.7	2.4	12.2
Wholesale/retial Trade	12.1	1,662	145.7	2.1	2.87	1.8	3.4	12.1
Transportation/communication	13.7	360	142.9	1.6	2.45	3.8	3.6	11.7
FIRE/Public administration	21.8	239	175.5	0.6	1.83	20.6	4.0	9.1
Mean		1,095	156.3	1.2	2.43	6.9	3.6	10.4
Median		547	155.0	1.2	2.34	4.4	3.8	10.9
Standard deviation		1,323	17.4	0.6	0.43	6.9	0.6	2.0

2000	Value added	Firms	CR	ATO	**Leverage**	NI/NS	ROA	ROE
All		7,537	114.6	2.7	**2.97**	0.6	1.5	4.6
Agriculture	9.9	96	135.1	2.0	2.55	0.1	1.8	8.8
Manufacturing	20.1	3,901	139.7	1.7	2.56	2.7	3.8	13.0
Construction	5.0	1,004	106.2	1.0	3.85	5.7	3.0	20.1
Wholesale/retial Trade	12.7	1,436	125.5	3.1	3.41	1.7	4.8	22.2
Transportation/communication	12.2	338	113.2	2.3	2.48	0.1	-0.2	7.7
FIRE/Public administration	22.7	154	162.6	1.6	1.81	10.5	8.3	17.8
Mean		1,155	130.4	1.9	2.78	3.5	3.6	14.9
Median		671	130.3	1.8	2.55	2.2	3.4	15.4
Standard deviation		1,445	20.2	0.7	0.73	4.0	2.9	6.0

Source: CBRT and authors' calculations.
Note: CR, ATO, NI, NS, ROA, and ROE denote the cash ratio, total asset turnover, net income, net sales, and return on assets and equity, respectively. Leverage is defined as total assets over equity and NI/NS is the net profit margin. Tabulated values denote industry averages. Averages across all sectors denoted with "All". Descriptive statistics for major sector shown are below each section of the table.

Table 2. Calibrated parameters

Calibrated parameters	Symbol	Value
Discount factor	β	0.9928
Consumption intra-temporal elasticity of substitution	ρ	1
Share of domestic goods in consumption	γ_i	0.75
Investment intra-temporal elasticity of substitution	ρ_i	0.25
Share of domestic goods in investment	γ_i	0.77
İnverse of the elasticity of work effort with respect to the real wage	σ_l	1
Share of capital in production function	α	0.4
Elasticity of marginal depreciation with respect to utilization rate	ϵ	1
Steady state mark up rate for domestically produced goods	μ^H	1.15
Steady state markup rate for imported goods	μ^F	1.15
Markup rate for wages	μ^w	1.15
Share of entrepreneurial labor	$1 - \Omega$	0.01
Steady state external finance premium	χ	1.03
Number of entrepreneurs who survive each period (at steady state)	ϱ	0.9728
Variance of idiosyncratic shock to entrepreneur production	σ_ω	0.4
Fraction of monitoring cost	μ_ω	0.15
Depreciation rate (at steady state)	$\bar{\delta}$	0.035

Source: Authors' calculations.

Table 3. Prior and posterior distributions

Parameter		Prior distribution			Posterior distribution		
Description	Symbol	Type	Mean	Standard deviation/ degree of freedom	Mean	Confidence interval 5%	95%
Calvo parameter							
Domestic prices	θ_H	Beta	0.50	0.10	0.333	0.219	0.449
Import prices	θ_F	Beta	0.50	0.10	0.376	0.279	0.477
Wages	θ_w	Beta	0.50	0.10	0.613	0.484	0.747
Indexation							
Domestic prices	γ_H	Beta	0.50	0.10	0.524	0.354	0.688
Import prices	γ_F	Beta	0.50	0.10	0.482	0.318	0.651
Wages	γ_w	Beta	0.50	0.10	0.592	0.430	0.754
Monetary policy							
Interest rate smoothing	ρ_i	Beta	0.70	0.20	0.584	0.396	0.779
Inflation reponse	τ_π	Normal	1.40	0.10	1.478	1.322	1.629
Output gap response	τ_y	Normal	0.25	0.10	0.118	-0.007	0.237
Nominal exchange rate depreciation response	τ_s	Normal	0.10	0.05	0.164	0.084	0.244
Others							
Export demand elasticity	χ	Normal	0.75	0.20	0.197	0.096	0.297
Export demand interia	ϖ	Beta	0.50	0.20	0.581	0.428	0.731
Habit formation	b	Beta	0.70	0.20	0.924	0.878	0.970
Invesment adjustment cost	ψ	Normal	4.00	0.50	4.229	3.439	5.014
Shock persistence							
Stationary technology	ρ_a	Beta	0.80	0.10	0.733	0.566	0.908
Unit root technology	ρ_ζ	Beta	0.80	0.10	0.415	0.279	0.550
Investment specific technology	ρ_{inv}	Beta	0.80	0.10	0.905	0.866	0.945
Domestic markup	ρ_{μ^h}	Beta	0.80	0.10	0.741	0.570	0.920
Import markup	ρ_{μ^f}	Beta	0.80	0.10	0.691	0.498	0.893
Foreign inflation	ρ_{π^*}	Beta	0.80	0.10	0.756	0.606	0.911
Foreign interest rate	ρ_{i^*}	Beta	0.80	0.10	0.728	0.575	0.886
Foreign demand	ρ_{y^*}	Beta	0.80	0.10	0.899	0.830	0.969
Country risk premium	ρ_ϕ	Beta	0.80	0.10	0.388	0.255	0.516
Preference	ρ_c	Beta	0.80	0.10	0.625	0.431	0.826
Labor supply	ρ_l	Beta	0.80	0.10	0.596	0.440	0.753
Exogenous spending	ρ_g	Beta	0.80	0.10	0.840	0.729	0.952
Net worth	ρ_N	Beta	0.80	0.10	0.566	0.419	0.718
Inflation target	$\rho_{\bar{\pi}}$	Beta	0.80	0.10	0.773	0.664	0.887
Shock volatility							
Stationary technology	σ_a	Inverse gamma	0.50	10.00	0.108	0.077	0.138
Unit root technology	σ_ζ	Inverse gamma	0.50	10.00	0.089	0.068	0.108
Investment specific technology	σ_{inv}	Inverse gamma	0.50	10.00	0.471	0.373	0.568
Domestic markup	σ_{ϵ^H}	Inverse gamma	0.50	10.00	0.118	0.080	0.155
Import markup	σ_{ϵ^F}	Inverse gamma	0.50	10.00	0.136	0.090	0.179
Foreign inflation	σ_{π^*}	Inverse gamma	0.50	10.00	0.072	0.059	0.083
Foreign interest rate	σ_{i^*}	Inverse gamma	0.50	10.00	0.072	0.059	0.083
Foreign demand	σ_{y^*}	Inverse gamma	0.50	10.00	0.096	0.074	0.118
Country risk premium	σ_ϕ	Inverse gamma	0.50	10.00	0.089	0.069	0.109
Preference	σ_c	Inverse gamma	0.50	10.00	0.502	0.207	0.782
Labor supply	σ_l	Inverse gamma	0.50	10.00	0.188	0.101	0.272
Exogenous spending	σ_g	Inverse gamma	0.50	10.00	0.087	0.069	0.105
Net worth	σ_N	Inverse gamma	0.50	10.00	0.148	0.102	0.193
Inflation target	$\sigma_{\bar{\pi}}$	Inverse gamma	0.50	10.00	0.188	0.111	0.268
Monetary policy		Inverse gamma	0.50	10.00	0.074	0.059	0.087

Log data density = 408.004

Source: Authors' calculations.

Table 4. Sensitivity Analysis

		Log Data Density	Δ	e^{Δ}	Posterior odds ratio		Does baseline model's ratio exceed unity?
	Baseline	407.686	0.0000	1.000		1.00	
	Sensitivity to frictions						
1	Financial accelerator	392.610	-15.0769	0.000	3.530E+06	0.96	Yes
2	Low price stickiness	405.690	-1.9963	0.136	7.362E+00	1.00	Yes
3	Low stickness including wages	372.925	-34.7618	0.000	1.250E+15	0.91	Yes
4	Low habit persistence	379.825	-27.8616	0.000	1.259E+12	0.93	Yes
5	Low investment costs	377.874	-29.8122	0.000	8.857E+12	0.93	Yes
	Sensitivity to shocks						
6	Technology (all)	359.201	-48.4851	0.000	1.140E+21	0.88	Yes
7	Investment-specific technology	366.929	-40.7576	0.000	5.021E+17	0.90	Yes
8	Preference	401.203	-6.4838	0.002	6.545E+02	0.98	Yes
9	Government	361.330	-46.3567	0.000	1.357E+20	0.89	Yes
10	Foreign output	268.225	-139.4619	0.000	3.694E+60	0.66	Yes
11	Financial (uncertainty and UIP)	404.866	-2.8205	0.060	1.678E+01	0.99	Yes
12	Unit root inflation target	400.280	-7.4064	0.001	1.647E+03	0.98	Yes
	Sensitivity to policy rules						
13	Drop nominal depreciation (no ΔS rule)	403.802	-3.8844	0.021	4.864E+01	0.99	Yes
14	No ΔS rule with change in output and inflation	406.577	-1.1094	0.330	3.032E+00	1.00	Yes
15	No ΔS rule with yoy inflation	401.766	-5.9207	0.003	3.727E+02	0.99	Yes
16	No ΔS rule with yoy inflation lead	403.420	-4.2665	0.014	7.127E+01	0.99	Yes
17	Fixed exchange rate regime	387.050	-20.6362	0.000	9.166E+08	0.95	Yes

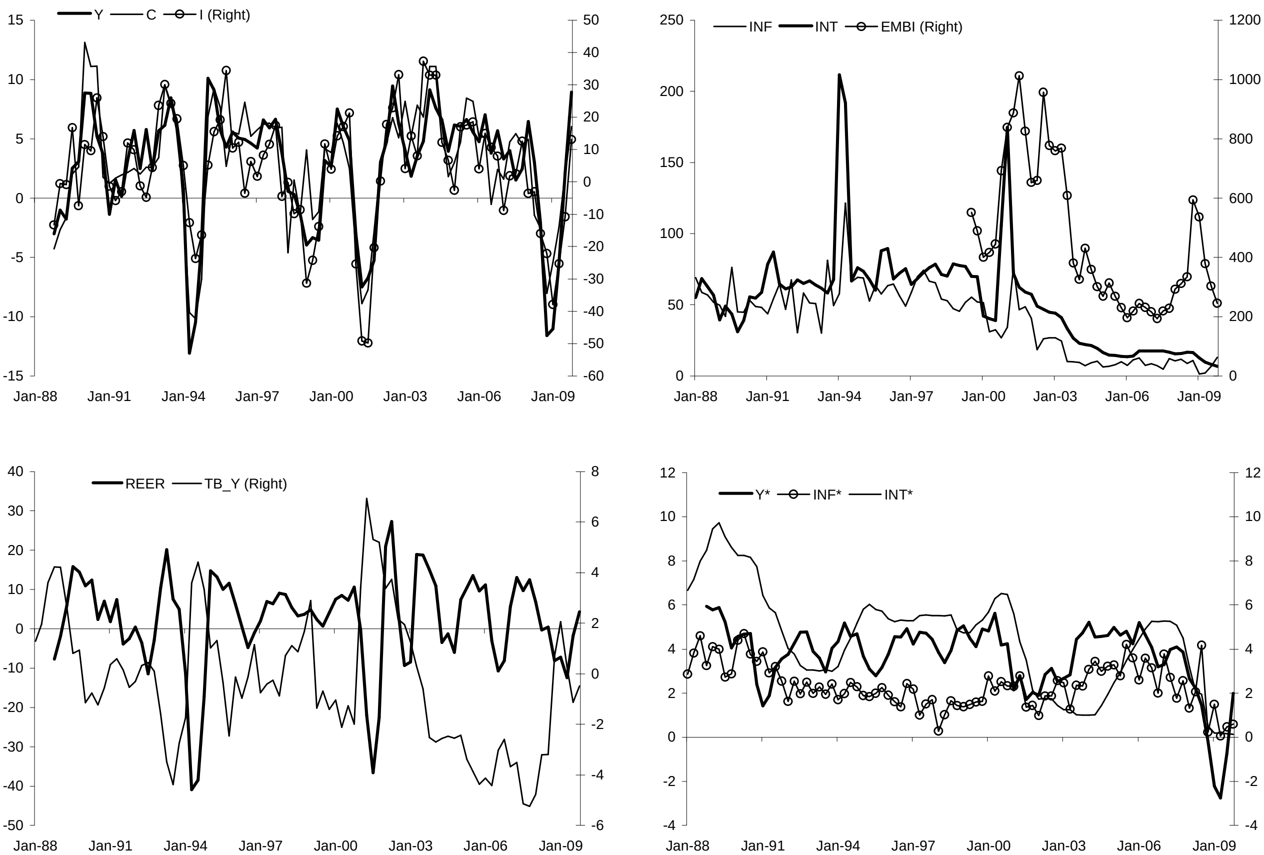
Source: Authors' calculations.

Table 5. The role of monetary policy and financial reforms during the recent global crisis

	Quarters	Cut in policy rate	Growth contributions of monetary policy owing to: [0] Pure Monetary policy shocks	[1] Monetary policy shocks	[2] Responsiveness to the output gap	[3] Flexible exchange rate regime	[4] Reduced financial vulnerability	[5] All factors ([1]—[4])
Average								
2008Q4—2009Q4	5	1.98%	0.98%	1.96%	2.22%	4.19%	2.17%	10.54%
2009Q1—2009Q4	4	2.40%	0.78%	2.26%	2.57%	3.11%	2.40%	10.33%
Christiano and others (2008)								
United States (2001Q2-2002Q2)	4		0.75%					
Euro area (2001q4-2004q4)	13		1.27%					
Cumulative								
2008Q4—2009Q4	5	9.92%	4.90%	9.81%	11.10%	20.95%	10.85%	52.71%
2009Q1—2009Q4	4	9.61%	3.14%	9.02%	10.26%	12.44%	9.60%	41.33%
Christiano and others (2008)								
United States (2001Q2-2002Q2)	4		3.00%					
Euro area (2001q4-2004q4)	13		17.00%					

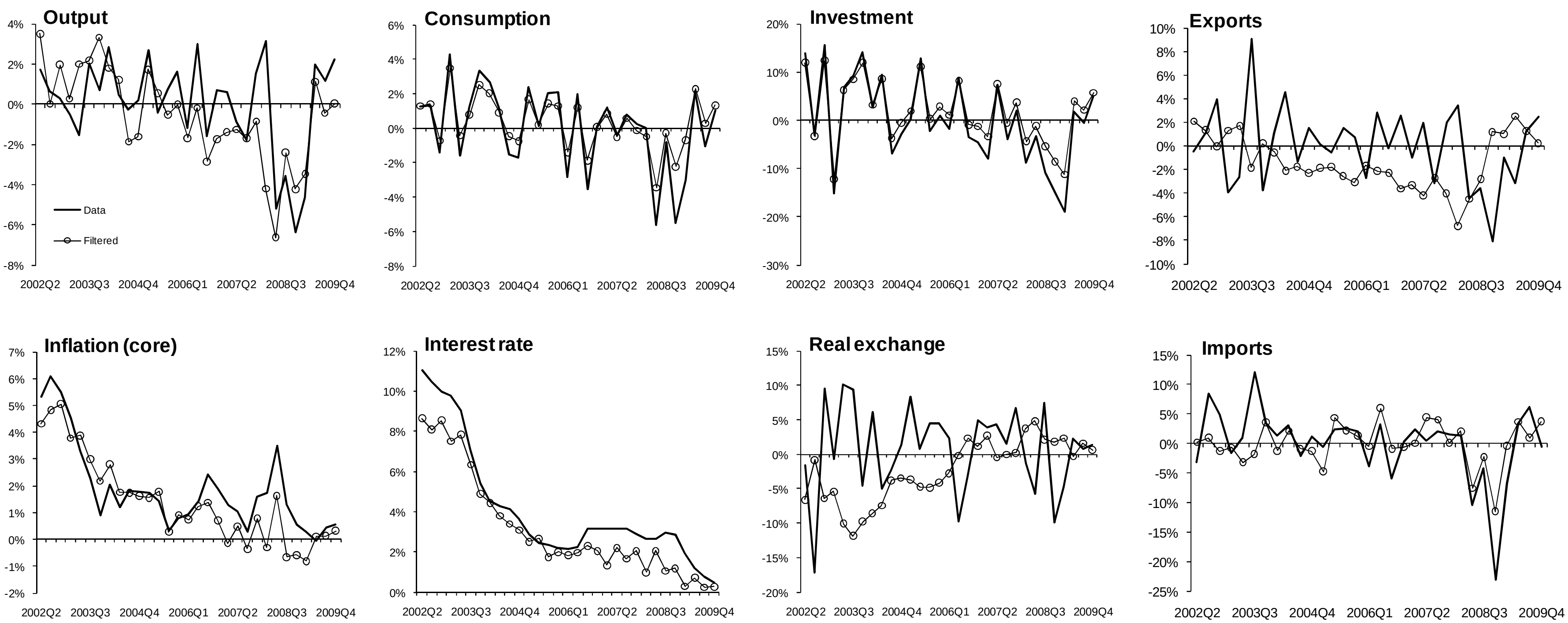
Source: Authors' calculations.

Figure 1. Turkey: Selected Macroeconomic Indicators
(Year-over-year growth rates and levels)



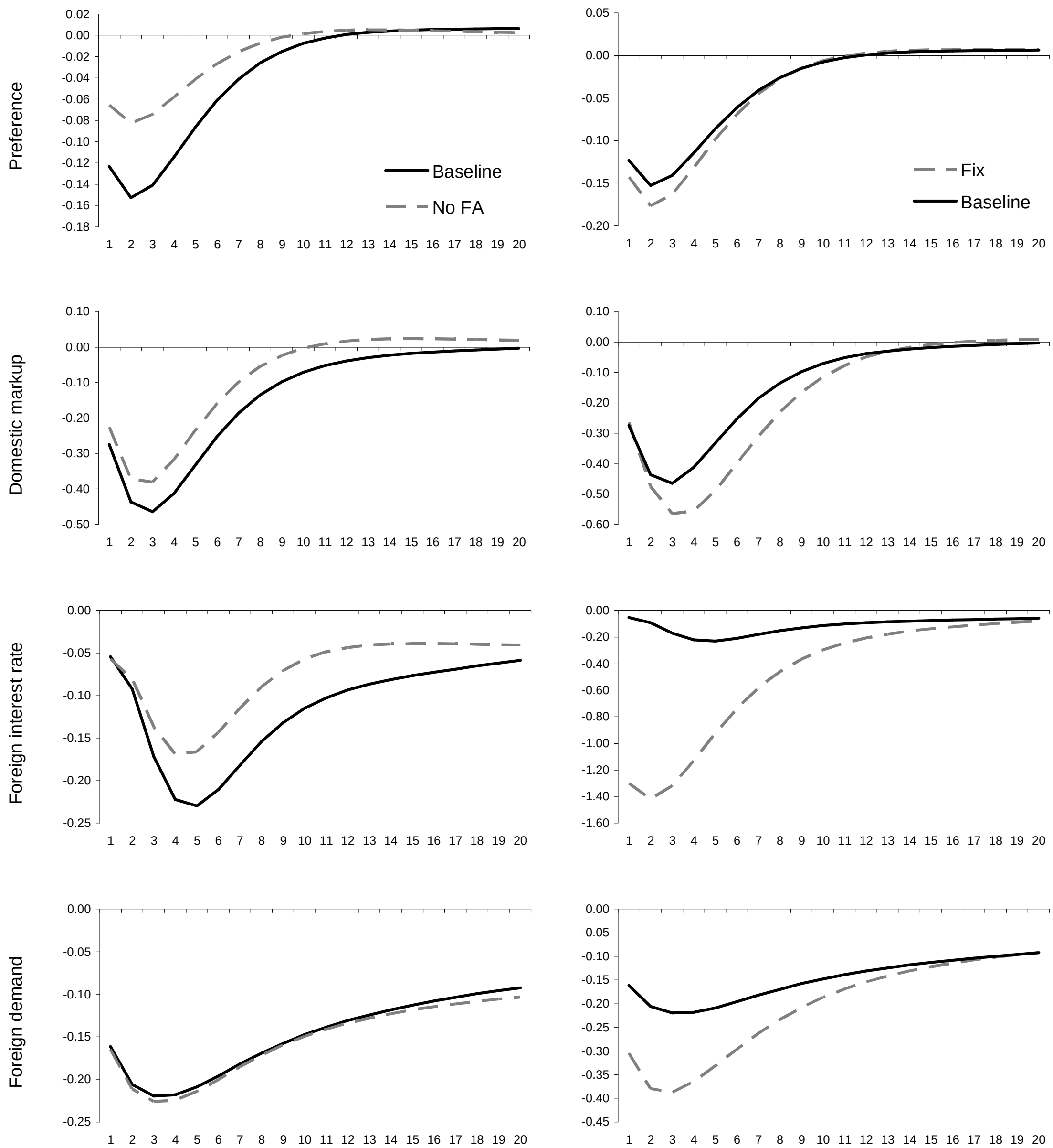
Source: CBRT, Bloomberg, and authors' calculations.
Note: Y, C, I, INT, INF, REER, and TB/Y denote real GDP, real consumption, real investment, overnight interest rates, quarterly inflation rates, real effective exchange rate and the trade balance-to-GDP ratio. EMBI represents JP Morgan's EMBI+ series for Turkey (in basis points). The series with an asterisk represent foreign variables. Y,C, I, and Y* were all seasonally adjusted as was the CPI series used to derive the inflation rates. Y,C, I, Y*, and the REER were logged before the seasonal adjustment, and then their year-over-year growth rates were calculated.

Figure 2. Model predictions versus the data
(Demeand year-over-year growth rates and levels)



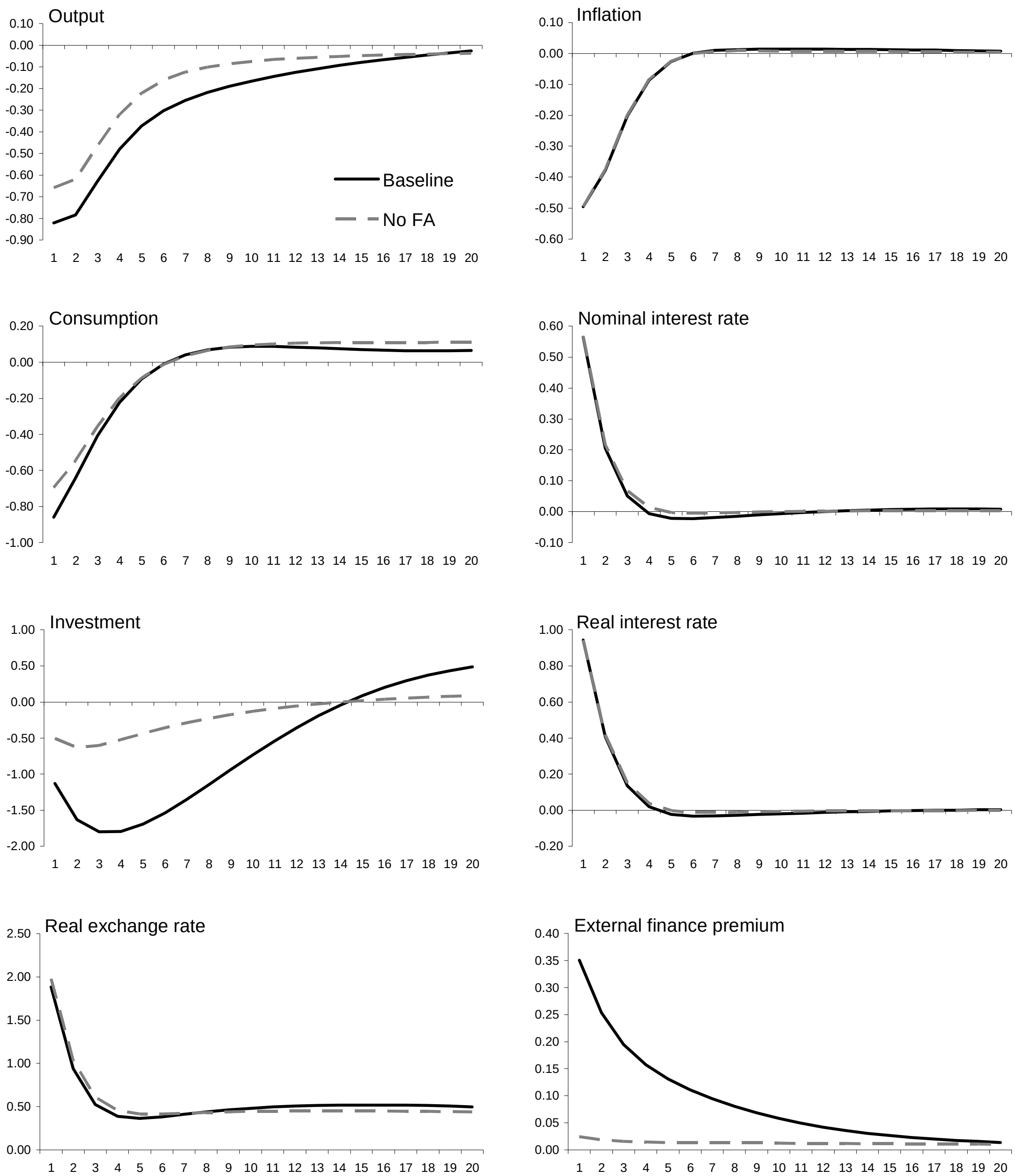
Source: Authors' calculations.
Note: Data in thick black versus filtered thin lines with circles, see text for further details.

Figure 3. Dynamic reponse of output to selected shocks
(Deviations from steady state)



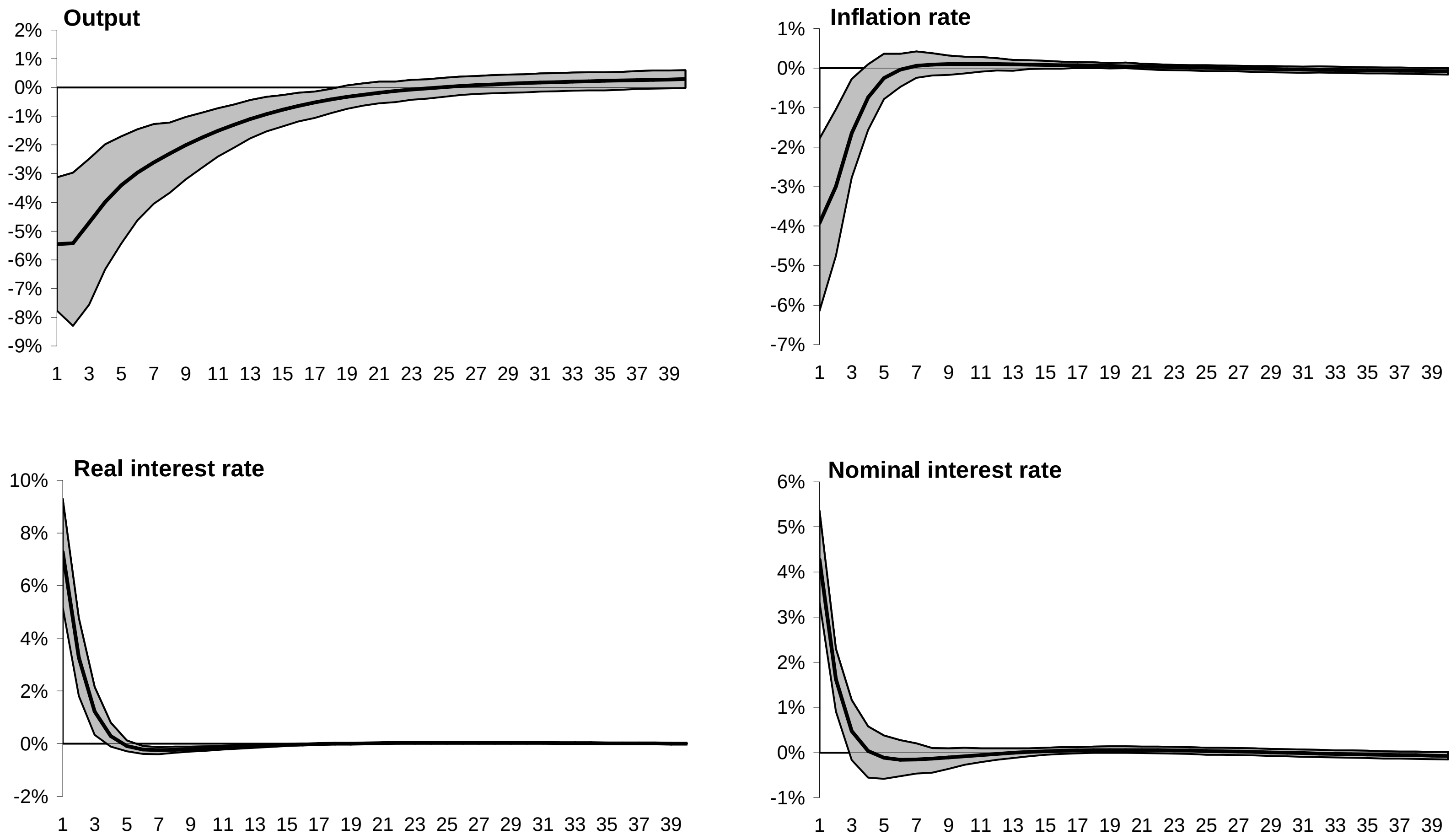
Source: Authors' calculations.

Figure 4. Dynamic reponses to a monetary policy shock
(Deviations from steady state)



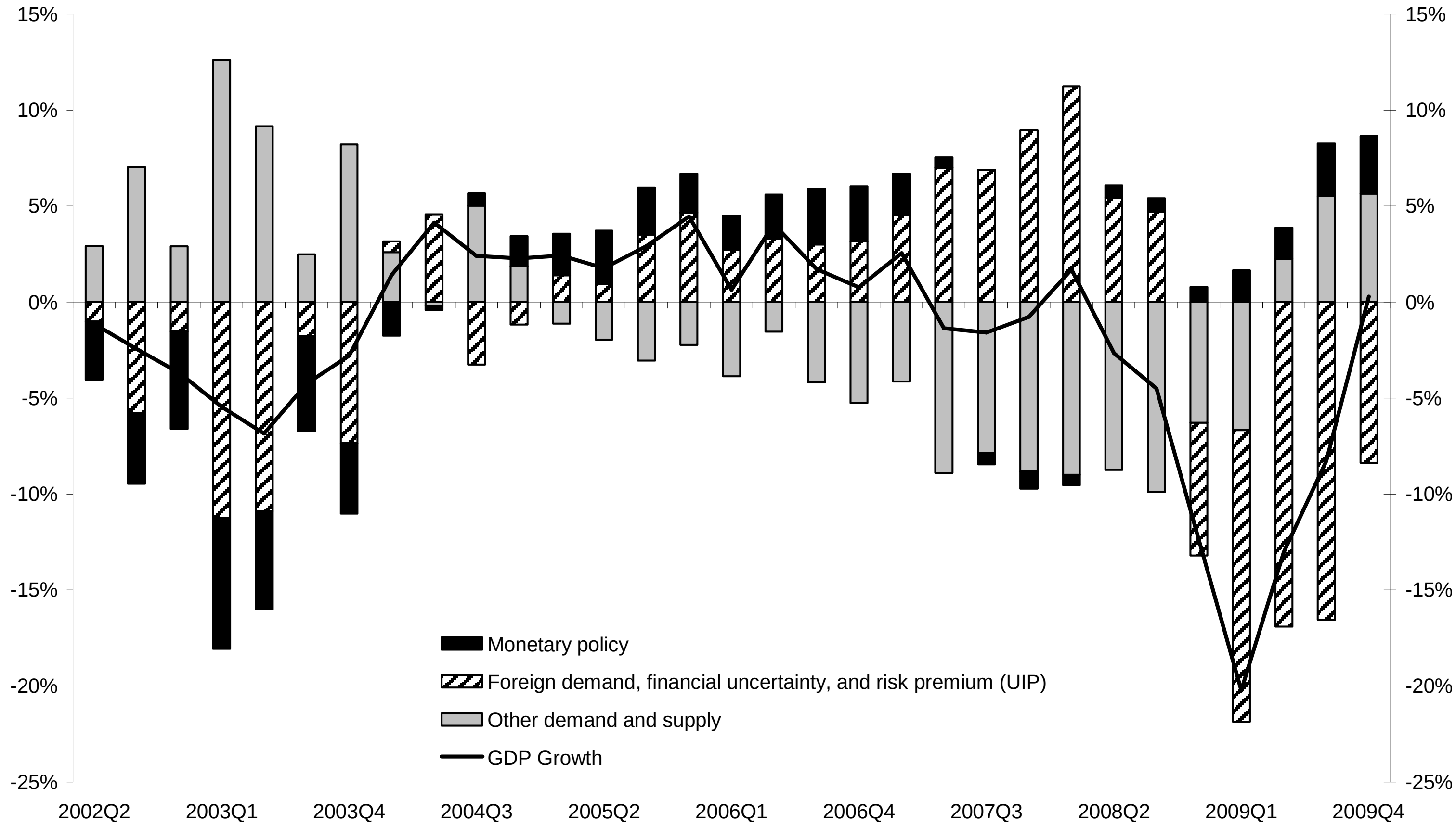
Source: Authors' calculations.

Figure 5. Turkey: Monetary Transmission Mechanism
(Percent deviations from steady state)



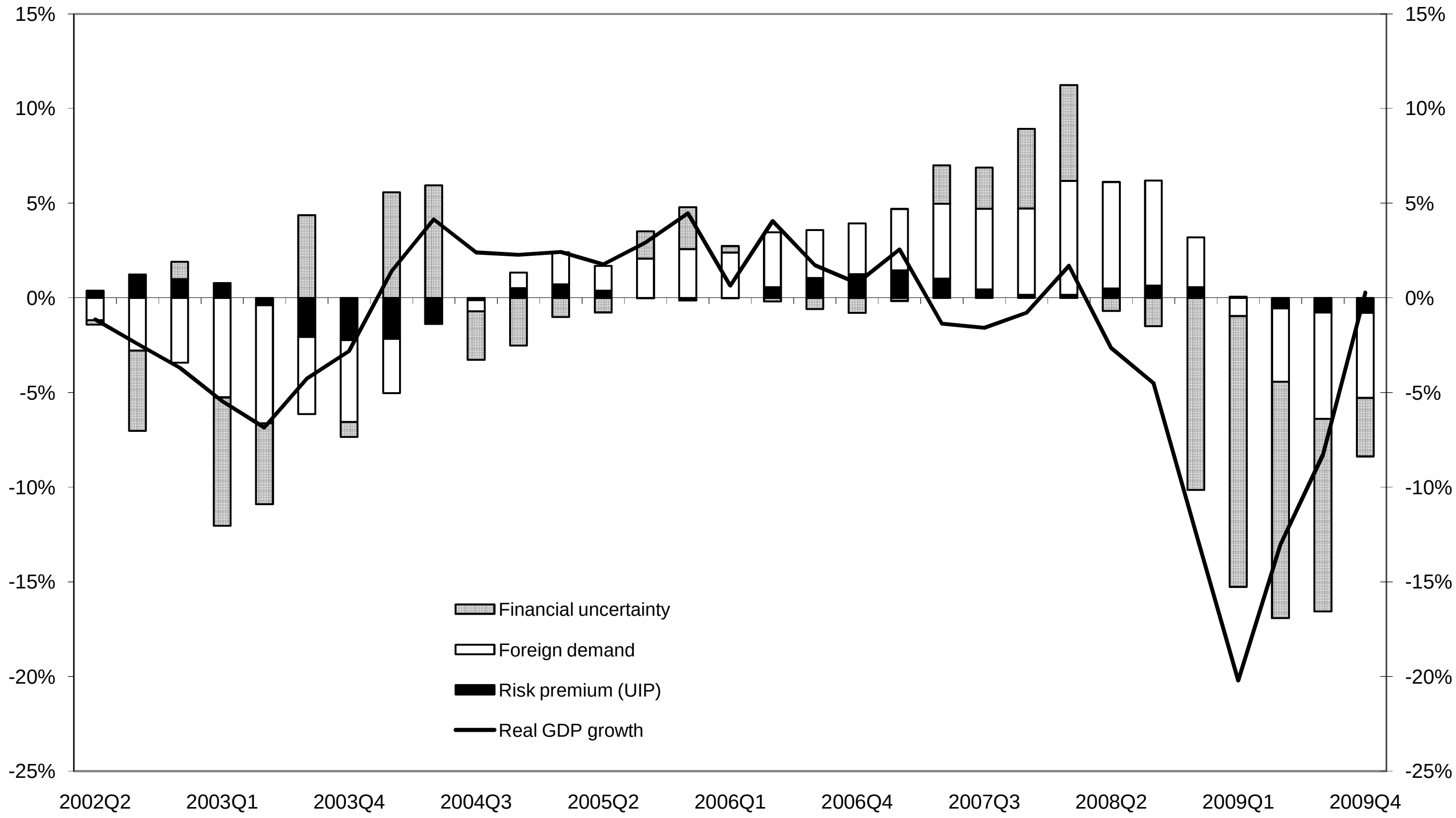
Source: Authors' calculations.

Figure 6. Historical Decomposition of Turkish Growth
(Demeaned year-over-year real GDP growth and shocks)



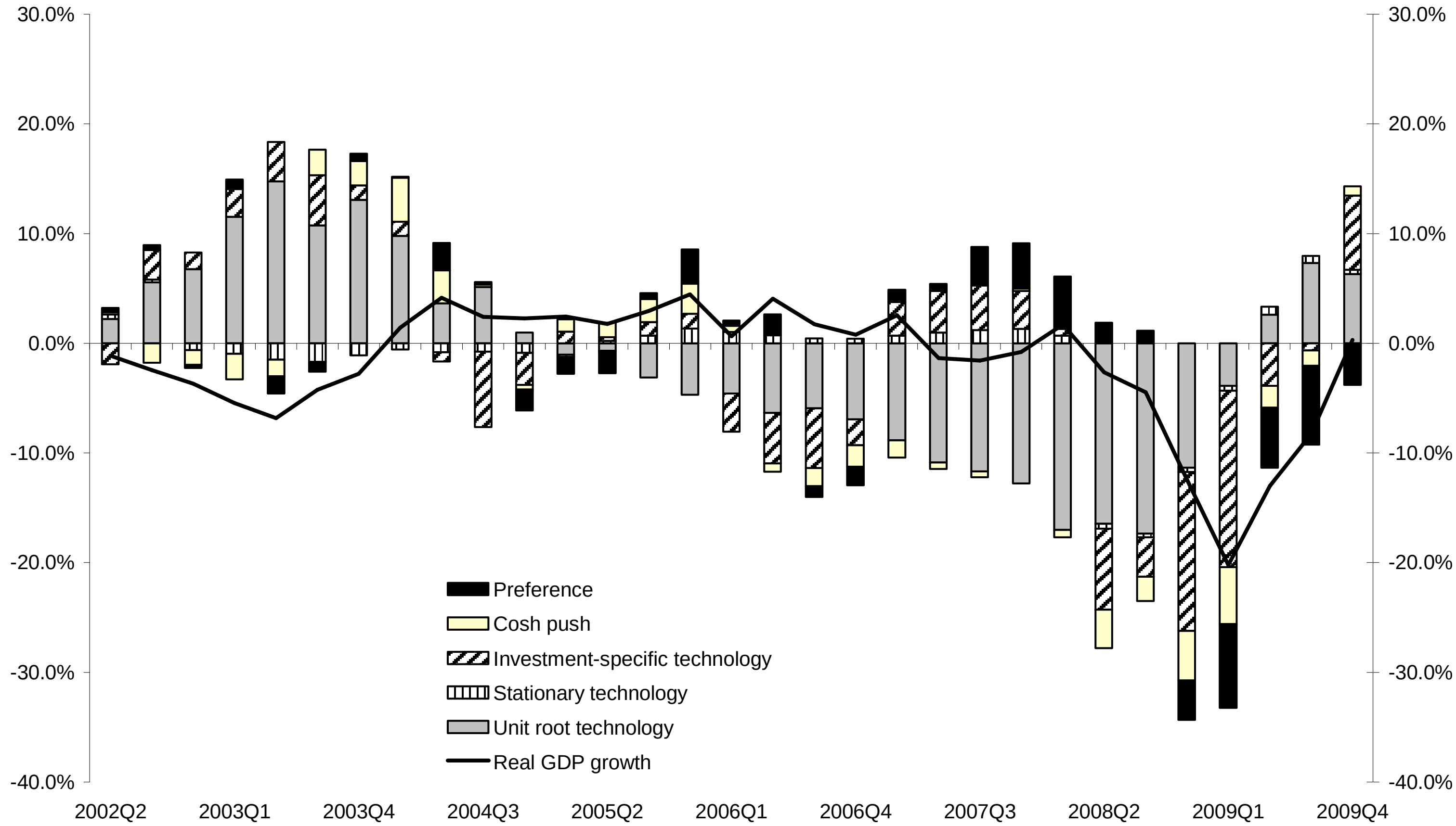
Source: Authors' calculations.

Figure 7. Shocks and Historical Decompositions
(Demeaned year-over-year real GDP growth and shocks)



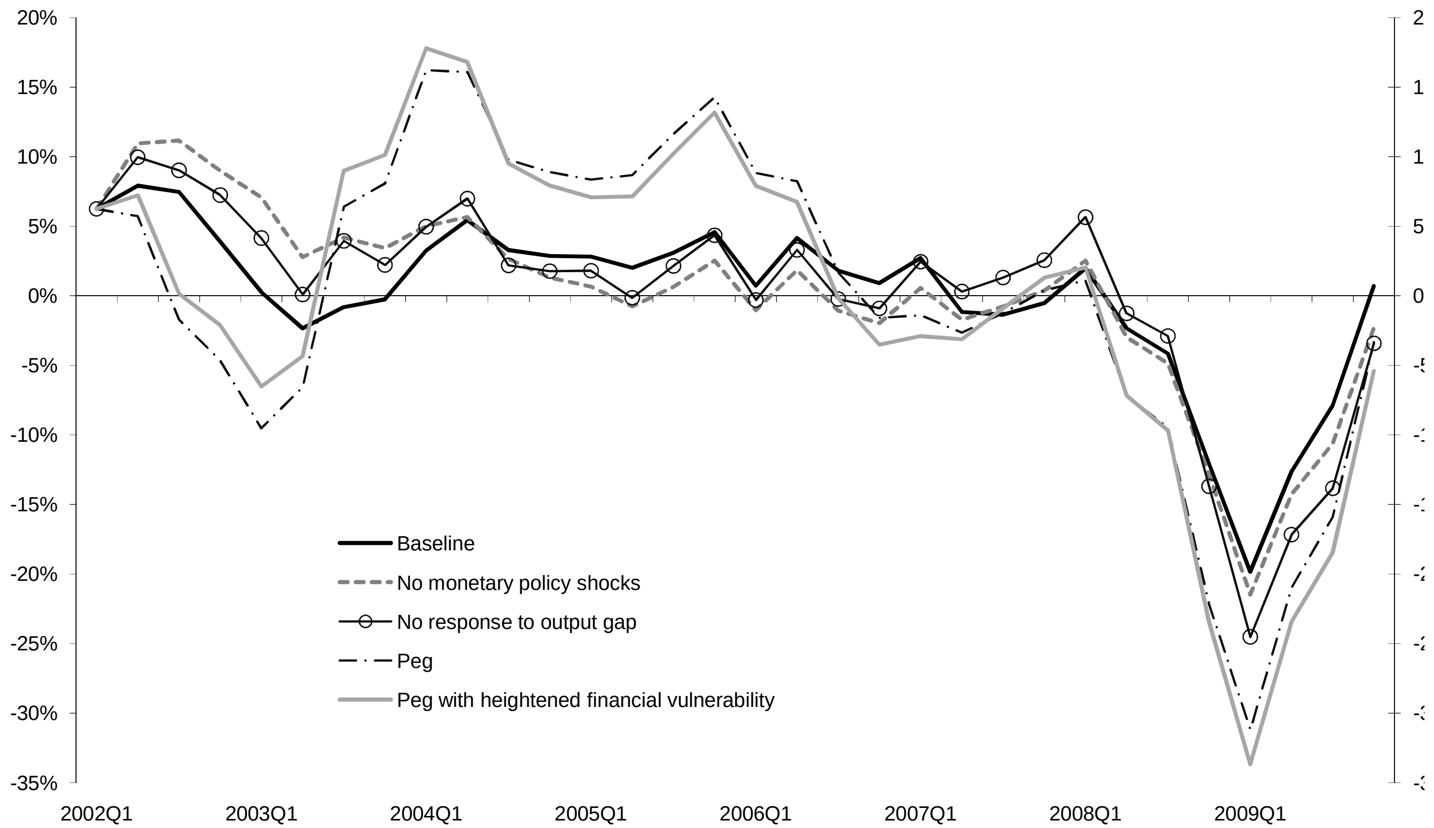
Source: Authors' calculations.

Figure 8. Other Shocks and Historical Decompositions
(Demeaned year-over-year real GDP growth and shocks)



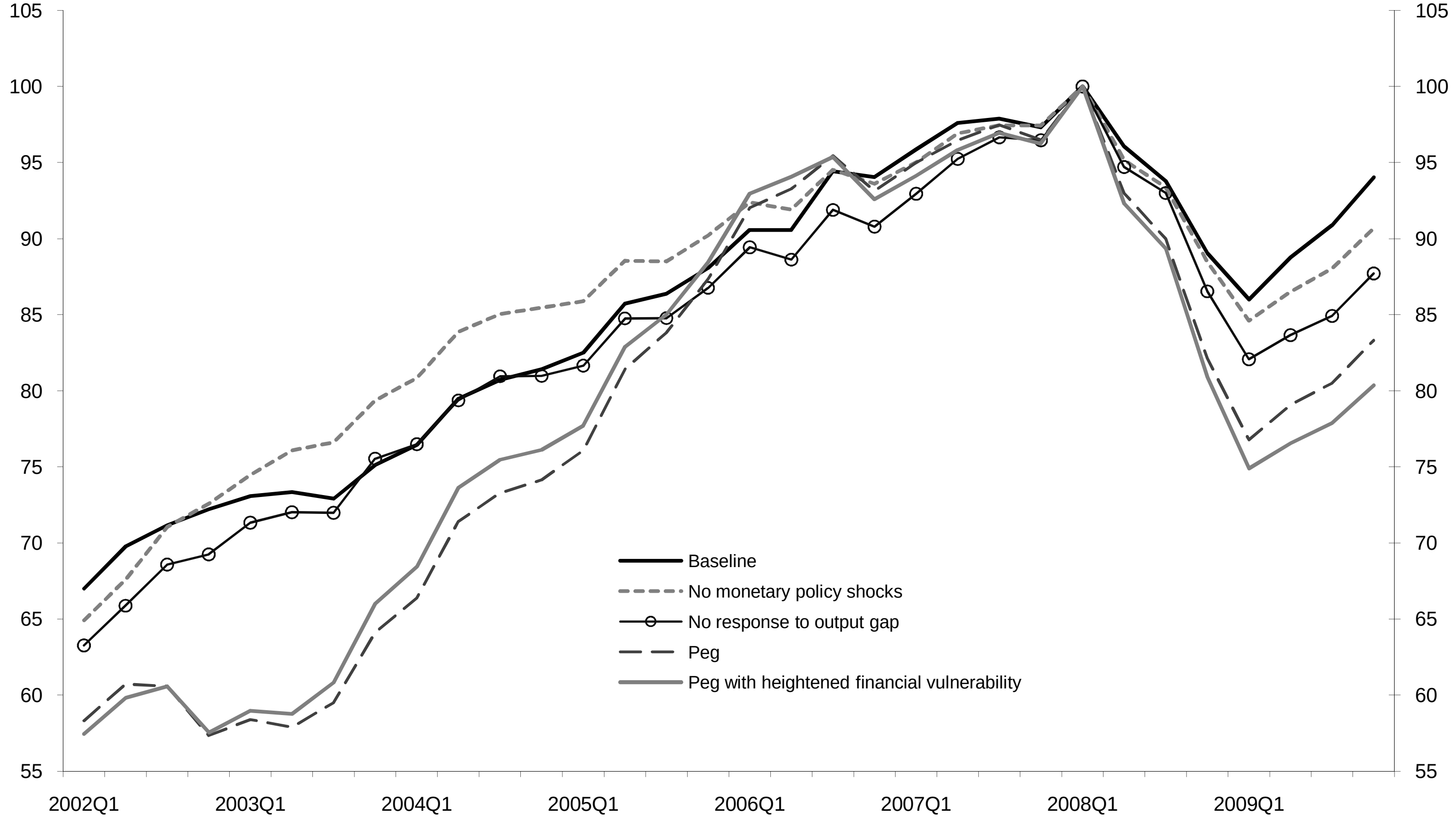
Source: Authors' calculations.

Figure 9. Monetary Counterfactual: Growth Rates
(Year-over-year growth rates)



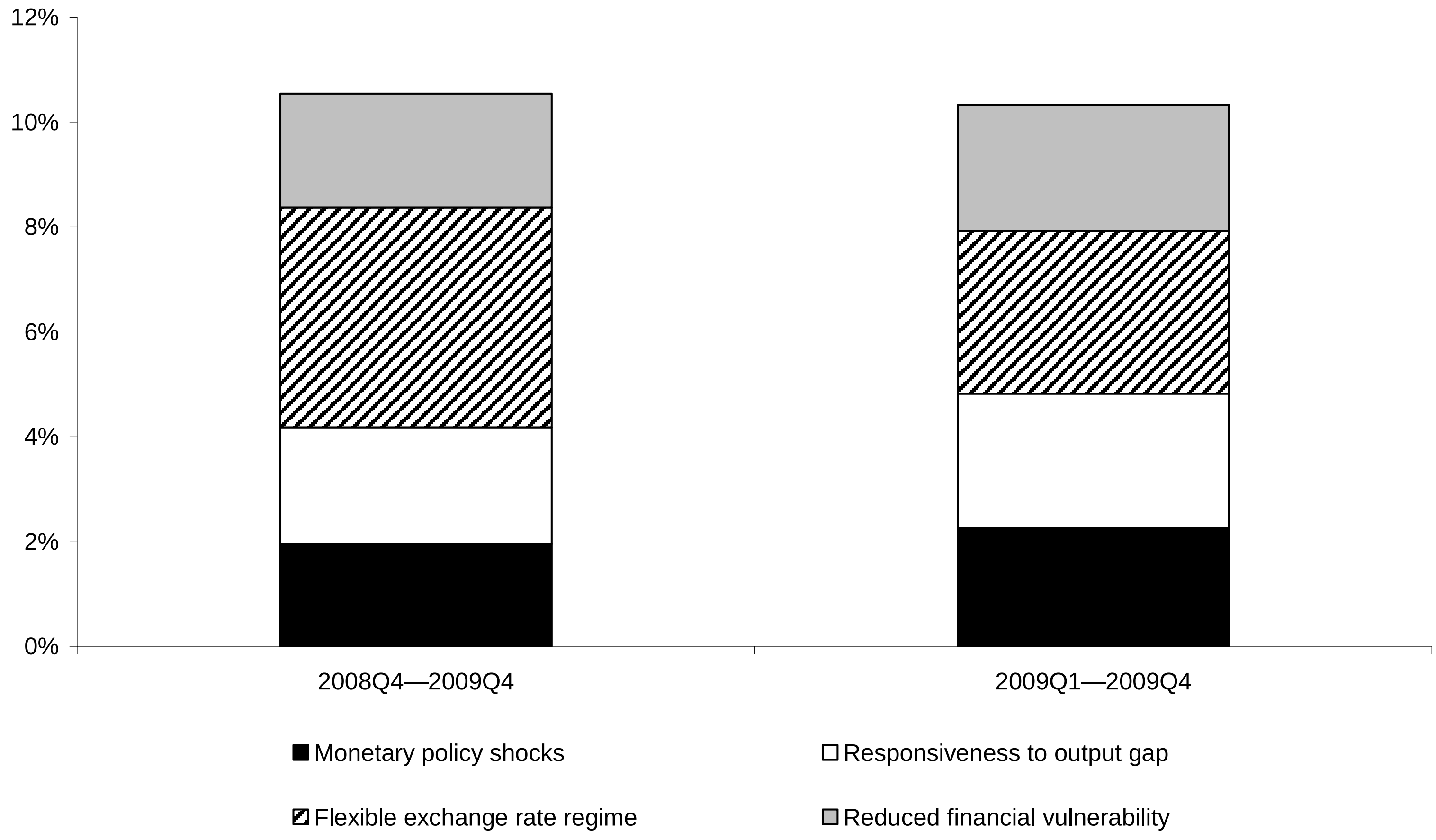
Source: Authors' calculations.

Figure 10. Monetary Counterfactual: Levels
(Year-over-year growth rates and levels)



Source: Authors' calculations.

Figure 11. Monetary Counterfactual: A Summary
(Year-over-year growth rates and levels)



Source: Authors' calculations.