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The Role of Monetary Policy in Turkey during the Global Financial Crisis

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The Role of Monetary Policy in Turkey during the Global Financial Crisis

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Abstract

Turkey is an interesting case study because it was one of the hardest hit emerging economies by the global financial crisis, with a year-over-year contraction of 15 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. In this context, this paper addresses the following broad question: If an inflation targeting framework underpinned by a flexible exchange rate regime was not adopted, how much deeper would the recent recession have been? Counterfactual experiments based on an estimated structural model provide quantitative evidence which suggests that the recession would have been substantially more severe. In other words, the interest rate cuts implemented by the CBRT and exchange rate flexibility both helped substantially soften the impact of the global financial crisis.

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Keywords: financial accelerator, Bayesian estimation, DSGE models, financial crises, sudden stops, monetary policy, Turkey, emerging economies, emerging markets

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EXECUTIVE SUMMARY

This paper argues that the monetary policy implemented by the Central Bank of the Republic of Turkey (CBRT) helped soften the impact of the global financial crisis. Specifically, the findings suggest that without key reforms—including the adoption of an inflation targeting framework underpinned by a flexible exchange rate regime—the global financial crisis would have been associated with a much deeper economic contraction.

Turkey is an interest emerging economy case study because it was one of the hardest hit countries by the crisis, with a year-over-year contraction of 14.7 percent during the first quarter of 2009. At the same time, anticipating the fallout from the crisis, the CBRT decreased policy rates by an astounding 1025 basis points over the November 2008 to November 2009 period.

Against this backdrop, the general question this paper attempts to address is the following: Did the monetary policy implemented by the CBRT help soften the impact of the recent crisis? In terms of monetary policy, we focus on the role of being able to implement countercyclical and discretionary monetary policy (through changes in the short-term interest rate) within an inflation targeting regime consistent with exchange rate flexibility. In this context, we seek a quantitative answer to the following question:

- If an inflation targeting framework underpinned by a flexible exchange rate regime had not been adopted, how much deeper would the recent recession have been?

This paper finds that the recession would have been substantially more severe.

The most intuitive way to communicate our quantitative results is by taking the growth rate during the most intense year of the global financial crisis, namely 2009, as our baseline. Model-based counterfactual simulations indicate that without the countercyclical and discretionary interest rates cuts implemented by the CBRT, growth in 2009 would have decreased from the actual realization of –4.8 percent to –6.2 percent. Moreover, if a fixed exchange rate regime would have been in place instead of the current inflation targeting regime (which is underpinned by a flexible exchange rate), the results indicate that growth in 2009 would have been –8.0 percent, a difference from the actual outcome of 3.2 percentage points. In other words, these simulations underscore the favorable output stabilization properties owing to the combination of countercyclical monetary policy and exchange rate flexibility.

These finding are based on counterfactual simulations derived from an estimated dynamic stochastic general equilibrium (DSGE) model which, along with standard nominal and real rigidities, includes a financial accelerator mechanism in an open-economy framework.

In sum, without the adoption of an inflation targeting framework underpinned by a flexible exchange rate regime, the impact of the recent global financial crisis would have been substantially more severe.

I. INTRODUCTION

Distinct features of the global financial crisis which intensified during September 2008 include a sharp slowdown in global economy activity—including severe recessions across many countries—along with an episode of acute financial distress across international capital markets. Another departure from past global downturns was the coordination of unprecedented countercyclical policy responses to the crisis, which seems to have supported the rebound in economic activity.

Turkey was one of the hardest hit countries by the crisis. Real GDP contracted sharply for four quarters, reaching a year-over-year contraction of 14.7 percent during the first quarter of 2009, resulting in a –4.8 percent annual growth rate for that year. 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.

The recent Turkish experience differs from the past in several dimensions. As discussed further in Section II, Turkey suffered from an intense financial crisis in 2001. While the 2001 crisis was certainly harsh, it was followed by at least two important reforms. First, the pegs and heavily managed exchange rate regimes of the past were replaced by a flexible exchange rate regime. Second, and relatedly, the policy framework of the CBRT gradually transitioned into a full-fledged inflation targeting regime.

Against this backdrop, this paper will focus on the macroeconomic implications of these two monetary policy reforms, particularly during the recent global financial crisis. The principle question of the paper is as follows: What was the role of these changes to the monetary policy framework in mitigating the severity of the recent recession? More specifically, we seek to address the following set of questions: (1) In contrast to the fixed exchange rate regimes of the past, what was the role of exchange rate flexibility in helping insulate the economy from the crisis? (2) Relatedly, consistent with the attainment of the inflation targets, what was the role of the CBRT‘s countercyclical interest rate cuts in softening the impact of the crisis?

This paper seeks to provide quantitative answers to these questions. To this end, we develop and estimate a small open economy dynamic stochastic general equilibrium (DSGE) model designed to capture salient features of the Turkish economy. The model contains a number of nominal and real frictions such as sticky prices, sticky wages, variable capital utilization, investment adjustment costs, habit persistence, and incorporates a financial accelerator mechanism à la Bernanke and others (1999) in an open-economy setup to better fit the data. Details regarding the setup of the model, the estimation procedure, its robustness, and its dynamics are briefly covered in Section III through Section V (with many of the details relegated to an extensive appendix).

Using the estimated structural model we can address the main question of the paper reformulated as follows:

- If an inflation targeting framework underpinned by a flexible exchange rate regime was not adopted, how much deeper would the recent recession have been?

This paper finds that the recession would have been substantially more severe.

We derive this result using model-based counterfactual simulations. These simulations represent the basis for our main policy implications and are discussed in detail in Section VI and Section VII. We contrast the actual realization of real GDP (the baseline scenario), with other counterfactual scenarios that, for example, consider the how the economy would have responded if the CBRT had not implemented any discretionary monetary policy loosening.

To more intuitively convey our quantitative results, we consider the growth rate during the most intense year of the global financial crisis, namely 2009, as our baseline. In this context, our counterfactual simulations indicate that without the discretionary interest rate cuts (expansionary monetary policy shocks) possible under the inflation targeting regime, growth in 2009 would have decreased from the actual realization of –4.8 percent to –5.9 percent, a difference of 1.1 percentage point. This lies within the range found by Christiano and others (2008), which finds growth contributions of monetary policy of 0.75 percent and 1.27 percent for the United States and the Euro area, respectively.

Other insightful counterfactual experiments are possible. For example, if there was absolutely no countercyclical responses to the crisis—in other words the CBRT did not take the output gap into account and at the same time did not implement any discretionary policy loosening (no expansionary monetary policy shocks)—then the 2009 growth outcome would have been –6.2 percent. Moreover, if a fixed exchange rate regime would have been in place instead of the current inflation targeting regime which operates with a flexible exchange rate, the results indicate that growth in 2009 would have been –8.0 percent, a difference from the actual outcome of 3.2 percentage points.

In sum, without the adoption of the flexible exchange rate regime, and active countercyclical monetary policy guided by an inflation targeting framework, the impact of the recent global financial crisis would have been substantially more severe. As emphasized in the final section of the paper, the inflation targeting framework underpinned by a flexible exchange rate seems to have increased the resilience of the Turkish economy to shocks. The inflation targeting framework allowed the CBRT to implement countercyclical and discretionary interest rate cuts, while exchange rate flexibility acted as a shock absorber, both of which increased the resiliency of the economy. The latter result echoes the favorable output stabilization properties of exchange rate flexibility which can be traced back to at least to the seminal contributions of Mundell and Fleming.

Our paper builds on a tradition of small open economy DSGE models popularized by Mendoza (1991). Over time, these real models were augmented with nominal rigidities to motivate and then explore the implications of monetary policy (for example, 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 feasibility and popularity of Bayesian method, building upon the closed economy studies of Smets and Wouters (2003, 2007), 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) to improve model fit and to facilitate the counterfactual simulations discussed below.

II. Economic Developments in Turkey: The Role of Macroeconomic Reforms

By way of background for the rest of the paper, the main objective of this section is to briefly discuss some key developments regarding the Turkish economy over the last two decades.[2] In particular, we would like to focus on a few key macroeconomic policy reforms that we argue helped soften the impact of the global financial crisis which intensified after the Lehman Brothers bankruptcy.

It will be useful to draw attention to the macroeconomic turbulence in Turkey during the 1990s (which included a financial crisis in 1994) as reflected in some selected macroeconomic indicators shown in **Figure 1**. How does the recent Turkish experience differ from the past? To address this question, we take the intense financial crisis of 2001 as our point of departure, which was associated with fragilities in the banking system and a speculative attack on the fixed-exchange rate regime in place at the time. A severe recession ensued.

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

[2] For more a comprehensive perspective on crises in Turkey, see Özatay (2009) which is in Turkish, or Yalçın and Thomas (2010) which focuses on the most recent crisis and is in English.

- First, the heavily managed and fixed exchange rates regimes of the past were abandoned in favor of floating exchange rates.

- Second, and relatedly, the CBRT started its transition, and in 2006, 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 economy grew by over five percent (year-over-year), and inflation declined markedly.[3] While global economic and financial conditions were favorable, it is hard to argue that the reforms mentioned above did not contribute positively toward achieving these growth rates.[4]

With the intensification of the global financial crisis during the fall of 2008, synchronized downturns coupled with financial stress affected international capital markets and economies across the world. As expected, the Turkish economy was severely affected by this abrupt collapse of the global economy. In fact, the contraction in world demand hit Turkish exports with severe implications for the rest of the economy. At the same time, the shock to global financial markets resulted in a collapse of asset prices (including the currency), an increase in spreads, and sizeable capital outflows. In addition, the heightened uncertainty associated with the unprecedented nature of this global financial crisis reinforced the foreign demand and financial shocks as well as acted as another channel suppressing consumption, investment, and credit extension. Therefore, for the purposes of this paper, we argue that the Turkish economy was unfavorably affected by a collapse in foreign demand, distress across international capital markets, and heightened uncertainty.

As a result, Turkey was one of the hardest hit countries by the crisis. Real GDP contracted sharply for four quarters, reaching a year-over-year contraction of 14.7 percent during the first quarter of 2009, resulting in a –4.8 percent annual contraction. The CBRT grasped the implications of this dire situation relatively early on. 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? We seek to address this question below.

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[3] It is also useful to indicate that the Turkish banking system was nearly completely overhauled after the 2001 crisis. Excessive leverage, maturity and currency mismatches which aggravated the severity of the 2001 crisis declined markedly. Evidence suggests that this lower risk profile became widespread as shown in the lower leverage ratios shown in Table 1. While the financial, insurance, and real estate sectors are shown together with public administration, it is well known that the risk management practices across the banking system improved. This is important because a sounder financial system increases the effectiveness of the monetary transmission mechanism.

[4] 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 of assets across many emerging economies.

III. The Model

This section presents an overview of the structural model underpinning our quantitative results. As mentioned above, readers primarily interested in the main policy implications of the paper could directly proceed to Section VII and Section VIII. The goal here is to present the general intuition of the model, while the details are relegated to the Appendix. The structural framework builds upon a core (New) Keynesian model. The model used is an open-economy variant of what the literature refers to as a New Keynesian dynamic stochastic general equilibrium (DSGE) model. However, to better fit the data, the model is augmented with a number of features including real and nominal rigidities (including, for example, investment adjustment costs and sticky wages), as well as a financial accelerator mechanism (to capture financial market imperfections) among several others.[5]

The model consists of several agents including households, producers, and the government. There are three types of producers: entrepreneurs, capital producers, and retailers. The government is responsible for implement monetary and fiscal policy. A visual representation of the flow of goods and services across these agents is shown in **Figure 2**. However, rather than elaborate on all aspects of the model, this goal in this section is to focus on the transmission of certain shocks and the role of monetary (and exchange rate) policy.

The transmission of shocks

For the purposes of this paper, we argue that during the global financial crisis, the Turkish economy was unfavorably affected by a collapse in foreign demand, distress across international capital markets, and heightened uncertainty. To assess this assertion, we posit that in terms of our model, these disturbances are captured by an export demand shock, a sudden stop shock, and a (financial) uncertainty shock. We now review each of these in turn. Later, we actually provide quantitative evidence that appraises the relative growth contribution of these three shocks (as well as the other structural shocks) during the recession which intensified in the first quarter of 2009.

The export demand shock

The export demand shock, or perhaps equivalently, the foreign demand shocks propagates through the model via the market clearing condition below:

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

[5] In terms of theory, our model brings together elements from papers including Adolfson and others (2007), Bernanke and others (1999), Elekdag and Tchakarov (2007), and Gertler and others (2007) among many others, while, in order to facilitate estimation, we build on the work of Smets and Wouters (2003, 2007) and Elekdag and others (2006).

Leaving aside differences in notation, this is basically the standard aggregate demand identity for home (domestically produced) goods, which posits that domestic output is equal to the sum of consumption of domestically produced goods (which is the sum of both household and entrepreneurial consumption, $C_t^H + C_t^{eH}$), domestic investment goods, I_t^H, government expenditures, G_t, and exports, C_t^{H*}. Therefore, leaving the other details to the complete model description in the Appendix (which also describes import demand), a collapse in export (foreign) demand is simply represented by a decline in C_t^{H*}.

The sudden stop shock

Turkey‘s experience during the global financial crisis was also associated with a reversal of capital inflows (a sudden stop in the parlance of Calvo and others, 2004), as well as a sharp depreciation of the exchange rate. To capture these interrelated disruptions, we augment the uncovered interest parity (UIP) condition with a shock as in many other papers as follows:

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

where i_t and i_t^*, represent the domestic and international (gross) interest rates, respectively, S_t denotes the nominal exchange rate (Turkish lira per U.S. dollar—an increase represents a depreciation), E_t is the expectations operator (conditional on information up to time *t*), and Φ_t is the sudden stop shock (also referred to an exchange rate shock, UIP shocks, and some other in the literature). Therefore, as in Gerlter and others (2007), a shock that triggers large capital outflows is captured by this exogenous terms which is appended to an otherwise standard UIP condition. This sudden stop shock would serves to capture an important dimension of the financial aspect of the recent crisis.

The (financial) uncertainty shock

The description of this shock warrants some background. In this model, the real cost of capital departs from the standard representation in other studies because of the existence of an external finance premium. Consider the equation below:

$$E_t[R_{t+1}^k] = \chi_t(\cdot) E_t[R_{t+1}]$$

where we have that the real cost of capital, R_t^k, is equal to the real interest rate, R_t, augmented by the external finance premium represented by the term $\chi_t(\cdot)$. In turn, the external finance premium depends on the leverage ratio (assets scaled by net worth) of the entrepreneurs:

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

Note that total assets, $Q_t K_{t+1}$, depends on the price of equity, Q_t, which is not sticky (by contrast to goods prices or wages). This implies that the leverage ratio is quite sensitive to asset price fluctuations.

The precise specification of the evolution of net worth, N_{t+1}, is complex (and shown in the Appendix), so here we use an abridged version:

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

where W_t^e and $V_t$denote the entrepreneurial wage bill and the value of the firm, respectively. The (financial) uncertainty shock is an exogenous process, represented by the term, ϱ_t, which by construction has direct impact on the level of aggregate net worth and therefore the external financial premium. Put differently, the net worth shock could be interpreted as a shock to the rate of destruction of entrepreneurial financial wealth (in line with several other studies). 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). Another way to think about this shock is that it could be thought of capturing counterparty risk—owing part to Knightian uncertainty—a key consideration during the global financial crisis. This heightened uncertainty regarding cash flows, for example, would impair assets and thus disrupt the financial system.

What role for monetary policy?

In our model, the central bank alters interest rates in an attempt to achieve certain policy objectives. Before proceeding to the details, note that the policy rule to be described below 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 (policy smoothing).

A simplified version of the interest rate rule takes the following (log-linear) form (see Appendix for further details):

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

where, in this flexible specification, $\hat{\imath}_t$, $\hat{\pi}_{t+1}$, $\hat{y}_t$, $\hat{s}_t$ denote the (short-term policy) interest rate, the (core CPI) inflation rate, the output gap, and the nominal exchange rate, respectively. Note that ϵ_t^i denotes the monetary policy shock—interest rate changes that deviate from the (empirical) interest rate rule would be captured by this disturbances and could be considered discretionary monetary policy. The time-varying inflation target, $\hat{\pi}_t^T$, is assumed to evolve according to the following stochastic process:

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

The time-varying inflation target captures the reality that the inflation target in Turkey was changed over time. However, it has also been used in the literature to capture structural changes in the conduct of monetary policy that are not captured otherwise (see Adolfson and others, 2007, for further details).

Anticipating the results to follow, notice that when the output gap is negative—that is, output is below potential—strict adherence to the rule above would imply that the interest rate decreases by an amount dictated by the coefficient τ_y. However, the monetary authority might decrease interest rates by more than what the systematic component of the rule would imply. Recall that this deviation from the rule is capture by the error term, ϵ_t^i, which is the monetary policy shock—thereby capturing discretionary monetary loosening. As will be discussed in further detail below, during the most intense episode of the global financial crisis, interest rates decreased by more than the amount the empirical counterpart of the rule would have implied, helping soften the impact of the global financial crisis.

IV. Estimation

This section gives an overview of model estimation. It briefly reviews issues pertaining to data, parameter calibration, the choice of prior distributions, the resulting posterior distributions, model fit, and sensitivity analysis. An extensive discussion of these issues is covered in the Appendix.

Data

The log-linearized model is estimated using Bayesian methods primarily developed by Schorfheide (2000), and later popularized by Smets and Wouters (2003, 2007). The model is estimated using quarterly data from the first quarter of 2002 to the second quarter of 2010 using the series shown in **Figure 3**. In line with many other studies, we have chosen to match the following set of twelve variables: the levels of the domestic policy and foreign interest rates, the inflation rates of domestic GDP deflator and core consumer price and foreign consumer price indices, as well as the growth rates of GDP, consumption, investment, exports, imports, foreign GDP, and the real exchange rate. The sample period used for estimation covering the 2002–2010 period under consideration captures the episode when the CBRT was transitioned to an inflation targeting regime (initially implicitly, and the explicitly starting in 2006).

Model Parameters

We followed the literature and calibrate certain parameters (see, for example, Christiano and others, 2010), which could be thought of as infinitely strict priors. Many of the parameters are chosen to pin down key steady state ratios, while the remaining parameters are taken from the literature as summarized in **Table 2**.

The remaining 43 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.

The posterior estimates of the variables are also shown in **Table 3**. The table reports the means along with the 5^{th} and 95^{th} percentiles of the posterior distribution of the estimated parameters obtained through the Metropolis-Hastings sampling algorithm. In general, the parameter estimates are in line with those found in other studies.

An initial assessment of model fit and sensitivity analysis

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 3** indicating that the sample fit is generally quite satisfactory.

To assess the robustness of the estimated model, we consider a battery of alternative specifications which include different monetary policy rules and alternative structural features. The results are summarized in **Table 4**, which depicts the log data density of the various models, and the posterior odd ratio contrasting the baseline and the alternative model specifications. While the details are discussed extensively in the Appendix, the main takeaway is that we consider 18 alternative specifications, and the results are very strongly, if not decisively, in favor of the baseline.

V. MODEL DYNAMICS

This section aims to explore the dynamics of the estimated model. It starts off by exploring the implications of a monetary policy shock, and then provides an overview of the dynamics associated with the other shocks relegating the details to the Appendix.

The monetary transmission mechanism

We start off by considering the monetary transmission mechanism in Turkey. This is critical because the focus of the paper is to assess the role of monetary policy during the global financial crisis.

To this end, we consider the impulse responses to a one standard deviation monetary tightening shock as shown in **Figure 4**. Also note that we compare models with and without the financial accelerator, to assess how financial frictions affect the monetary transmission mechanism. The shock propagation is effected via three main channels:

- The first channel operates as interest rates affect domestic demand, which primarily comprises of consumption and investment. Working through the Euler equation, higher real interest rates foster an increase in saving as consumption is postponed to later periods. At the same time, higher real interest rates increase the opportunity cost of investment, decreasing the rate of capital accumulation (a channel that is operational in models with capital). As a result, domestic demand and output decreases, putting downward pressure on inflation.

- The second channel brings out the open economy features of the model as it works via the exchange rate. Because of the nominal rigidities, the increase in the nominal interest rate translates into higher real interest rates and is associated with an increase in the real exchange rate. In turn, this appreciation of the real exchange rate suppresses net exports (the expenditure switching effect), further decreasing aggregate demand.

- The third channel is characterized by the financial accelerator mechanism. Higher interest rates depress asset prices (the real price of capital) bringing about a deterioration in net worth. Weaker balance sheet fundamentals cause an increase in the external finance premium thereby raising the opportunity cost of investment above and beyond the initial effect generated by the monetary tightening. As indicated in **Figure 4**, this brings about an even sharper contraction in investment, which is the primary determinant of the deeper contraction. As is clear in the impulse responses, the financial accelerator mechanism can amplify the effects of certain shocks (as discussed in Bernanke, Gertler, and Gilchrist, 1999) and is further explored in the Appendix.

To more openly communicate the degree of uncertainty regarding the monetary transmission mechanism in Turkey during a sample period which encompasses the global financial crisis, **Figure 5** presents Bayesian impulses response functions for a selected set of variables along with their 90 percent bands which take into consideration parameter uncertainty. As shown in the **Table 3**, a one standard deviation contractionary monetary policy shock corresponds to a 70 basis point (quarterly) increase in the nominal interest rate—in other words, an annual increase in the policy rate of about three percent. The impulse response functions indicate that the output gaps dips below the steady state by 70 basis points, whereas the year-over-year inflation rate reaches a trough of about 140 basis points below steady state after four periods.[6]

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[6] A shock to the time-varying inflation target is also represents a change in monetary policy (Smets and Wouters, 2003). As will be discussed in detail below, this shock barely affects output, we opted not to focus on it here. Suffice to say, that the impulses responses are broadly similar to those shown in Adolfson and others (2005), with differences owing to the fact that they calibrate the persistence coefficient to 0.975, whereas we find an estimated value of 0.77.

The model includes 15 structural shocks including the monetary policy shock discussed above. For the purposes of this paper, a detailed discussion of the impulse responses of the remaining shocks is relegated to the Appendix in order to proceed to the sections of the paper which presents our main results and policy implications.

VI. Historical Decompositions

This section seeks to better understand the contributions of the structural shocks to output growth. Of course, in line with the main theme of the paper, the key structural shock we will focus on is the monetary policy shock. In this context, the section will quantify the role of monetary policy shocks on output growth, and will therefore provide one of our main policy implications.

For the purposes of this paper, we categorize the 15 structural shocks in the model into three groups to reinforce intuition. The first group consists of the monetary policy shocks and is the focus of this section. The second group comprises the crisis shocks, namely, shocks to foreign demand, financial uncertainty, and the uncovered interest rate parity (the sudden stop shock), and the final group contains the remaining supply and demand shocks. Our goal here is to assess the role of these groups of shocks on (year-over-year) output growth over the 2005–2010 period, which includes the run-up and the most intense episode of the global financial crisis.

What was the growth contribution of the monetary policy shocks?

The main takeaway of this section is shown in **Figure 6**. The figure plots real (year-over-year, demeaned) GDP growth, as well as the growth contributions of the three groups of shocks described above. The figure addresses the following question: What was the growth contribution of the monetary policy shocks? The monetary policy shocks are shown in black, and as is clear from the figure, they positively contributed to output growth during the crisis episode.

As we discuss in extensive detail in the next section, the average growth contribution of the monetary policy shocks during the crisis episode is about 1.1 percent. To put this number in perspective, recall that the year-over-year real GDP contraction in Turkey in 2009 was –4.8 percent. Without these monetary policy shocks, that is discretionary departures from the estimated interest rate rule, our model indicates that the growth rate for this year would have been –5.9 percent instead. In other words, monetary policy seems to have markedly contributed the softening the impact of the global financial crisis. We contrast this growth contribution of 1.1 percent to those in the literature in the following section below.

What was the role of the other structural shocks?

Consider first the role of the crisis shocks. To better understand the effects of the second group of shocks (foreign demand, risk premium, and financial uncertainty), each of these shocks is shown separately along with real (demeaned, year-over-year) GDP growth in **Figure 7**. To start off, however, note that the sudden stop (UIP or risk premium) shock does not seem to have an important effect on growth during the crisis. 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 arguably could reduce the role of risk premium (UIP) shocks, an important determinant of exchange rate dynamics. However, given that foreign currency exposure in Turkey has generally decreased markedly after 2002, and because it was never as serious an issue as in some Latin American countries, for example, we do not pursue this (straightforward) extension in this paper, but leave it for future research.

The role of the crisis shocks depicted in **Figure 7** could be analyzed in three phases. First there was the run-up to the global financial crisis. During the period starting around 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. The last phase corresponds to the onset of the recovery lead by a decrease in the financial uncertainty shocks. We find that the financial uncertainty shock explains a large fraction of the downturn among the three crisis shocks. It is also interesting to note the lingering effects of the foreign demand shock. The depressed growth trajectory in our main trading partner—the Euro area—surely contributed these dynamics.

The growth contributions of the remaining supply and demand shocks are shown in **Figure 8**. The two prominent supply shocks are the unit-root and investment-specific technology shocks. In contrast to some other studies, there seems to be a limited role for the cost push (markup) 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 important determinants of business cycle fluctuations across emerging markets. There also seems to be an important contribution by the investment-specific technology shocks, a point made by Justiniano and others (2010). The demand shocks consist of the government spending, preference, and time-varying inflation target shock. The latter has a negligible role, and the remaining two demand shocks usually tend to offset each other to varying degrees over time. Overall, we see that the net effect of these shocks acted as a drag on growth, particularly in the early phase of the global financial crisis.

VII. 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 adoption of the flexible exchange rate regime and the implementation of active countercyclical monetary policy within an inflation targeting framework 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, the counterfactual experiments we discuss below indicate that the countercyclical and discretionary interest rate cuts implemented by the CBRT within an inflation targeting regime underpinned by a flexible exchange rate added at least 3.2 percentage points to the 2009 real GDP growth outturn.

Before proceeding, it may be useful to recall that after the 2001 financial crisis, two monetary policy reforms were carried out: (1) the fixed and heavily managed exchange rate regimes of the past were abandoned in favor of a flexible exchange rate, and (2) the CBRT started implementing an inflation targeting regime—implicit initially, then officially as of 2006. Against this backdrop, while not the focus of the paper, as a by-product of our modeling setup, we can also take a first pass at assessing the possible role of the post-2001 financial reforms. As discussed in Section II, with these reforms the risk profile of the Turkish economy—lead by the banking sector—decreased markedly in the aftermath of the 2001 crisis. In terms of a summary indicator, consider the leverage ratio in **Table 1**. Based on a cross section of firms, the average leverage ratio decreased to a value of two in 2007 from a value of three in 2000. In an illustrative scenario we seek to quantify the role of these reforms by altering the steady state leverage ratio.

Setting up the counterfactual simulations

Therefore in what follows, we consider four counterfactual simulations and compare them with the actual realization which is our baseline. Under the baseline, the monetary policy framework operates under a flexible exchange rate regime, follows the estimated baseline interest rate rule which reacts to the output gap 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 shocks**: this counterfactual posits strict adherence to the baseline empirical interest rate rule. It is a simulation that excludes the monetary policy shocks, that is, the monetary policy shocks, ϵ_t^i, are all set to zero in this simulation. It serves to address the following question: What would the dynamics of output growth have been if the CBRT did not implement any discretionary policy (deviations from the interest rate rule) during the crisis? While the previous section answered this question, here we seek to underscore this result and provide further context.

- **No response to the output gap**: under this counterfactual, the output gap coefficient in the empirical interest rate rule is set to zero ($\tau_y = 0$). 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 not implement any discretionary policy 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.[7] 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). 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 under a fixed exchange rate regime as above, but the leverage ratio is calibrated to correspond to the case where it equals three in line with the value in **Table 1** during 2000.[8] While not the main focus of the paper, out modeling framework allows us to construct such an illustrative counterfactual serving 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?

Results based on the counterfactual simulations

Figure 9 depicts the level of real GDP with the first quarter of 2008 (the pre-crisis peak) normalized to 100 to allow the reader to better distinguish the (cumulative) effects of each

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[7] Just as the model-based framework assumes that the inflation targeting regimes are fully credible, it also assumes that the exchange rate regimes are fully credible. While the latter assumption is harder to justify, the credibility of both regimes is needed for comparability. For a lack of a better term, credibility was used, but perhaps sustainability is a more related or even more appropriate characterization.

[8] Recall that the Turkish banking system was nearly completely overhauled after the 2001 crisis. Key vulnerabilities including excessive leverage, maturity and currency mismatches which aggravated the severity of the 2001 crisis declined markedly. Evidence suggests that this lower risk profile became widespread as shown in the lower leverage ratios shown in Table 1, which indicates that the aggregate leverage ratio decreased to 2.0 in 2007 from 3.0 in 2000. For these illustrative scenarios, we use these leverage ratios to calibrate the risk profile of the entrepreneurs in our model economy.

counterfactual. The figure depicts (1) the actual realization of real GDP (the baseline scenario), (2) the counterfactual scenario without the monetary policy shocks, (3) the counterfactual scenario without the monetary policy shocks and with the output gap coefficient in the empirical interest rate rule is set to zero, (4) the counterfactual scenario with the fixed exchange rate regime (peg), and (5) an illustrative counterfactual scenario with the peg under heightened financial vulnerabilities.

As clearly seen from **Figure 9**, the inflation targeting framework underpinned by a flexible exchange rate regime clearly softened the impact of the global financial crisis. More specifically, it is useful to discuss three main results:

- First, as expected, output growth declines the most under the fixed exchange rate regime. The lack of the exchange rate to serve as a shock absorber decreases the resiliency of the economy to the shocks that ensued during the global crisis. Intuitively, the illustrative counterfactual experiment with heightened financial vulnerabilities, and thereby a more pronounced balance sheets channel, leads to an even sharper decline in output. These counterfactual experiments highlight the role of the exchange rate flexibility as well as financial reforms that promote the soundness of the financial system.

- Second, giving weight to the output gap seems to have a more limited role, but that is to be expected as the estimated coefficient (of 0.02) is quite low. In other words, the interest rate rule coefficient implies a small systematic response of policy rate to output gap, and a large discretionary (nonsystematic) response as summarized by the expansionary monetary policy shocks which we discuss next.

- Third, as discussed in the previous section, there is an important role for the discretionary departure from the interest rate rule, which helped soften the impact of the crisis. At first glance, while they may seem small, as we discuss in further detail in the next subsection, the role of these discretionary departures from the interest rate rule (the monetary policy shocks) are very much in line with the literature.

While our results suggest that the inflation targeting framework underpinned by a flexible exchange rate supported growth during the global financial crisis, clearly other policies also played a role. For example, it should be noted that we do not capture the direct effects of the liquidity measures enacted by the CBRT starting in the fourth quarter of 2008. Some of these policies include extending the terms of repurchase (repo) transactions, restarting foreign exchange auctions, and reducing reserve requirements on foreign exchange deposits (for further details, see Yalcin and Thomas, 2010). Moreover, fiscal policy is modeled along the lines of many other studies in this strand of the literature, and is admittedly cursory. Therefore, it is important to recognize that it might be possible that some of the contributions of expansionary fiscal policy and some of the liquidity measures implemented during the crisis (and not directly captured by our model) could have been attributed to the monetary policy shocks.[9]

How do our results compare with those in the literature?

We now focus on the growth implications associated with the counterfactuals discussed above. The main takeaways discussed above could have also been based using (year-over-year, demeaned) growth rates as shown in Appendix Figure 7. However, this section tabulates the precise contributions to growth under the various counterfactuals as shown in **Table 5**. The intention is for the table to focus on the most intense period of the crisis, but this could be open to interpretation. Therefore, in the context of the Turkish economy, we consider two alternative crisis episodes: 2008:Q4–2009:Q4 or 2009:Q1–2009:Q4.

Before investigating the details, it would be useful to clarify the information contained in **Table 5**. The values under columns show either the average or cumulative contributions to growth during these two episodes. It presents our results, as well as the results of Christiano and others (2007), the most closely related study to our in terms of conducting counterfactual experiments. The number of quarters in each episode and the quarterly cut in interest rates is also presented. Columns 1 through 5 indicate the incremental contribution to growth owing to the consecutive implementation of each policy. For example, consider the 2009:Q1–2009:Q4 episode. Under Column 4 indicates that reducing financial vulnerabilities added, on average, 1.45 percentage points to growth. In addition to this effect, the incremental growth contribution of adopting a flexible exchange rate regime, denoted under column 3, is 1.86 percentage points.

It would be useful to first compare the results in **Table 5** with the literature. Turning our attention to column 1, we see that the average contribution of the monetary shocks (discretionary deviations from the empirical interest rate rule) to output growth of around one percent (1.14 or 1.18 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 cumulative growth contributions also seem reasonable, and give some context on the role of monetary policy in terms of softening the impact of the crisis.

To more intuitively summarize the findings in the counterfactuals above, we focus on the most intense year of the crisis, namely 2009. As shown in **Table 6**, the actual growth rate for 2009 was –4.8 percent. Our model-based simulations suggest that if the CBRT had not departed from the empirical interest rate rule, growth would have instead been –5.9 percent, a difference of 1.1 percentage points. Furthermore, if instead of the inflation targeting regime, a peg was in place, the results imply a growth rate of –8.0 percent, a difference from the actual of 3.2 percentage points. In sum, without the adoption of the flexible exchange rate

[9] We thank Fatih Özatay for pointing out this possibility.

regime, and active countercyclical monetary policy guided by an inflation targeting framework, the impact of the recent global financial crisis would have been substantially more severe.

The appendix provides two other measures to gauge the severity of the recessions presented in the counterfactual scenarios. First, using the level of GDP, we show the differences in the peak-to-trough output contractions. Second, we consider the ―area under the curve," whereby the metric compares the annualized average output loss relative to the baseline. Both of these alternative measures are quantified in Appendix Table 1. Overall, whatever metric one prefers, it is clear that the adoption of an inflation targeting framework underpinned by a flexible exchange rate regime helped soften the impact of the recent global financial crisis.

VIII. Summary and Main Policy Implications

This paper develops and estimates a structural model using Turkish time series over the 2002–10 period corresponding to the Central Bank of the Republic of Turkey (CBRT)'s gradual transition to full-fledged inflation targeting. Turkey is an interest emerging economy case study because it was one of the hardest hit countries by the crisis, with a year-over-year contraction of 14.7 percent during the first quarter of 2009. At the same time, anticipating the fallout from the crisis, the CBRT decreased policy rates by an astounding 1025 basis points over the November 2008 to November 2009 period.

To this end, general question this paper seeks to address is the following: Did the monetary policy implemented by the CBRT help soften the impact of the recent crisis? However, we interpret monetary policy more broadly and therefore investigate the role of being able to implement countercyclical monetary policy within an inflation targeting regime underpinned by a flexible exchange rate regime. In this context, we seek to address the following question: If an inflation targeting framework underpinned by a flexible exchange rate regime was not adopted, how much deeper would the recent recession been? This paper finds that the recession would have been substantially more severe.

This finding is based on counterfactual simulations derived from an estimated dynamic stochastic general equilibrium (DSGE) model which includes a financial accelerator mechanism in an open-economy framework. These counterfactual situations allow us to quantify the differences in terms of growth between actual outcomes, and for example, a case where the CBRT did not implement any countercyclical and discretionary interest rate cuts.

The most intuitive way to communicate our quantitative results is by taking the growth rate during the most intense year of the global financial crisis, namely 2009, as our baseline. In this context, our counterfactual simulations indicate that without the countercyclical interest rates cuts implemented by the CBRT, growth in 2009 would have decreased from the actual realization of –4.8 percent to –6.2 percent. Moreover, if a fixed exchange rate regime would have been in place instead of the current inflation targeting regime (which is underpinned by a flexible exchange rate), the results show that growth in 2009 would have been –8.0 percent, a difference from the actual outcome of 3.2 percentage points. In other words, these simulations underscore the favorable output stabilization properties owing to the combination of countercyclical interest rate cuts (consistent with the inflation target) and exchange rate flexibility.

In sum, without the adoption of an inflation targeting framework underpinned by a flexible exchange rate regime, the impact of the recent global financial crisis would have been substantially more severe.

APPENDIX

This appendix has four main sections providing further details regarding some of our main results. First, we present a detailed description of the structural DSGE model that underpins our quantitative results. The next two sections discuss model estimation and sensitivity analysis, while the fourth section sheds further light on model dynamics, and the final section presents the counterfactual simulations using the time series of year-over-year growth rates.

The Model

This section presents a detailed description of the dynamic stochastic general equilibrium (DSGE) model that serves as our analytical framework. The model is an open economy New Keynesian DSGE model equipped with additional features to better fit the data including a number of nominal and real rigidities, a stochastic trend, and a financial accelerator mechanism among others. Our model brings together elements from papers including Adolfson and others (2007), Bernanke and others (1999), Elekdag and others (2006), aw well as Gertler and others (2007) among many others.

The model consists of several agents including households, producers, and the government. There are three types of producers: entrepreneurs, capital producers, and retailers. The government is responsible for implement monetary and fiscal policy. A visual representation of the flow of goods and services across these agents is shown in **Figure 2**. We consider the role of each of these agents, and there interactions with the rest of the world in turn below.

Households

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

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

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

Intratemporal optimization by the household implies the following two conditions, the latter being the consumer price index, P_t:

$$\frac{C_t^H}{C_t^F} = \frac{\gamma}{1-\gamma}\left(\frac{P_t^H}{P_t^F}\right)^{-\rho} \tag{2}$$

$$P_t = [\gamma(P_t^H)^{1-\rho} + (1-\gamma)(P_t^F)^{1-\rho}]^{\frac{1}{1-\rho}} \quad (3)$$

The households decide on their current and future level of consumption as well as their amount of domestic and foreign bond holdings based on the following preference structure which allows for habit persistence as captured by the term bC_{t-1}:

$$U_t = E_0 \sum_{t=0}^{\infty} \beta^t \left\{ \varepsilon_t^c \ln(C_t - bC_{t-1}) - \frac{\varepsilon_t^l}{1+\sigma_l}(L_t)^{1+\sigma_l} \right\} \quad (4)$$

where ε_t^c and ε_t^l are the preference and labor supply shocks, respectively, each having the following first-order autoregressive (AR(1)) time series representations:

$$log\, \varepsilon_t^c = \rho_c\, log\, \varepsilon_{t-1}^c + \epsilon_t^c \quad (5)$$

$$log\, \varepsilon_t^l = \rho_l\, log\, \varepsilon_{t-1}^l + \epsilon_t^l \quad (6)$$

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

$$C_t = \frac{W_t}{P_t} L_t + \Pi_t - \frac{B_{t+1} - i_{t-1} B_t}{P_t} - \frac{S_t B_{t+1}^* - S_t \Phi_{t-1} i_{t-1}^* B_t^*}{P_t} \quad (7)$$

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. The foreign interest rate is an exogenous AR(1) process. In addition, Φ_t represents a gross borrowing premium that domestic residents must pay to obtain funds from abroad, specifically:

$$\Phi_t = \Phi(b_{t+1}^*, \varepsilon_t^\Phi) \quad (8)$$

$$b_{t+1}^* \equiv \frac{S_t B_{t+1}^*}{P_t} \quad (9)$$

As in Gertler and others (2007), the country borrowing premium depends on total net foreign indebtedness and an exogenous process, ε_t^Φ, also modeled as an AR(1) process. 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 intertemporal utility maximization problem yields the following Euler equation:

$$E_t\left[\beta\frac{\lambda_{t+1}}{\lambda_t}\frac{i_t P_t}{P_{t+1}}\right]=1 \tag{10}$$

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

$$\lambda_t=\frac{\varepsilon_t^C}{C_t-bC_{t-1}} \tag{11}$$

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:

$$E_t\left\{\lambda_{t+1}\frac{P_t}{P_{t+1}}\left[i_t-\Phi_t i_t^*\frac{S_{t+1}}{S_t}\right]\right\}=0 \tag{12}$$

As will be discussed below, shocks to the UIP condition are 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). In the context of this paper, we follow suit, and use this shock to capture the financial aspect of the global financial crisis.

Wage setting

Each household is 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 services, $l_t(j)$, to a firm which transforms household labor into a homogeneous input good, L_t, using the following production function:

$$L_t=\left[\int_0^1 (l_t(j))^{\frac{1}{\mu^w}}dj\right]^{\mu^w} \tag{13}$$

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:

$$l_t(j)=\left[\frac{W_{j,t}}{W_t}\right]^{\frac{\mu^w}{1-\mu^w}}L_t \tag{14}$$

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:

$$W_{j,t} = \pi_{t-1}{}^{\gamma_w}(\pi_t^T)^{1-\gamma_w}\zeta_t W_{j,t-1} \tag{15}$$

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

Household j can re-optimize its wage according to the following dynamic program:

$$\begin{aligned}&\max_{W_{new,t}} E_t \sum_{s=0}^{\infty}(\beta\theta_w)^s \Bigg[-\frac{\varepsilon_{t+s}^l}{1+\sigma_l}(l_{t+s}(j))^{1+\sigma_l} \\ &+ \lambda_{t+s}(\pi_t\pi_{t+1} \dots \pi_{t+s-1})^{\gamma_w}(\pi_{t+1}^T\pi_{t+2}^T \dots \pi_{t+s}^T)^{1-\gamma_w}(\zeta_{t+1} \dots \zeta_{t+s})W_{new,t}l_{t+s}(j)\Bigg]\end{aligned} \tag{16}$$

where θ_w is the probability of not changing the wage rate. After inserting the relevant expressions for $l_{t+s}(j)$ in the optimization problem, the following first order condition can be derived:

$$\begin{aligned}&E_t \sum_{s=0}^{\infty}(\beta\theta_w)^s l_{t+s}(j)\Bigg[-\varepsilon_{t+s}^l(l_{t+s}(j))^{\sigma_l} \\ &+ \frac{W_{new,t}}{P_t z_t}\frac{z_{t+s}}{\mu^w}\lambda_{t+s}P_{t+s}\left(\frac{P_{t+s-1}}{P_{t-1}}\right)^{\gamma_w}(\pi_{t+1}^T \dots \pi_{t+s}^T)^{1-\gamma_w}\frac{P_{w,t}}{P_{w,t+s}}\Bigg] = 0\end{aligned} \tag{17}$$

where $-\varepsilon_{t+s}^l(l_{t+s}(j))^{\sigma_l}$ is the marginal disutility of labor. The log-linearized real wage equation, which is derived from the above equation, can be obtained as:

$$\begin{aligned}&\Xi\theta_w\widehat{w}_{t-1} + \left(\sigma_l\mu^w - \Xi(1+\beta\theta_w^2)\right)\widehat{w}_t + \beta\Xi\theta_w E_t\widehat{w}_{t+1} - \Xi\theta_w(\hat{\pi}_t - \hat{\pi}_t^T) \\ &+\beta\Xi\theta_w(E_t\hat{\pi}_{t+1} - \rho_{\overline{\pi}}\hat{\pi}_t^T) + \gamma_w\Xi\theta_w(\hat{\pi}_{t-1} - \hat{\pi}_t^T) - \gamma_w\beta\Xi\theta_w(\hat{\pi}_t - \rho_{\overline{\pi}}\hat{\pi}_t^T) \\ &+ (1-\mu^w)\hat{\lambda}_t - \sigma_l(1-\mu^w)\hat{l}_t - (1-\mu^w)\hat{\varepsilon}_t^l = 0\end{aligned} \tag{18}$$

with

$$\Xi = \mu^w\sigma_l - (1-\mu^w)/(1-\beta\theta_w)(1-\theta_w) \tag{19}$$

It should be noted that as shown in **Figure 1**, Turkey was plagued with high and persistent levels of inflation which became entrenched. These nominal rigidities, that is the sticky wages (and prices discussed below) clearly capture an important aspect of the Turkish economy. Exacerbating the persistence stemming from the stick wages (and prices), it is also assumed that indexation is prevalent across the economy. The estimation of the model would help determine the importance of these features.

Foreign Economy

In considering arbitrage in goods markets, we distinguish between the wholesale (import) price of foreign goods and its 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:

$$P_{w,t}^{F} = S_t P_t^{F*} \tag{20}$$

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

$$C_t^{H*} = \left[\left(\frac{P_t^{H*}}{P_t^{*}}\right)^{-\chi} Y_t^{*}\right]^{\varpi} (C_{t-1}^{H*})^{1-\varpi} \tag{21}$$

where Y_t^* is real foreign output (or equivalently, foreign demand) and P_t^* is the foreign price level, which are assumed to be exogenous AR(1) processes. The term $(C_{t-1}^{H*})^{1-\varpi}$ represents inertia in foreign demand for domestic products, and $P_t^{H*} = P_t^H / S_t$, where P_t^H is the retail price of exported good in domestic currency. By now one can anticipate that a shock to Y_t^* would capture the trade channel of the global financial crisis.

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 entrepreneur 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 Christiano and others (2003), 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:

$$H_t = L_t^{\Omega} L_{e,t}^{1-\Omega} \tag{22}$$

where $L_{e,t}$ is managerial labor, which is assumed to be constant as in Bernanke and others (1999). 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.

$$GY_t = \frac{P_{w,t}}{P_t} Y_t + \left(Q_t - \frac{P_{I,t}}{P_t}\delta_t\right)\omega_t K_t \tag{23}$$

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:

$$Y_t = \omega_t A_t (u_t K_t)^{\alpha} (z_t H_t)^{1-\alpha} \tag{24}$$

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

$$\frac{z_t}{z_{t-1}} = \zeta_t \tag{25}$$

$$\log \zeta_t = \rho_\zeta \log \zeta_{t-1} + \epsilon_t^{\zeta} \tag{26}$$

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

$$\delta_t = \delta + \frac{\tau}{1+\epsilon} u_t^{1+\epsilon} \tag{27}$$

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:

$$(1-\alpha)(1-\Omega)\frac{Y_t}{L_t} = \frac{W_t}{P_{w,t}} \tag{28}$$

$$(1-\alpha)\Omega\frac{\mathrm{Y_t}}{\mathrm{L_t^e}} = \frac{\mathrm{W_t^e}}{\mathrm{P_{w,t}}} \tag{29}$$

where W_t^e is the managerial wage. The optimality condition for capital utilization is:

$$\alpha \frac{Y_t}{u_t} = \delta'(u_t) K_t \frac{P_{I,t}}{P_{w,t}} \tag{30}$$

The entrepreneurs also make capital acquisition decisions. 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 are purchased by the household. Then capital financing is divided between net worth and debt, as follows (a standard balance sheet identity):

$$Q_t K_{t+1} = N_{t+1} + \frac{B_{t+1}}{P_t} \tag{31}$$

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:

$$R^k_{t+1} = \frac{GY_{t+1} - \frac{W_{t+1}}{P_{t+1}} H_{t+1}}{Q_t K_{t+1}} = \frac{\omega_{t+1}\left[\frac{P_{w,t+1}}{P_{t+1}} \alpha \frac{\bar{Y}_{t+1}}{K_{t+1}} - \frac{P_{I,t+1}}{P_{t+1}} \delta_{t+1} + Q_{t+1}\right]}{Q_t} \tag{32}$$

where , R^k_{t+1}, depends on the 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 ($Y_{t+1} = \omega_{t+1} \bar{Y}_{t+1}$). Taking expectations, the equation above can be recast as:

$$E_t R^k_{t+1} = \frac{E_t \left\{\frac{P_{w,t+1}}{P_{t+1}} \alpha \frac{\bar{Y}_{t+1}}{K_{t+1}} - \frac{P_{I,t+1}}{P_{t+1}} \delta_{t+1} + Q_{t+1}\right\}}{Q_t} \tag{33}$$

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 financing cost, thereby influencing 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 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:

$$\chi_t(.) = \chi_t\left(\frac{Q_t K_{t+1}}{N_{t+1}}\right) \tag{34}$$

$$\chi'(.) > 0,\ \ \chi(1) = 1$$

Note that role played by Q_t, the real price of capital, or perhaps more intuitively, the asset price. The equation for external finance premium suggests that, through its effect on the leverage ratio, the movements in real price of capital may affect the external finance premium significantly. Therefore, this equation provides an explicit mechanism that captures the link between asset price movements and variations in firms‘ cost of financing.

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:

$$E_t R_{t+1}^k = \chi_t\left(\frac{Q_t K_{t+1}}{N_{t+1}}\right) E_t\left[i_t \frac{P_t}{P_{t+1}}\right] \tag{35}$$

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, as mentioned above, 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:

$$V_t = R_t^k Q_{t-1} K_t - \left\{\chi_{t-1}\left(\frac{Q_{t-1} K_t}{N_t}\right) E_t\left[i_{t-1} \frac{P_{t-1}}{P_t}\right]\right\} \frac{B_t}{P_{t-1}} \tag{36}$$

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

$$N_{t+1} = \varrho_t V_t + \frac{W_t^e}{P_t} \tag{37}$$

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

$$\varrho_t = \varrho \varepsilon_t^N \tag{38}$$

$$\log \varepsilon_t^N = \rho_N \log \varepsilon_{t-1}^N + \epsilon_t^N \tag{39}$$

Here, the net worth shock, 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. Put differently, the net worth shock could be interpreted as a shock to the rate of destruction of entrepreneurial financial wealth. As is clear from above, this financial uncertainty shock directly affects entrepreneurial net worth and has been used in various forms by Elekdag and others (2006), Curdia (2007), Christiano and others (2003). Another way to think about this shock is that it could be thought of capturing counterparty risk—owing part to Knightian uncertainty—a key consideration during the global financial crisis. This heightened uncertainty regarding cash flows, for example, would impair assets and thus disrupt the financial system.

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

$$C_t^e = (1 - \varrho_t)V_t \tag{40}$$

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

Capital producer

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 $t+1$. Production technology is described by the following evolution of capital:

$$K_t = (1 - \delta_t)K_{t-1} + \left[1 - \psi\left(\frac{I_t}{I_{t-1}}\right)\right] I_t \varepsilon_t^i \tag{41}$$

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 following an AR(1) process. 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):

$$I_t = \left[(\gamma_i)^{\frac{1}{\rho_i}}(I_t^H)^{\frac{\rho_i - 1}{\rho_i}} + (1 - \gamma_i)^{\frac{1}{\rho_i}}(I_t^F)^{\frac{\rho_i - 1}{\rho_i}}\right]^{\frac{\rho_i}{\rho_i - 1}} \tag{42}$$

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 function:

$$\frac{I_t^H}{I_t^F} = \frac{\gamma_i}{1-\gamma_i}\left(\frac{P_t^H}{P_t^F}\right)^{-\rho_i} \tag{43}$$

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

$$P_t^I = [\gamma_i (P_t^H)^{1-\rho_i} + (1-\gamma_i)(P_t^F)^{1-\rho_i}]^{\frac{1}{1-\rho_i}} \tag{44}$$

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

$$\max_{\{I_t\}} \sum_{t=0}^{\infty} E_0 \left\{ \beta^t \lambda_t \left[Q_t (K_t - (1-\delta_t) K_{t-1}) - \frac{P_{I,t}}{P_t} I_t \right] \right\} \tag{45}$$

subject to the evolution of capital, and implies the following first order condition:

$$\frac{P_{I,t}}{P_t} = Q_t \varepsilon_t^i \left[1 - \psi_t - \psi_t' \frac{I_t}{I_{t-1}} \right] + \beta E_t \left\{ \frac{\lambda_{t+1}}{\lambda_t} Q_{t+1} \varepsilon_{t+1}^i \psi_{t+1}' \left(\frac{I_{t+1}}{I_t} \right)^2 \right\} \tag{46}$$

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 in a competitive manner at price $P_{w,t}$ and then differentiate the product slightly and sell their output to households, capital producers, and foreign country. Given that their output is differentiated, retailers have the monopolistic power to set prices of these final output goods.

Let $Y_t^H(i)$ be the good sold by retailer *i*. Final domestic output is a CES composite of individual retail goods, given by:

$$Y_t^H = \left[\int_0^1 Y_t^H(i)^{\frac{1}{\mu_t^H}} di \right]^{\mu_t^H} \tag{47}$$

where μ_t^H is a stochastic process determining the time-varying markup which is assumed to follow:

$$\mu_t^H = (1-\rho_{\mu^F})\mu^H + \rho_{\mu^F}\mu_{t-1}^H + \epsilon_t^{\mu^H} \tag{48}$$

The cost minimization problem implies that each retailer faces an isoelastic demand for his product given by:

$$Y_t^H(i) = \left[\frac{P_t^H(i)}{P_t^H}\right]^{\frac{\mu_t^H}{1-\mu_t^H}} Y_t^H \tag{49}$$

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:

$$P_t^H = \left[\int_0^1 P_t^H(i)^{\frac{1}{1-\mu_t^H}} di\right]^{1-\mu_t^H} \tag{50}$$

In parallel to the problem considered for wage determination, the price setting decision in retail sector is modeled as a variant of the Calvo (1983) framework with indexation. In this setting, each retailer can re-optimize its price with probability $(1-\theta_H)$, independently of the time elapsed since the last adjustment. With probability θ_H, on the other hand, the retailer is not allowed to re-optimize, and its price in period *t+1* is updated according to the scheme:

$$P_t^H(i) = \pi_{H,t-1}^{\gamma_H}(\pi_t^T)^{1-\gamma_H} P_{t-1}^H(i) \tag{51}$$

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

Under these assumptions, the retailer of domestic good which is allowed to set its price, $P_{new,t}^H$, solves the following optimization problem when setting its price:

$$\begin{aligned}\max_{P_{new,t}^H} E_t \sum_{s=0}^{\infty} (\beta\theta_H)^s \lambda_{t+s} \Bigg\{ & \left[\begin{matrix}(\pi_{H,t}\pi_{H,t+1} \dots \pi_{H,t+s-1})^{\gamma_H} \times \\ (\pi_{t+1}^T \pi_{t+2}^T \dots \pi_{t+s}^T)^{1-\gamma_H} P_{new,t}^H\end{matrix}\right] Y_{t+s}^H(i) \\ & - MC_{t+s}^H(i)(Y_{t+s}^H(i) + z_{t+s}\kappa^H)\Bigg\}\end{aligned} \tag{52}$$

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

Solving this problem, the following first-order condition is obtained:

$$E_t \sum_{s=0}^{\infty} (\beta\theta_H)^s \lambda_{t+s} \left[\frac{\left(\frac{P_{t+s-1}^H}{P_{t-1}^H}\right)^{\gamma_H} (\pi_{t+1}^T \pi_{t+2}^T \dots \pi_{t+s}^T)^{1-\gamma_H}}{\left(\frac{P_{t+s}^H}{P_t^H}\right)}\right]^{\frac{\mu_{t+s}^H}{1-\mu_{t+s}^H}} Y_{t+s}^H P_{t+s}^H \tag{53}$$

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

From the aggregate price index discussed above follows that the average price in period *t* is:

$$\begin{aligned}P_t^H &= \left[\int_0^{\theta_H}(P_{t-1}^H(\pi_{t-1}^H)^{\gamma_H}(\pi_t^T)^{1-\gamma_H})^{\frac{1}{1-\mu_t^H}}+\int_{\theta_H}^1(P_{new,t}^H)^{\frac{1}{1-\mu_t^H}}\right]^{1-\mu_t^H} \\ &= \left[\begin{array}{c}\theta_H(P_{t-1}^H(\pi_{t-1}^H)^{\gamma_H}(\pi_t^T)^{1-\gamma_H})^{\frac{1}{1-\mu_t^H}}+ \\ (1-\theta_H)(P_{new,t}^H)^{\frac{1}{1-\mu_t^H}}\end{array}\right]^{1-\mu_t^H}\end{aligned} \quad (54)$$

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

$$\begin{aligned}\hat{\pi}_t^H-\hat{\pi}_t^T = &\frac{\beta}{1+\beta\gamma_H}(E_t\hat{\pi}_{t+1}^H-\rho_{\bar{\pi}}\hat{\pi}_t^T)+\frac{\gamma_H}{1+\beta\gamma_H}(\hat{\pi}_{t-1}^H-\hat{\pi}_t^T) \\ &-\frac{\gamma_H\beta(1-\rho_{\bar{\pi}})}{1+\beta\gamma_H}\hat{\pi}_t^T+\frac{(1-\theta_H)(1-\beta\theta_H)}{\theta_H(1+\beta\gamma_H)}(\widehat{mc}_t^H+\hat{\mu}_t^H)\end{aligned} \quad (55)$$

Retailers of Imported Good

The import sector consists of a 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 $S_tP_t^{F*}$. In order to allow for incomplete exchange rate pass-through to the consumption and investment import prices, we assume local currency price stickiness. In particular, similar to the domestic good retailer case, the importing firms follow a Calvo (1983) price setting framework and are allowed to change their price only when they receive a random price change signal with probability $(1-\theta_F)$. The firms that are not allowed to re-optimize, update their prices according to the scheme similar to the domestic retailer's case:

$$P_t^F(i)=\pi_{F,t-1}^{\gamma_F}(\pi_t^T)^{1-\gamma_F}P_{t-1}^F(i) \quad (56)$$

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

Let $Y_t^F(i)$ denote the good sold by imported retailer *i*. Then, the final imported good (sum of consumption and investment imported good) is a CES composite of individual retail goods, given by:

$$Y_t^F = \left[\int_0^1 Y_t^F(i)^{\frac{1}{\mu_t^F}} di \right]^{\mu_t^F} \tag{57}$$

where μ_t^F is a stochastic process determining the time-varying markup for importing good firms which is assumed to follow:

$$\mu_t^F = (1 - \rho_{\mu^F})\mu^F + \rho_{\mu^F}\mu_{t-1}^F + \epsilon_t^{\mu^F} \tag{58}$$

The cost minimization problem implies that each retailer faces an isoelastic demand for his product given by:

$$Y_t^F(i) = \left[\frac{P_t^F(i)}{P_t^F}\right]^{\frac{\mu_t^F}{1-\mu_t^F}} Y_t^F \tag{59}$$

where $P_t^F(i)$ denotes the price of retailer *i* and P_t^F is the corresponding price of the composite final imported good, given by:

$$P_t^F = \left[\int_0^1 P_t^F(i)^{\frac{1}{1-\mu_t^F}} di \right]^{1-\mu_t^F} \tag{60}$$

Under these assumptions, the profit maximization problem of the imported good firm which is allowed to set its price is given by:

$$\max_{P_{new,t}^F} E_t \sum_{s=0}^{\infty} (\beta\theta_F)^s \lambda_{t+s} \left\{ \left[\begin{matrix} (\pi_{F,t}\pi_{F,t+1} \dots \pi_{F,t+s-1})^{\gamma_F} \times \\ (\pi_{t+1}^T \pi_{t+2}^T \dots \pi_{t+s}^T)^{1-\gamma_F} P_{new,t}^F \end{matrix} \right] Y_{t+s}^F(i) - MC_{t+s}^F(i)(Y_{t+s}^F(i) + z_{t+s}\kappa^F) \right\} \tag{61}$$

where κ^F is fixed cost of the imported good firm and $MC_t^F = S_t P_t^{F*}$.

The problem yields the following first-order condition:

$$E_t \sum_{s=0}^{\infty} (\beta\theta_F)^s \lambda_{t+s} \left[\frac{\left(\frac{P_{t+s-1}^F}{P_{t-1}^F}\right)^{\gamma_F} (\pi_{t+1}^T \pi_{t+2}^T \dots \pi_{t+s}^T)^{1-\gamma_F}}{\left(\frac{P_{t+s}^H}{P_t^H}\right)} \right]^{\frac{\mu_{t+s}^F}{1-\mu_{t+s}^F}} Y_{t+s}^H P_{t+s}^H \times \left[\frac{\left(\frac{P_{t+s-1}^F}{P_{t-1}^F}\right)^{\gamma_F} (\pi_{t+1}^T \pi_{t+2}^T \dots \pi_{t+s}^T)^{1-\gamma_F}}{\left(\frac{P_{t+s}^F}{P_t^F}\right)} \frac{P_{new,t}^F}{P_t^F} - \mu_t^F \frac{MC_{t+s}^F}{P_{t+s}^F} \right] = 0 \tag{62}$$

The first order condition and aggregate price index for imported goods given above yield the following log-linearized Phillips curve relation for imported good inflation;

$$\hat{\pi}_t^F - \hat{\pi}_t^T = \frac{\beta}{1+\beta\gamma_F}(E_t\hat{\pi}_{t+1}^F - \rho_{\bar{\pi}}\hat{\pi}_t^T) + \frac{\gamma_F}{1+\beta\gamma_F}(\hat{\pi}_{t-1}^H - \hat{\pi}_t^T) - \frac{\gamma_F\beta(1-\rho_{\bar{\pi}})}{1+\beta\gamma_F}\hat{\pi}_t^T + \frac{(1-\theta_F)(1-\beta\theta_F)}{\theta_F(1+\beta\gamma_F)}(\widehat{mc}_t^F + \hat{\mu}_t^F) \tag{63}$$

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:

$$\hat{\imath}_t = \rho_i\hat{\imath}_{t-1} + (1-\rho_i)\left[\hat{\pi}_t^T + \tau_\pi(E_t\hat{\pi}_{t+1} - \rho_{\bar{\pi}}\hat{\pi}_t^T) + \tau_y\hat{y}_t + \tau_s(\hat{s}_t - \hat{s}_{t-1})\right] + \epsilon_t^i \tag{64}$$

where ϵ_t^i denotes an independent and identically distributed domestic 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 evolve according to the following stochastic process:

$$\hat{\pi}_t^T = \rho_{\bar{\pi}}\hat{\pi}_{t-1}^T + \epsilon_t^\pi \tag{65}$$

Anticipating the results to follow, notice that when the output gap is negative—that is output is below potential—strict adherence to the rule above would imply that the interest rate decreases by an amount dictated by the coefficient τ_y . However, the monetary authority might decrease interest rates by more than what the systematic component of the rule would imply. This deviation from the rule is capture by the error term, which is the monetary policy shock. As will be discussed in further detail below, during the most intense episode of the global financial crisis, interest rates decreased by more than the amount the empirical counterpart of the rule would have implied.

Market Clearing Conditions

Finally, good market equilibrium is defined by the following equations:

$$Y_t^H = C_t^H + C_t^{eH} + I_t^H + C_t^{H*} + G_t \tag{66}$$

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

In the model, all nominal variables are scaled by consumer price index, P_t, and all real variables, except labor, are scaled by the real stochastic trend, z_t, in order to render the model stationary. Then the model is log-linearized around its steady state.

Estimation

The log-linearized model is estimated using Bayesian methods primarily developed by Schorfheide (2000), and later popularized by Smets and Wouters (2003, 2007). In what follows, we discuss the data used in the estimation process, the calibration of the parameters that pin down key steady state ratios, the prior and posterior distributions of the estimated parameters, and then end with an assessment of the fit of the model.

Data

The model is estimated using quarterly data from the first quarter of 2002 to the second quarter of 2010 using the series shown in **Figure 3**. In line with many other studies, we have chosen to match the following set of twelve variables: the levels of the domestic policy and foreign interest rates, the inflation rates of domestic GDP deflator and core consumer price and foreign consumer price indices, as well as the growth rates of GDP, consumption, investment, exports, imports, foreign GDP, and the real exchange rate. This implies that we derive the state space representation for the following vector of observed variables (shown using model notation):

$$Y_t^{observable} = \{\pi_t^H, \pi_t, \pi_t^*, i_t, i_t^*, \Delta lnY_t, \Delta lnC_t, \Delta lnI_t, \Delta lnC_t^{H*}, \Delta lnM_t, \Delta lnY_t^*, \Delta lnRER_t\},$$

where, just to avoid any ambiguity, ΔlnC_t^{H*}, and, $\Delta lnRER_t$, denote the growth rates of exports and the real exchange rate, respectively. As is common in the literature, standard transformations were needed to align the data with the model-based definitions. For example, all interest rates are divided by four so that the periodic rates are consistent with the quarterly time series. In addition, in order to make observable variables consistent with the corresponding model variables, the data are demeaned by removing their sample mean, with the exception of inflation and the interest rates, which are demeaned by subtracting their steady-state values, A spreadsheet which contains our estimation dataset and shows in detail all of our data transformations (including, for example, seasonal adjustment) is available upon request.

As discussed above, the various regimes changes, structural breaks, and their attendant effects on the Turkish time series suggests that utilizing a longer time span could yield spurious inference. In fact, the sample period used for estimation covering the 2002–2010 period under consideration captures the episode when the CBRT was transitioned to an inflation targeting regime (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 in similar length including Del Negro and Schorfheide (2008).

Regarding the foreign variables, a weighted average of the time series from the United States and the Euro area were used for real GDP, interest rate, and inflation rate. These two large economies were chosen owing to data availability and because the Euro area is Turkey‘s largest trading partner—the destination of over fifty percent of Turkish exports—and the

United States is where the recent global financial crisis originated. We tried various other combinations, including, for example, using just the time series from the United States, and found that our main results do not change noticeably.

Calibrated parameters

We followed the literature and calibrate certain parameters (see, for example, Christiano and others, 2010), which could be thought of as infinitely strict priors. Many of the parameters are chosen to pin down key steady state ratios, while the remaining parameters are taken from the literature as summarized in **Table 2**.

To this end, we chose the values of α, δ, γ, and γ_i, to calibrate the consumption-, investment-, government expenditures-, and exports-to-GDP ratios to the values of 70, 20, 10, and 24 percent, respectively. The parameter β was fixed at 0.9928 implying an annual riskless real interest rate of approximately three percent, close to many other studies in the literature.

Regarding the calibration of the financial accelerator, we wanted to fit the leverage ratio of two for the year 2007 shown in **Table 1** and the average EMBI spread of 300 basis points, over the 2004-2010 period which excludes the immediate aftershocks of the 2001 financial crisis. To achieve these steady state values, the parameters for the entrepreneurial survival rate, the monitoring cost fraction, and the variance of the shocks to entrepreneurial productivity were chosen to be 0.9728, 0.15, and 0.40, respectively.

The remaining calibrated parameters were taken from the literature. For example, the share of entrepreneurial labor is set at 0.01 as in Bernanke and others (1999). The steady state price and wage markups were chosen to be 15 percent, which lies in the 10 to 20 percent range utilized in many other studies. The remaining parameters were based off Gertler and others (2007) and include various elasticities of substitution summarized in **Table 2**.

Prior distributions of the estimated parameters

The remaining 43 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 our choices of prior means for some parameters across some selected papers. For the Calvo (1983) parameters, we set the mean of the prior distribution 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. Lastly, the priors guiding most of the standard deviations of the shocks are based on an inverse gamma distribution, typically centered around 0.03 with one degree of freedom.

Posterior distributions of the estimated parameters

The posterior estimates of the variables are also shown in **Table 3**. The table reports the means along with the 5^{th} and 95^{th} percentiles of the posterior distribution of the estimated parameters obtained through the Metropolis-Hastings sampling algorithm. The results are based on a total of 500,000 draws and two independent chains, and the Brooks and Gelman (1998) convergence criteria are achieved.

Additional information on our estimation results is presented in Appendix Figure 1a through Appendix Figure 1c, which plot the kernel density estimates for the posteriors, together with the priors for the estimated parameters. These kernel density estimates provide a visual summary indicating that the data are quite informative regarding most of the estimated parameters.

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 others (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 of the economies investigated are different, sample periods and the choice of time series used also differ. For example, this paper deliberately includes the arguably most intense periods of the recent global financial crisis, while most (if not all) other studies do not. Third, 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, 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. By contrast to wages and imports prices, domestic prices seem to adjust every 1.5 quarters. Relatedly, the parameters dictating the degree of indexation are found to be in the 0.5–0.6 range, implying that the Philips curve have significant backward looking components. These findings are quite close to those presented by Adolfson and other (2007) and Teo (2009). As for the real rigidities, the estimates regarding habit formation and investment adjustment costs are 0.9 and 3.6, 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 0.7, in line with many other studies. 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 to the nominal exchange rate depreciation is smaller echoing the findings of Elekdag and others (2006). The responsiveness of policy rates to the output gap takes on an even lower value of 0.02. It should be noted that although the interest rate rule coefficient implies a small systematic response of policy rate to output gap, it will be shown that CBRT responded to the large output drops during the crisis through discretionary departures from the rule.

Turning to the exogenous shocks, we start off by discussing persistence. The estimated persistence parameters lie within the range of 0.49 for the unit root technology shock, and 0.93 for the foreign demand shock. The 95th percentile of this shock persistence parameter is estimated to be 0.96 indicating an absence of unit roots in these processes. The results also echo the general finding in Adolfson and others (2007) which is that the persistence parameters in our open economy setup are typically below those in close economy frameworks like Smets and Wouters (2003). As for standard deviations, the foreign interest rate shock is the least volatile, whereas the variability of the preference and investment shocks are noteworthy. It may also be useful to point out that as in other studies, the unit-root technology shock is more volatile than the stationary technology shock. As we will discuss in further detail below, in terms of driving the business cycle, we shall see that the unit-root technology shocks plays a much more prominent role, which is consistent with the theoretical predictions of Aguiar and Gopinath (2007).

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 3** indicating that the sample fit is generally satisfactory.

First note that the model and data track each other well with respect to the interest rate and inflation rate series. The model is able to capture the downtrend in these variables during the disinflation process in Turkey over our estimation sample. In fact, the correlations between the model and the data for the inflation and interest rates are over 0.95 and 0.99, respectively. Turning to the real variables, the model‘s consumption and investment predictions closely mimic the data (with correlation coefficients exceeding of 0.97 and 0.99, respectively).

However, the fit of the model deteriorates for some other variables. In particular, the actual evolution of exports markedly differs from what the model predicts. Recall that our sample intentionally includes the recent global financial crisis including the attendant collapse in global trade. Intuitively, the model‘s external linkages seem to have difficulty replicating the unprecedented nature of this period. Also, Turkey‘s main export destinations have been changing relatively rapidly more recently. Exporters have been quite successful in diversifying across destinations and penetrating new markets (for example, the Middle East and North Africa). The (unstable) interaction between exports and the real exchange rate also could be a culprit. This appears to be related to the exchange ‗disconnected‘ puzzle discussed in by Devereux and Engel (2002) as well as Duarte and Stockman (2005).

Sensitivity Analysis

As discussed in the main text, we investigate the importance of the various features of the model by either reducing the degree of certain nominal and real frictions, omitting a shock process, or evaluating another policy rule. Using the posterior odds ratio as our decision metric, the baseline model seems to outperform the other competing models. As summarized in **Table 4**, we consider 18 alternative specifications, and in all but one case, the results are decisively in favor of the baseline, whereas in the remaining case, the results very strongly favor the baseline. 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, and ratios above 100 provide decisive evidence in favor of our baseline model. 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, a result also discussed extensively in Elekdag and others (2006), and later in Garcia-Cicco (2010).

- Second, the baseline is favored to models with low nominal and real rigidities. In other words, as compared to the canonical real business cycle or New Keynesian models, other features are needed to better fit the data.

- Third, 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, Smets and Wouters (2003) noted the role of labor supply shocks, and Justiniano and others (2007) find a critical role of investment-technology shocks in accounting the variability of output dynamics. The sensitivity analysis confirms the insight of these previous studies.

- Fourth, 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 baseline model is decisively chosen in contrast to a specification where the financial shocks (financial uncertainty and the UIP shocks) are eliminated. In line with Ireland (2007), we also consider a model where the persistence parameter of the time-varying inflation target is set to unity; once again the results are decisively in favor of the baseline specification.

- Fifth, we consider five alternative monetary policy rules. In sum, the results are at least very strongly in favor of the baseline specification. As shown in the table, as in Smets and Wouters (2003), the change in output and the inflation rate is added, the nominal depreciation rate is dropped, or a combination thereof. We also consider cases without interest rate smoothing, strict inflation targeting, and lastly, a fixed exchange rate regime. Especially regarding the later, the results are decisively in favor of the model with a baseline interest rate rule.

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.

Model dynamics

As mentioned in the main text, the shocks are categorized into three groups. The first group consisted of the monetary policy shock which was discussed extensively. In what follows we investigate the impulse responses of the other two groups, which include the crisis shocks and the other supply and demand shocks.

- We first consider shocks to the UIP condition. Here we have two choices: we could either focus on foreign interest rate shocks, or an exogenous shock to the condition itself. In our model, the foreign interest rate shock is pinned down by the foreign interest rate data used in the estimation process. Nonetheless, the estimated persistence coefficients of the two shocks are similar, and therefore the impulse responses related to these shocks are alike as shown in Appendix Figure 2a and Appendix Figure 2b. For the purposes of this paper, because it matches the narrative more closely, the first ―crisis" shock we focus on is the exogenous shocks to the UIP condition, which we also refer to as the risk premium shock. In what follows, while we focus on the baseline model—with an operational financial accelerator and flexible exchange rates—we also present the dynamics under a fixed exchange rate regime (sometimes referred as a peg) and when the financial accelerator mechanism is shut off.

- In the case of the risk premium shock, it might be useful to first start off discussing the dynamics under the fixed exchange rate regime. As shown in Appendix Figure 2a, the shock to the UIP condition results in an increase in the domestic nominal interest rate. Because prices are sticky, this translates into an increase in the real interest rate, thereby leading to a contraction. As expected, the financial accelerator amplifies the initial impact of this shock. The rise in the real interest rate causes asset prices to fall, which raises the leverage ratio and thus the external finance premium. The increase in the latter further depresses investment, and therefore output. Under the baseline, the depreciation of the exchange rate helps offset some of the adverse effects of the shock—in other words, the flexibility of the nominal exchange rate serves as a shock absorber. Real interest rates do not display a spike and the real exchange rate actually depreciates by more, both which serve to soften the impact of the shock. Intuitively, under the case with flexible exchange rates and no financial accelerator, the shock has an even smaller perverse effect on output.

- The shock to foreign demand is shown in Appendix Figure 3a. A foreign demand shocks is essentially a decrease in exports and therefore directly depresses aggregate demand. As discussed in Devereux and others (2006), such income shocks are similar to terms of trade shocks as we will highlight further below. Under the baseline, the sudden nominal exchange rate depreciation is the main driver of the real exchange rate in the short-term, and helps mitigate the impact of the shock.

- The financial uncertainty shock impairs the balance sheet of the entrepreneur by eroding the value of net worth and is shown in Appendix Figure 3b. The sudden decline in the value of equity causes an increase in the leverage ratio, and therefore the external finance premium, thereby generating a decline in investment and output. While the shock is estimated to be modestly persistent (with an autoregressive coefficient of 0.72), the balance sheet of the entrepreneur evolves gradually adding to the protracted nature of this shock. Another interesting feature of this shock is that it converts the financial frictions from an accelerator to an attenuator because of endogenous counter-cyclical adjustments as discussed in Christiano and others (2010). This point is also made by Christensen and Dib (2008) who state that the effect of the financial accelerator on output and investment fluctuations depends on the nature of the shocks. Iacoviello (2005)—using a framework based on Kiyotaki and Moore (1997) rather than Bernanke, Gertler, and Gilchrist (1999)—illustrates these differences using nominal debt contracts whereby a supply shock, by increasing prices, decreases the real value of debt (the debt deflation channel) which serves to dampen the effects of supply shocks. Also note that because the fixed exchange rate is associated with a lower real interest rate and small appreciation of the real exchange rate, the contraction in output is not as severe as under the baseline.

- It might also be useful to discuss some of the other supply and demand shocks in the model. We first consider a shock to trend growth, also referred to as a unit-root technology shock. Aguilar and Gopinath (2007) argue that this type of trend shock us a key determinant of business cycle fluctuations across emerging markets. As shown in Appendix Figure 4a, because the shock permanently affects the trend, the output gap settles at a permanently lower level. Owing to the permanent nature of the shock, household consumption decreases and is associated with a real exchange rate depreciation (see, for example, Teo, 2009). Under the peg, the nominal exchange rate does not depreciate by definition and thus the decrease in inflation is greater. This situation is characterized by a larger rise in the real interest adding to the decline in output.

- Next we consider a stationary technology shock shown in Appendix Figure 4b. This is the benchmark supply shock which has been attributed a pivotal role in the real business cycle literature as it has been documented to be an important source of business cycle fluctuations in open economies. As shown, the output gap widens while inflation increases—the intuitive textbook negative correlation between (the changes in) output and prices. By contrast to its permanent counterpart discussed above, the stationary technology shock induces households to smooth consumption fluctuations by borrowing internationally, which is characterized by the appreciation of the exchange rate.

- The model contains five other supply shocks, but because of similarities, here we focus on two interesting cases. There are three reasons: brevity, similarity of the impulse responses, and because some shocks have a negligible role in terms of contributing to growth (for example that markup shock affecting importers). To start off, consider the domestic markup shock popularized by Smets and Wouters (2003) shown in Appendix Figure 5a. Casual observation quickly reveals that it is remarkably similar to the stationary technology shock. One difference is that under the baseline, the external finance premium increases thereby making the output contraction slightly more severe than in the case with the financial accelerator operational. The model is also buffeted with a labor supply shock, but this is not shown because of the resemblance to the domestic markup shock. We also consider a foreign cost push shock as depicted in Appendix Figure 5b. With the risk of oversimplification, this could be thought of as a terms of trade (oil price) shock. Notice that the dynamics are remarkably similar to those of the foreign demand shock. This is because, as discussed above and noted by Devereux and others (2006), terms of trade shocks bear semblance to income shocks to the external sector.[10]

- Lastly, we turn to the two remaining demand shocks. Appendix Figure 6a and Appendix Figure 6b depict the government spending and preference shocks. In general, contractionary demand shocks puts downward pressure on real marginal costs and thereby inflation. However, as shown in the figures, the choice of exchange rate regime has an important bearing on the final outcomes of exchange and interest rates as well as the external finance premium.[11]

Growth counterfactual

While the main text discussed the counterfactual scenarios using levels of real GDP, we could have also conveyed the same policy messages using the (demeaned, year-over-year) growth rates under the baseline (actual) and counterfactuals simulations as shown in Appendix Figure 7. In sum, without the adoption of an inflation targeting framework underpinned by a flexible exchange rate regime, the impact of the recent global financial crisis would have been substantially more severe. It is worth emphasizing that while the growth rates under the fixed exchange rates regimes are quite high in the last few quarters of our sample, this is a main a results of base effects. In particular, as shown in Figure 9, the level of economic activity is substantially depressed under the fixed exchange rate regimes, thereby the year-over-year growth rates include this base effect and should accordingly be carefully interpreted.

[10] Given the negligible role in terms of contributing to growth, we do not discuss the markup shock that affects the importers (however, the results are available from the authors upon request).

[11] Given the negligible role in terms of contributing to growth, we do not discuss the inflation target shock (however, the results are available from the authors upon request).

Table 1. Turkey: Financial Ratios Across Selected Industries[1]

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

Sources: CBRT; and authors' calculations.

[1] 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

Parameter	Symbol	Value
Discount factor	β	0.9928
Consumption intra-temporal elasticity of substitution	ρ	1
Share of domestic goods in consumption	γ	0.75
Investment intra-temporal elasticity of substitution	ρ_i	0.25
Share of domestic goods in investment	γ_i	0.77
Inverse 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 markup rate for domestically produced goods	μ^H	1.15
Steady state markup rate for imported goods	μ^F	1.15
Steady state 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	δ	0.035
Elasticity of country risk premium with respect to net foreign debt	Φ	0.01

Source: Authors' calculations.

Table 3. Prior and Posterior Distributions

Parameter		Prior distribution			Posterior distribution		
Description	**Symbol**	**Type**	**Mean***	**Standard deviation**	**Mean**	**Confidence interval 5%**	**95%**
Calvo parameter							
Domestic prices	θ_H	Beta	0.50	0.10	0.306	0.177	0.435
Import prices	θ_F	Beta	0.50	0.10	0.554	0.434	0.679
Wages	θ_W	Beta	0.50	0.10	0.558	0.387	0.739
Indexation							
Domestic prices	γ_H	Beta	0.50	0.10	0.460	0.296	0.623
Import prices	γ_F	Beta	0.50	0.10	0.475	0.313	0.641
Wages	γ_W	Beta	0.50	0.10	0.562	0.400	0.731
Others							
Export demand elasticity	χ	Normal	1.00	0.20	0.182	0.090	0.271
Export demand inertia	ϖ	Beta	0.50	0.20	0.883	0.794	0.979
Habit formation	b	Beta	0.70	0.20	0.904	0.850	0.958
Investment adjustment cost	ψ	Normal	4.00	0.50	3.625	2.769	4.511
Monetary policy							
Interest rate smoothing	ρ_i	Beta	0.70	0.20	0.724	0.639	0.808
Inflation response	τ_π	Normal	1.40	0.10	1.537	1.383	1.685
Output gap response	τ_y	Normal	0.25	0.10	0.021	-0.022	0.064
Nominal exchange rate response	τ_s	Normal	0.10	0.05	0.173	0.101	0.242
Shock persistence							
Stationary technology	ρ_a	Beta	0.80	0.10	0.767	0.593	0.939
Unit root technology	ρ_ξ	Beta	0.80	0.10	0.497	0.386	0.604
Investment specific technology	ρ_{inv}	Beta	0.80	0.10	0.916	0.893	0.940
Domestic markup	ρ_{μ^h}	Beta	0.80	0.10	0.774	0.609	0.945
Import markup	ρ_{μ^f}	Beta	0.80	0.10	0.713	0.545	0.881
Foreign inflation	ρ_{π^*}	Beta	0.80	0.10	0.623	0.459	0.792
Foreign interest rate	ρ_{i^*}	Beta	0.80	0.10	0.847	0.751	0.948
Country risk premium	ρ_ϕ	Beta	0.80	0.10	0.895	0.836	0.956
Foreign demand	ρ_{y^*}	Beta	0.80	0.10	0.928	0.892	0.962
Preference	ρ_c	Beta	0.80	0.10	0.721	0.556	0.888
Labor supply	ρ_l	Beta	0.80	0.10	0.762	0.605	0.931
Exogenous spending	ρ_g	Beta	0.80	0.10	0.868	0.791	0.944
Net worth	ρ_N	Beta	0.80	0.10	0.715	0.574	0.856
Inflation target	$\rho_{\bar{\pi}}$	Beta	0.80	0.10	0.769	0.620	0.931
Shock volatility							
Stationary technology	σ_a	Inverse gamma	0.03	1.00	0.015	0.009	0.022
Unit root technology	σ_ξ	Inverse gamma	0.03	1.00	0.047	0.036	0.057
Investment specific technology	σ_{inv}	Inverse gamma	0.03	1.00	0.421	0.334	0.504
Domestic markup	σ_{μ^h}	Inverse gamma	0.03	1.00	0.020	0.009	0.030
Import markup	σ_{μ^f}	Inverse gamma	0.03	1.00	0.052	0.032	0.072
Foreign inflation	σ_{π^*}	Inverse gamma	0.03	1.00	0.008	0.007	0.010
Foreign interest rate	σ_{i^*}	Inverse gamma	0.03	1.00	0.005	0.004	0.005
Country risk premium	σ_ϕ	Inverse gamma	0.03	1.00	0.011	0.007	0.015
Foreign demand	σ_{y^*}	Inverse gamma	0.03	1.00	0.063	0.048	0.077
Preference	σ_c	Inverse gamma	0.30	1.00	0.429	0.218	0.642
Labor supply	σ_l	Inverse gamma	0.03	1.00	0.016	0.007	0.024
Exogenous spending	σ_g	Inverse gamma	0.03	1.00	0.046	0.036	0.055
Net worth	σ_N	Inverse gamma	0.05	1.00	0.061	0.035	0.086
Inflation target	$\sigma_{\bar{\pi}}$	Inverse gamma	0.02	1.00	0.012	0.005	0.020
Monetary policy	σ_i	Inverse gamma	0.03	1.00	0.007	0.005	0.008

Source: Authors' calculations.

* For the inverse gamma distribution, the mean and the degrees of freedom are reported in the table.

Table 4. Sensitivity Analysis

		Log Data Density	Posterior Odds Ratio	Is the Alternative Model Superior?
	Baseline	802.482		
	Sensitivity to frictions			
1	Financial accelerator	779.963	6.025E+09	No
2	Low price stickiness	787.606	2.888E+06	No
3	Low stickiness including wages	726.449	1.049E+33	No
4	Low habit persistence	719.789	8.193E+35	No
5	Low investment costs	753.752	1.456E+21	No
	Sensitivity to shocks			
6	Technology (all)	619.305	3.573E+79	No
7	Labor supply	706.645	4.185E+41	No
8	Investment-specific technology	664.178	1.161E+60	No
9	Preference	664.068	1.296E+60	No
10	Government	699.794	3.951E+44	No
11	Financial (uncertainty and UIP)	796.283	4.924E+02	No
12	Unit root inflation target	794.754	2.272E+03	No
	Sensitivity to policy rules			
13	Add change in output and inflation	798.223	7.073E+01	No
14	Baseline rule, but without ΔS rule	796.913	2.622E+02	No
15	Same as (13), but without ΔS	792.821	1.570E+04	No
16	No interest rate smoothing	779.072	1.469E+10	No
17	Strict inflation targeting	776.368	2.193E+11	No
18	Fixed exchange rate regime	752.835	3.644E+21	No

Source: Authors' calculations.

Table 5. The Role of Monetary Policy and Financial Reforms

(In percent)

			Growth contributions of monetary policy owing to:				
			[1]	[2]	[3]	[4]	[5]
	Quarters	Cut in policy rate	Monetary policy shocks	Responsiveness to the output gap	Flexible exchange rate regime	Reduced financial vulnerability	All factors ([1]—[4])
Average							
2008Q4—2009Q4	5	1.98	**1.18**	0.32	2.22	1.69	5.42
2009Q1—2009Q4	4	2.40	**1.14**	0.35	1.86	1.45	4.81
Christiano and others (2008)							
United States (2001Q2-2002Q2)	4		0.75				
Euro area (2001q4-2004q4)	13		1.27				
Cumulative							
2008Q4—2009Q4	5	9.90	5.92	1.60	11.11	8.44	27.08
2009Q1—2009Q4	4	9.59	4.56	1.42	7.45	5.81	19.23
Christiano and others (2008)							
United States (2001Q2-2002Q2)	4		3.00				
Euro area (2001q4-2004q4)	13		17.00				

Source: Authors' calculations.

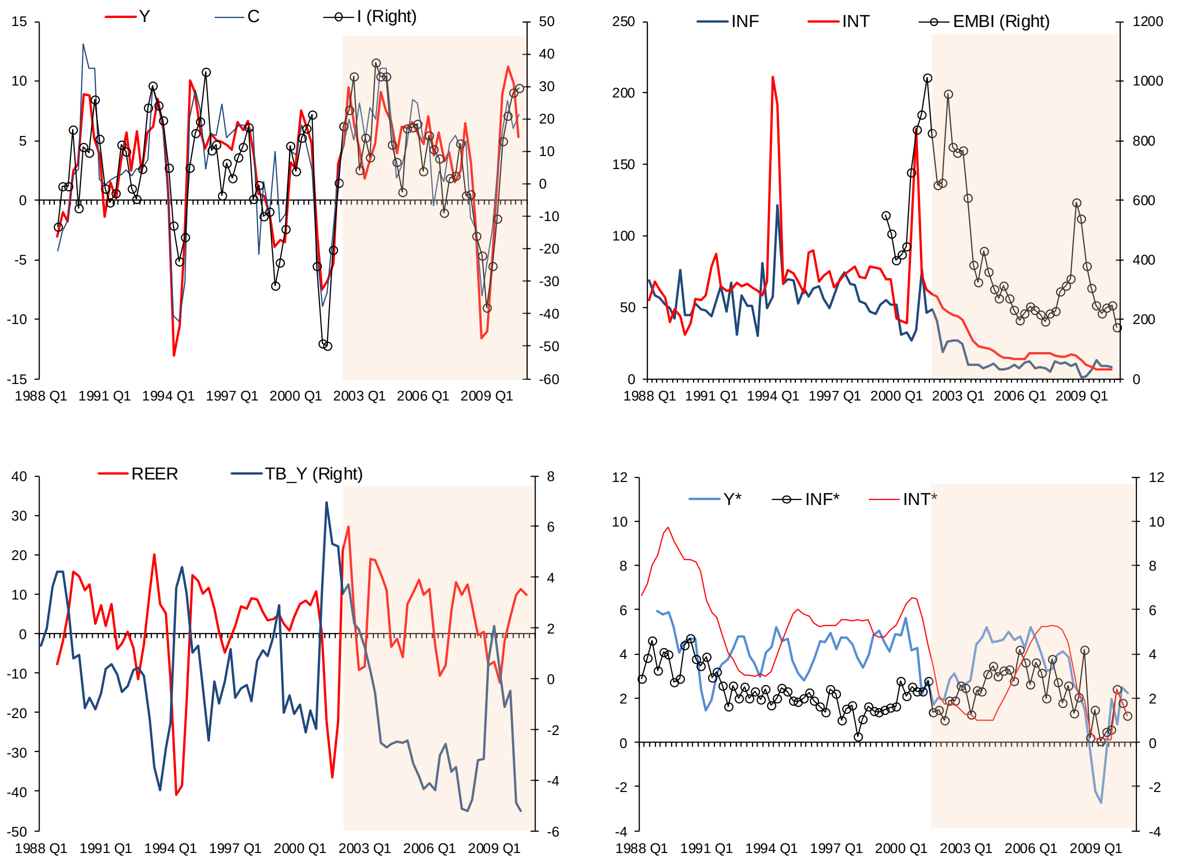
Table 6. Measuring the Severity of Economic Contractions

(In percent; calculations relative to actual 2009 annual real GDP growth)

	Growth	Difference	Cumulative Difference
Baseline (actual)	–4.8		
No monetary policy shocks	–5.9	–1.1	–1.1
No response to output gap	–6.2	–0.3	–1.4
Fixed exchange rate regime (peg)	–8.0	–1.8	–3.2
Peg with heightened financial vulnerability	–9.3	–1.3	–4.5

Source: Authors' calculations.

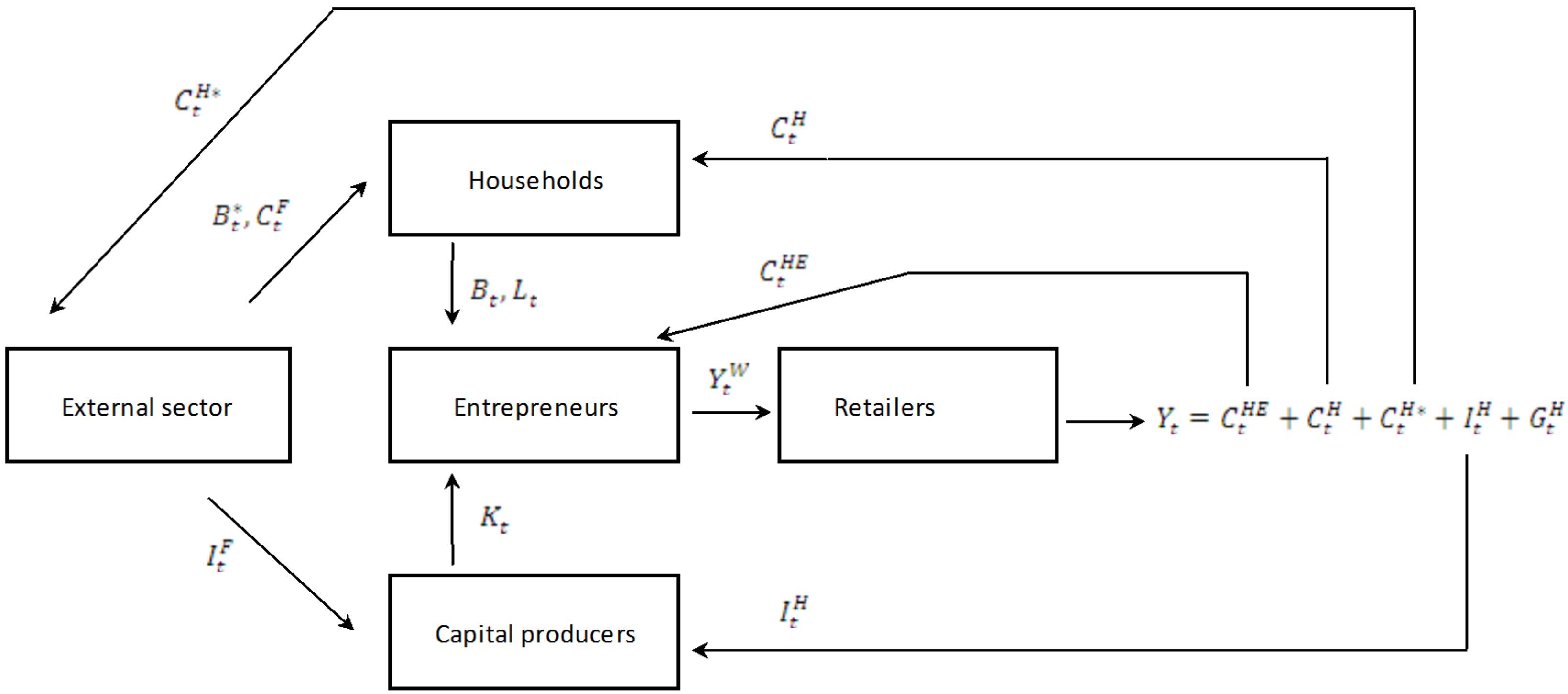
Figure 1. Turkey: Selected Macroeconomic Indicators[1]
(Year-over-year growth rates and levels)



Sources: CBRT; Bloomberg; and authors' calculations.

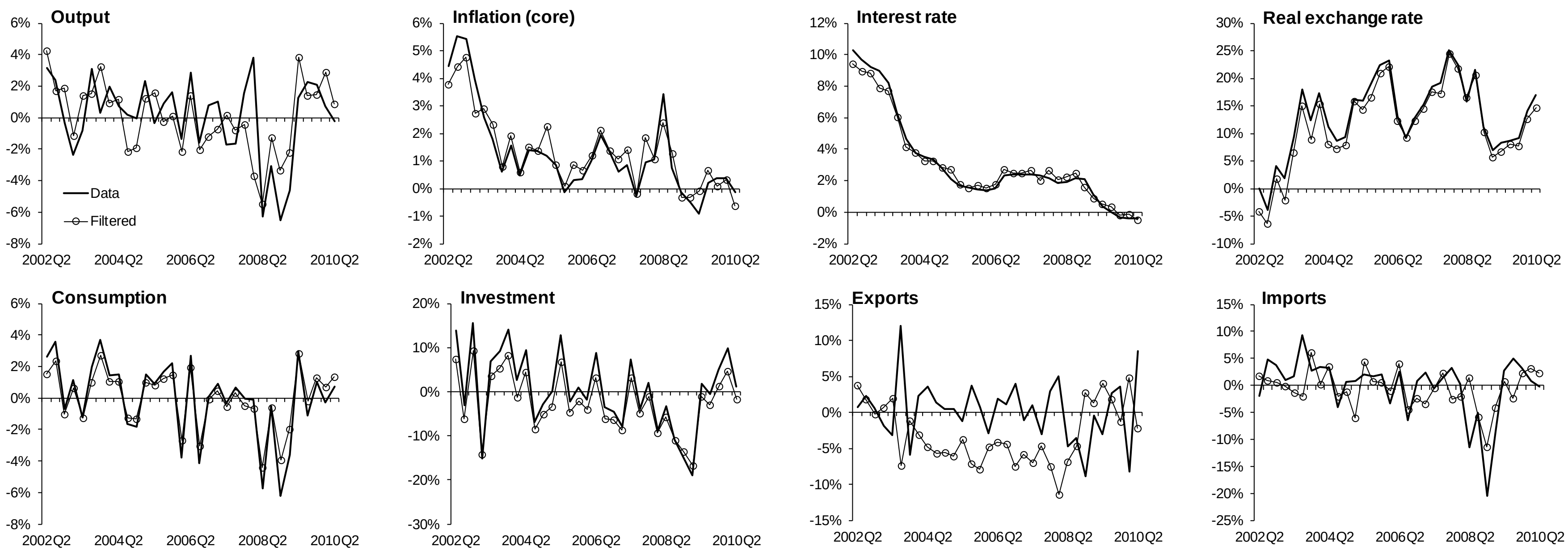
[1] Y, C, I, INT, INF, REER, and TB/Y denote real GDP, real consumption, real investment, overnight interest rates, quarterly inflation rates, real effective exchange rate and the trade balance-to-GDP ratio. EMBI represents JP Morgan's EMBI+ series for Turkey (in basis points). The series with an asterisk 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 Schematic



Source: Authors' calculations.

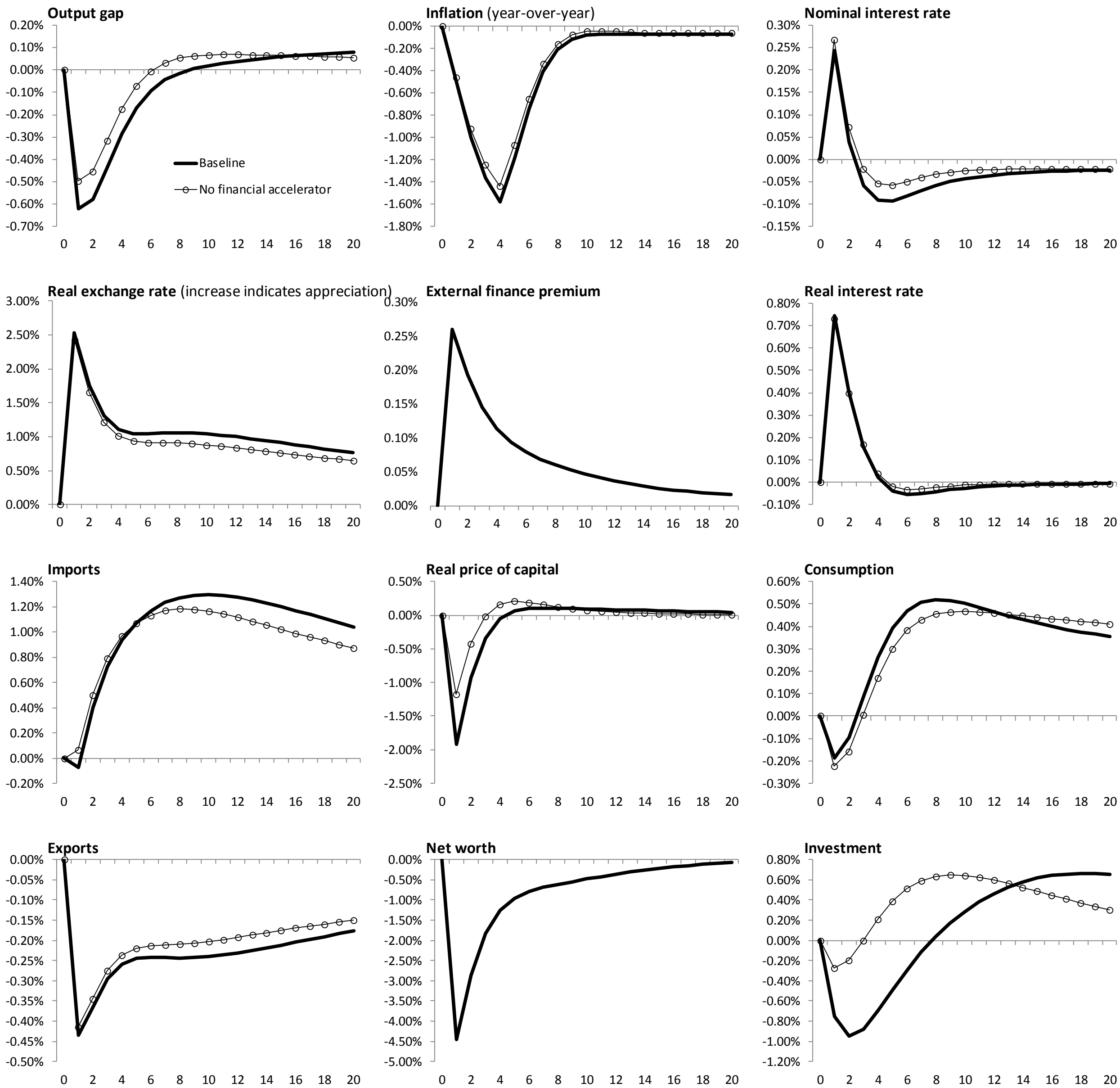
Figure 3. Model Predictions versus the Data[1]



Source: Authors' calculations.

[1] Data in thick black versus filtered thin lines with circles, see text for further details.

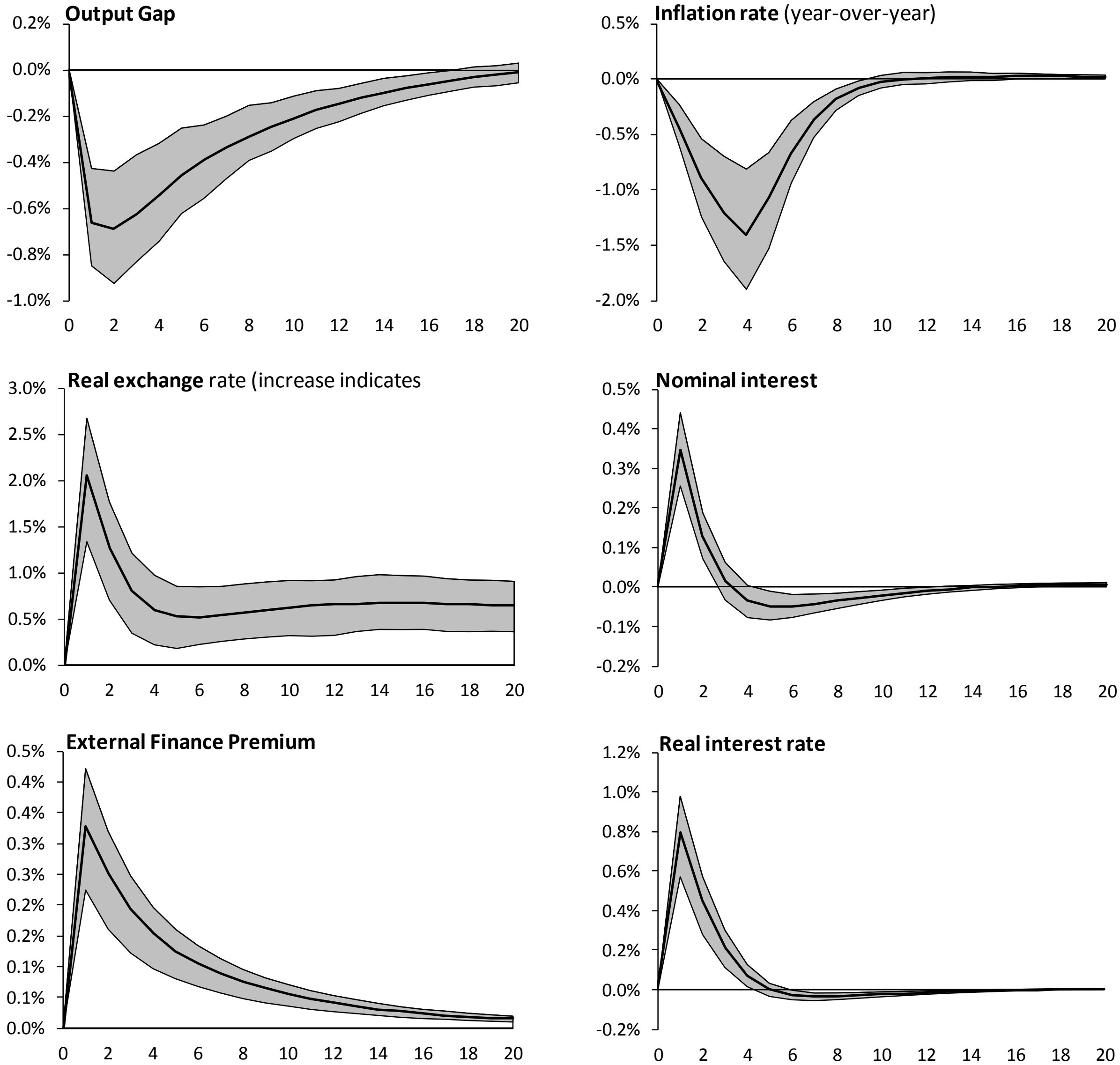
Figure 4. Dynamic Responses to a Monetary Policy Shock[1]



Source: Authors' calculations.

[1] Interest rates, inflation rates, and the external finance premium are shown as absolute deviations from their steady states, while the other variables are percentage deviations from their steady states.

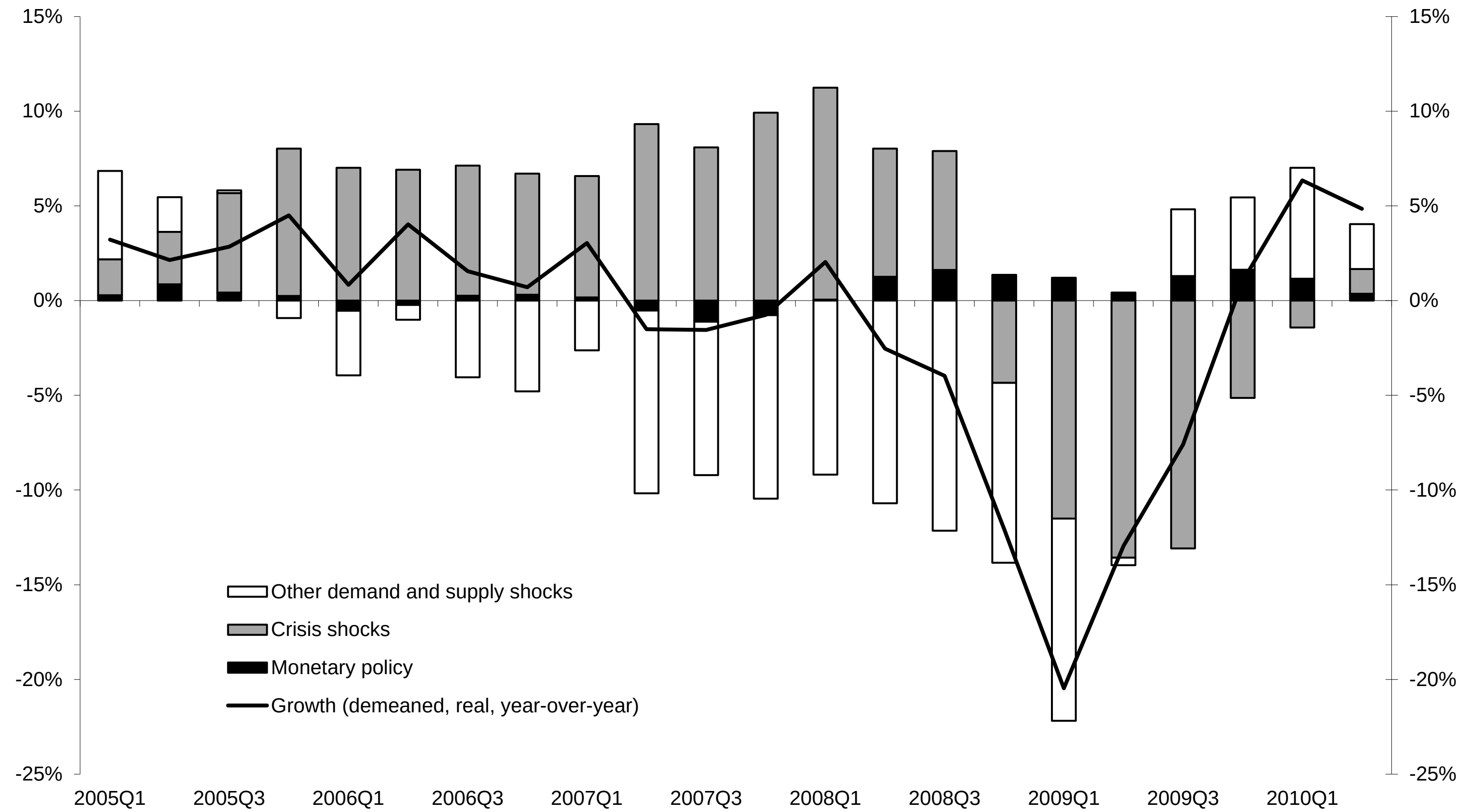
Figure 5. Turkey: The Monetary Transmission Mechanism[1]



Source: Authors' calculations.

[1] Interest rates, inflation rates, and the external finance premium are shown as absolute deviations from their steady states, while the other variables are percentage deviations from their steady states.

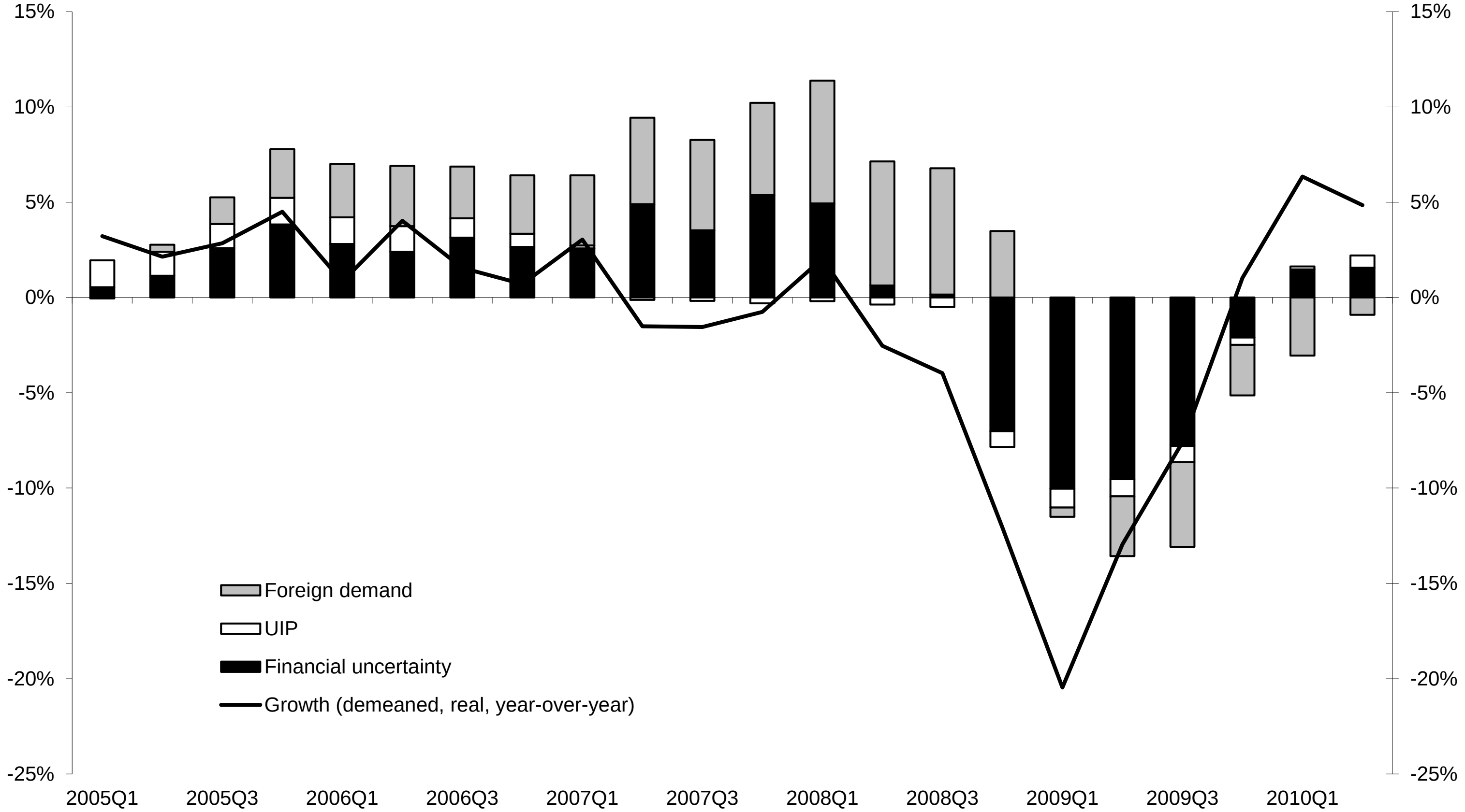
Figure 6. Historical Decomposition: The Role of Monetary Policy
(Demeaned year-over-year real GDP growth and shock contributions)



Source: Authors' calculations.

Figure 7. Historical Decomposition: Crisis Shocks

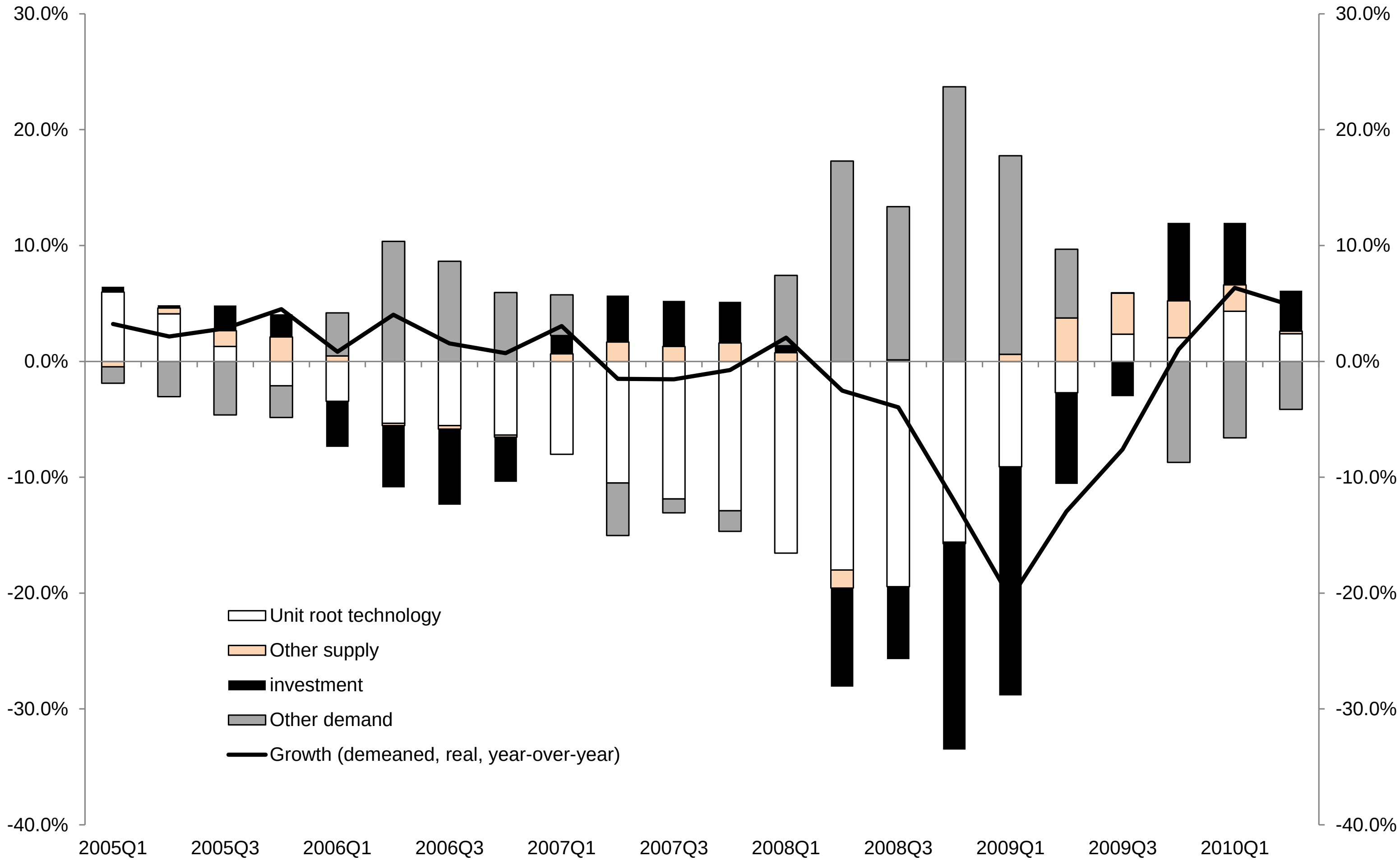
(Demeaned year-over-year real GDP growth and shock contributions)



Source: Authors' calculations.

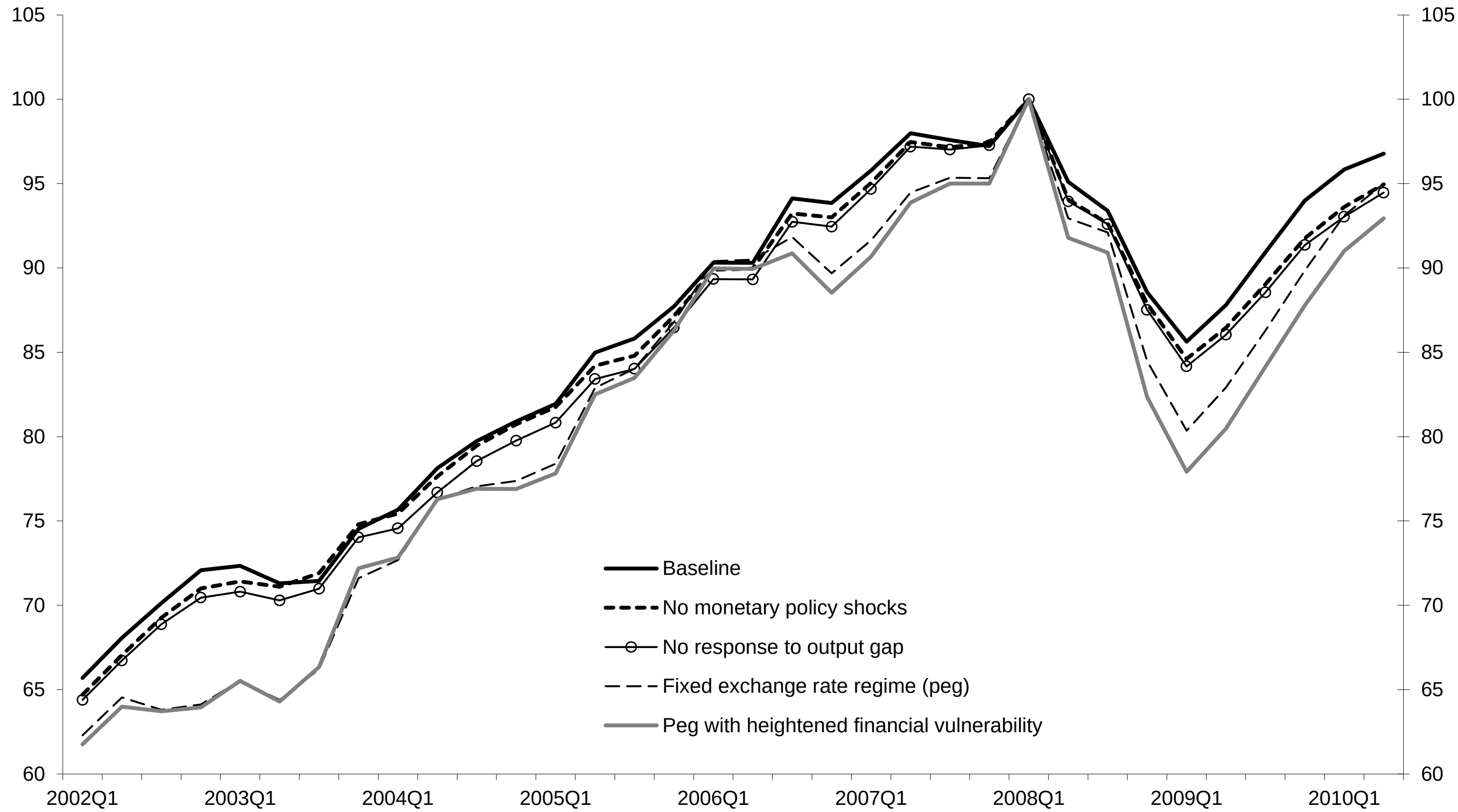
Figure 8. Historical Decomposition: Other Supply and Demand Shocks

(Demeaned year-over-year real GDP growth and shock contributions)



Source: Authors' calculations.

Figure 9. Counterfactual Scenarios: The Role of Monetary Policy and Real GDP
(Levels)



Source:Authors'calculations

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Appendix Table 1. Alternative Measuring of Actual and Simulated Recessions[1]

In terms of 2009 annual real GDP Growth

(Percent)

	Growth	Difference	Cumulative Difference
Baseline (actual)	–4.8		
No monetary policy shocks	–5.9	–1.1	–1.1
No response to output gap	–6.2	–0.3	–1.4
Fixed exchange rate regime (peg)	–8.0	–1.8	–3.2
Peg with heightened financial vulnerability	–9.3	–1.3	–4.5

In terms of peak-trough output contraction

(Percent of peak)

	Peak-to-trough contraction	Difference	Cumulative Difference
Baseline (actual)	–14.4		
No monetary policy shocks	–15.4	–1.0	–1.0
No response to output gap	–15.8	–0.4	–1.5
Fixed exchange rate regime (peg)	–19.6	–3.8	–5.3
Peg with heightened financial vulnerability	–22.1	–2.4	–7.7

Annual average percentage loss

(Relative to baseline)

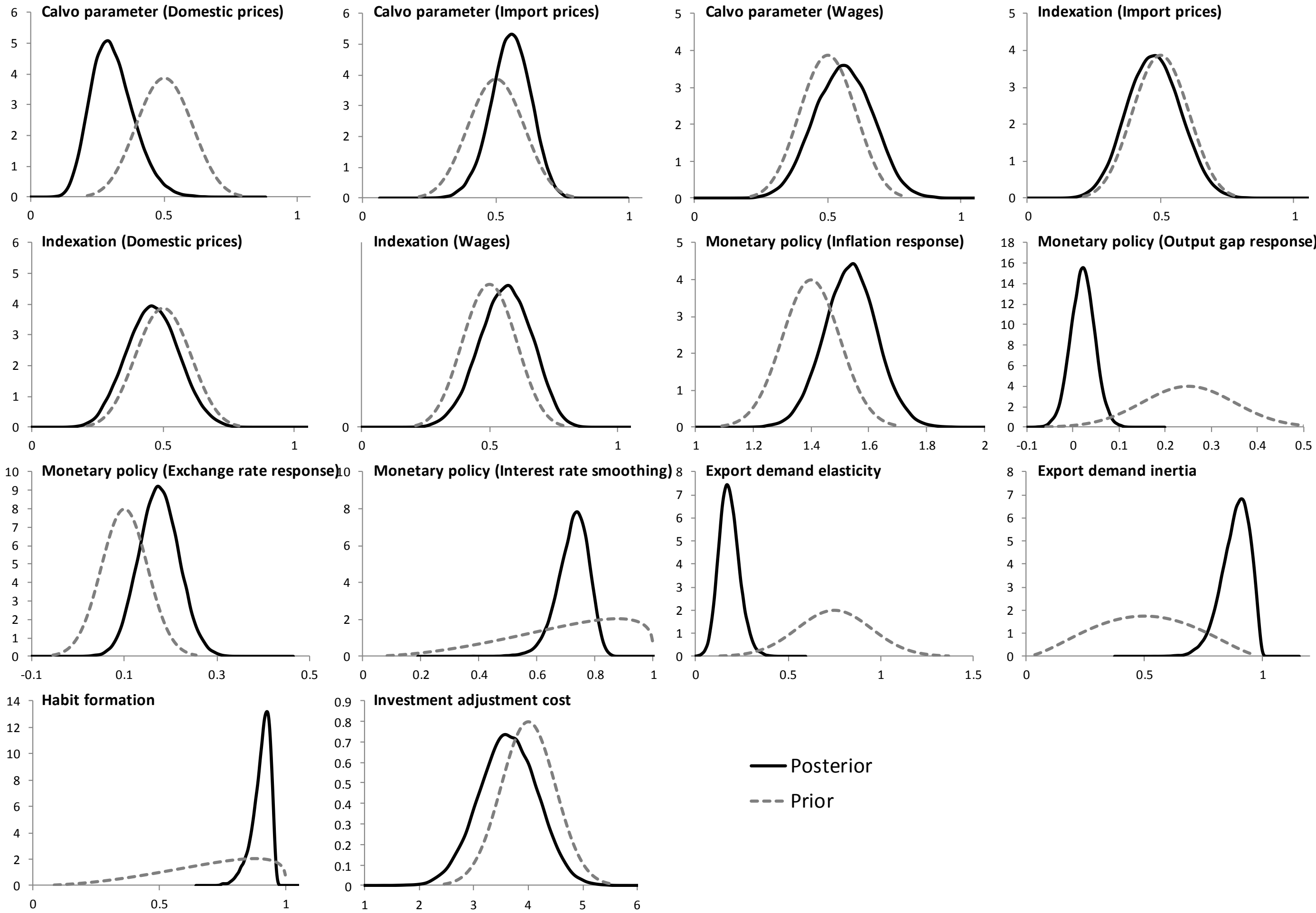
	Difference	Cumulative Difference
Baseline (actual)		
No monetary policy shocks	–5.7	–5.7
No response to output gap	–1.5	–7.2
Fixed exchange rate regime (peg)	–6.8	–14
Peg with heightened financial vulnerability	–8.2	–22.2

Source: Authors' calculations.

[1] See main text for details.

Appendix Figure 1a. Prior Posterior Distributions

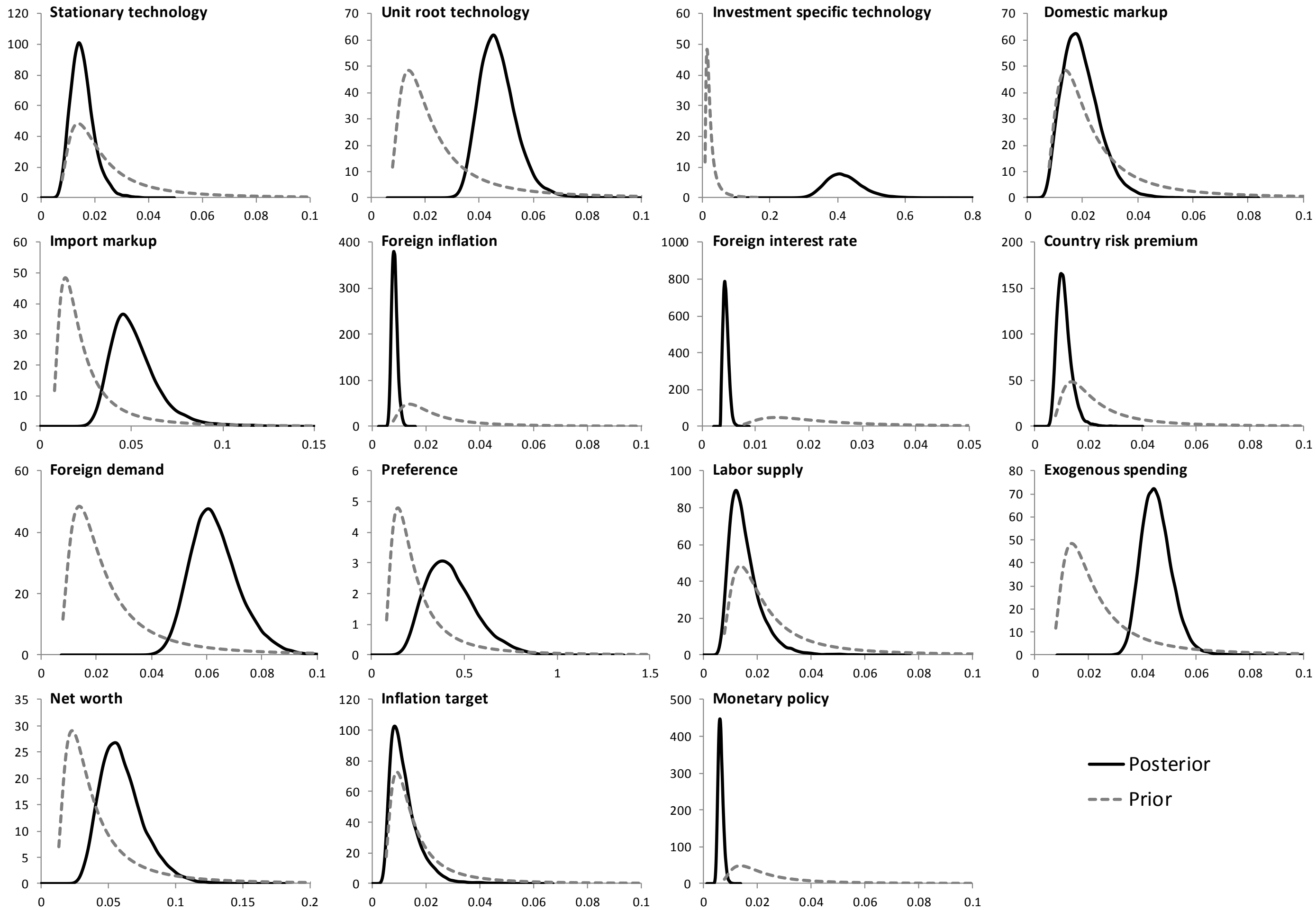
(Parameters)



Source: Authors' calculations.

Appendix Figure 1b. Prior Posterior Distributions

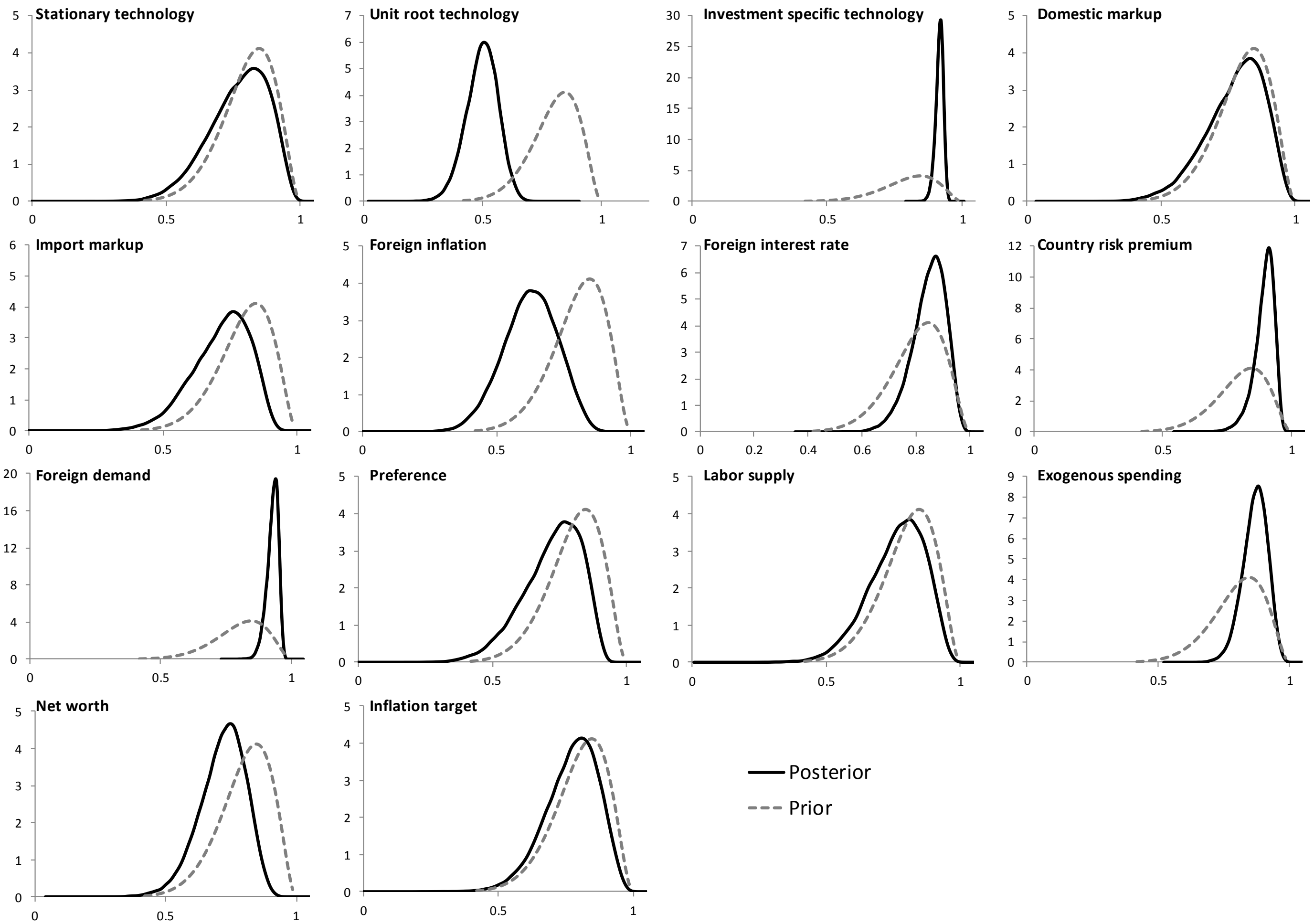
(Standard deviations of shocks)



Source: Authors' calculations.

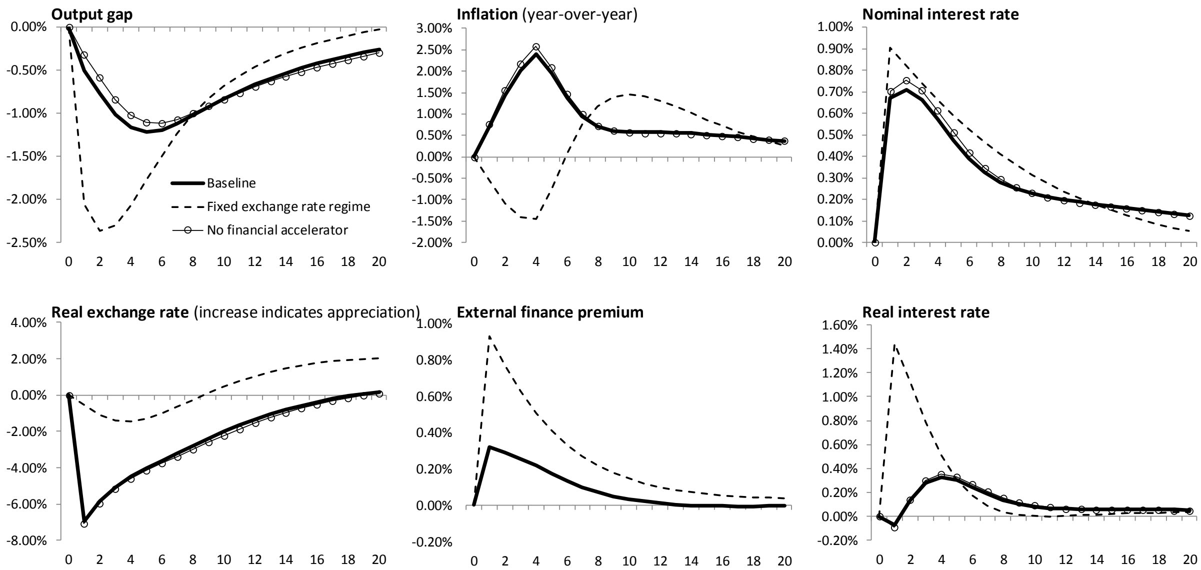
Appendix Figure 1c. Prior Posterior Distributions

(Shock Processes Parameter)

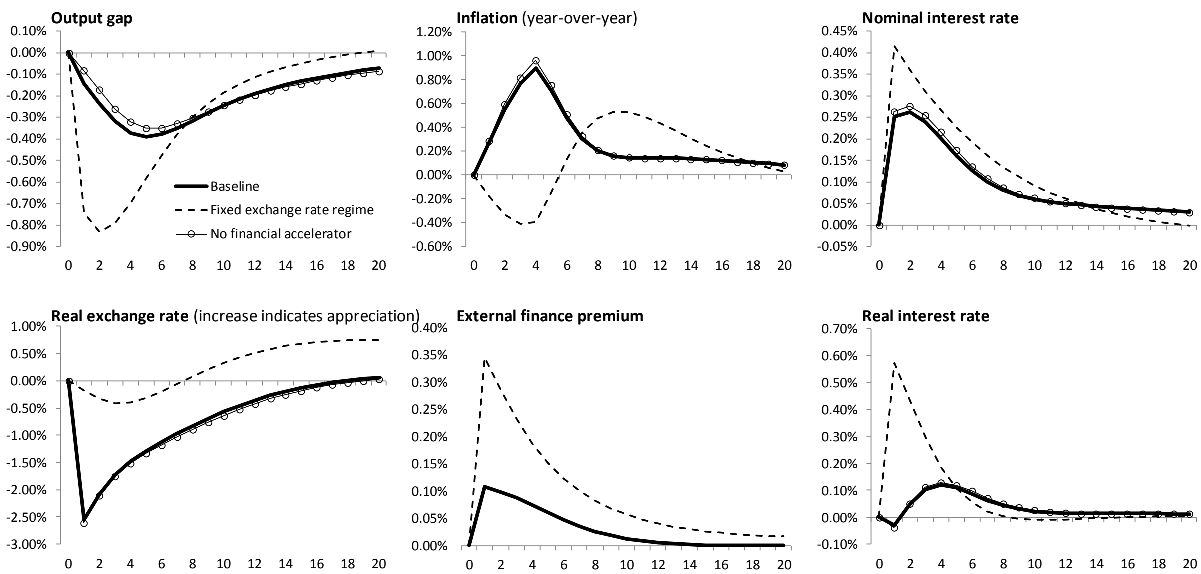


Source: Authors' calculations.

Appendix Figure 2a. Impulse Responses: UIP Shock[1]



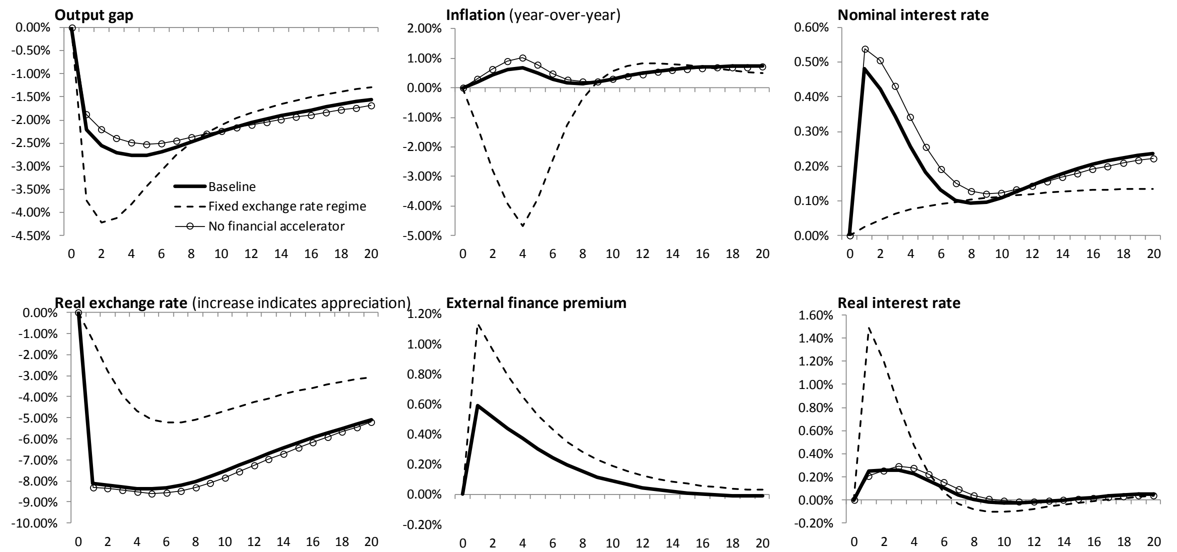
Appendix Figure 2b. Impulse Responses: Foreign Interest Rate Shock



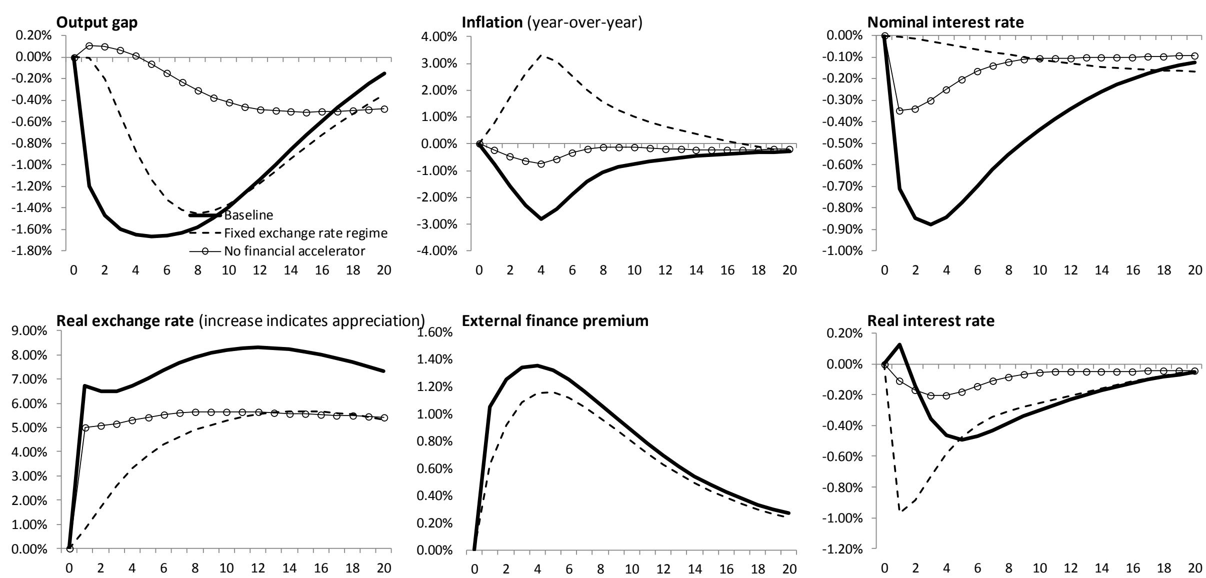
Source: Authors' calculations.

[1] Interest rates, inflation rates, and the external finance premium are shown as absolute deviations from their steady states, while the other variables are percentage deviations from their steady states.

Appendix Figure 3a. Impulse Responses: Foreign Demand Shock[1]



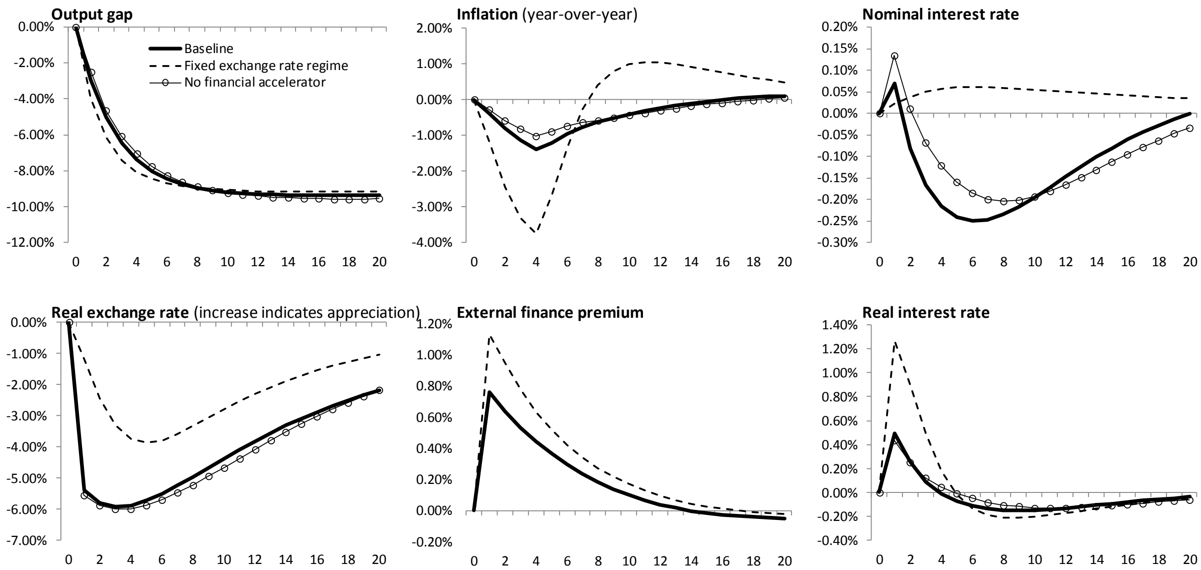
Appendix Figure 3b. Impulse Reponses: Net Worth Shock



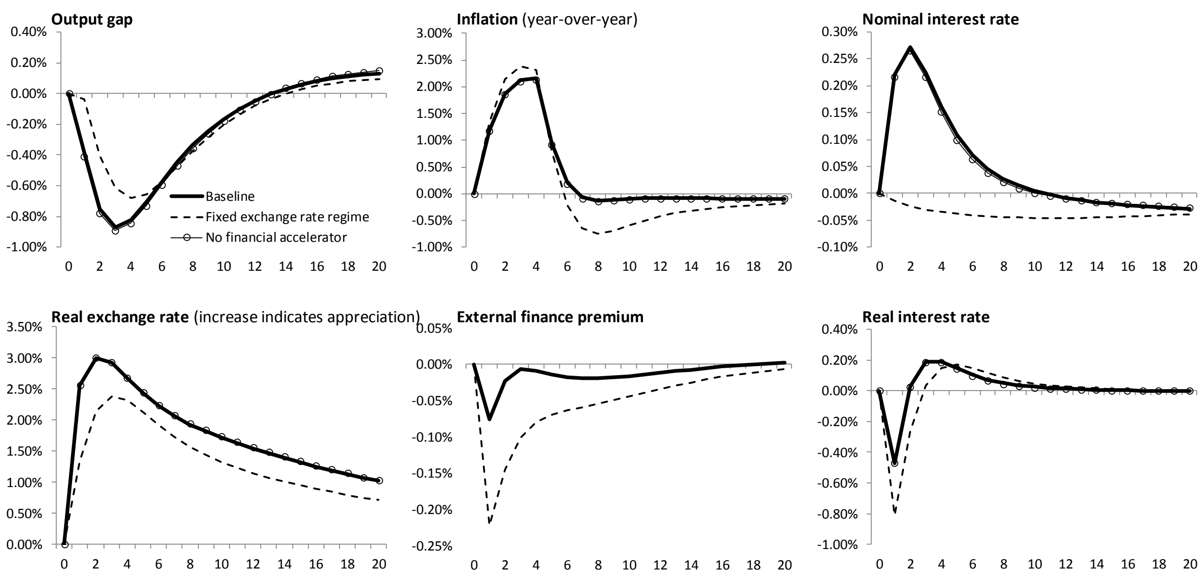
Source: Authors' calculations.

[1] Interest rates, inflation rates, and the external finance premium are shown as absolute deviations from their steady states, while the other variables are percentage deviations from their steady states.

Appendix Figure 4a. Impulse Responses: Unit Root Technology Shock



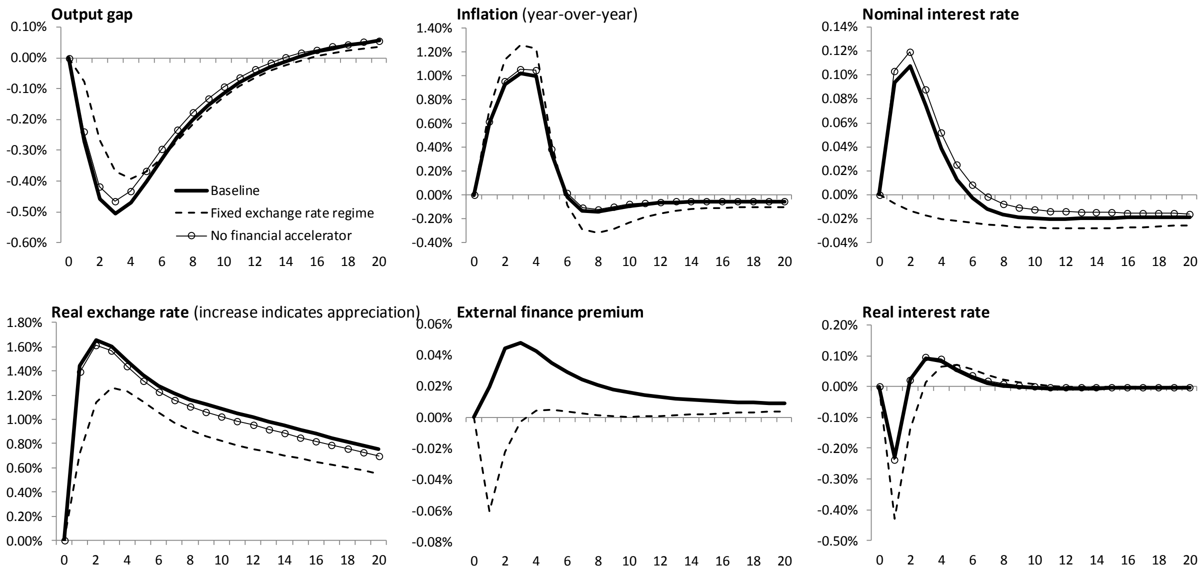
Appendix Figure 4b. Impulse Reponses: Stationary Technology Shock[1]



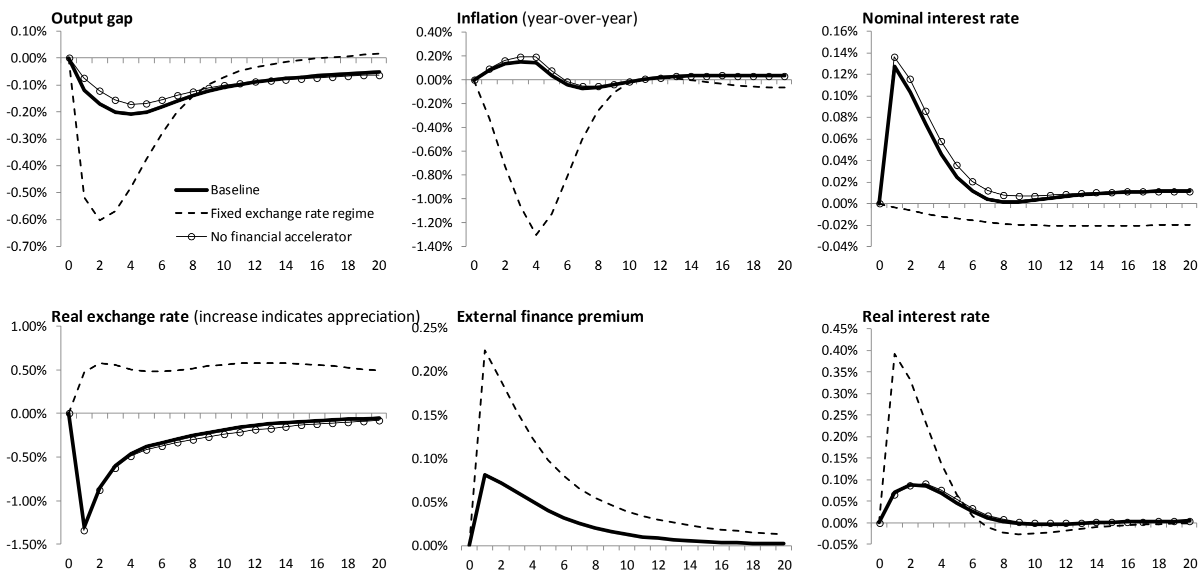
Source: Authors' calculations.

[1] Interest rates, inflation rates, and the external finance premium are shown as absolute deviations from their steady states, while the other variables are percentage deviations from their steady states.

Appendix Figure 5a. Impulse Responses: Domestic Mark-up Shock



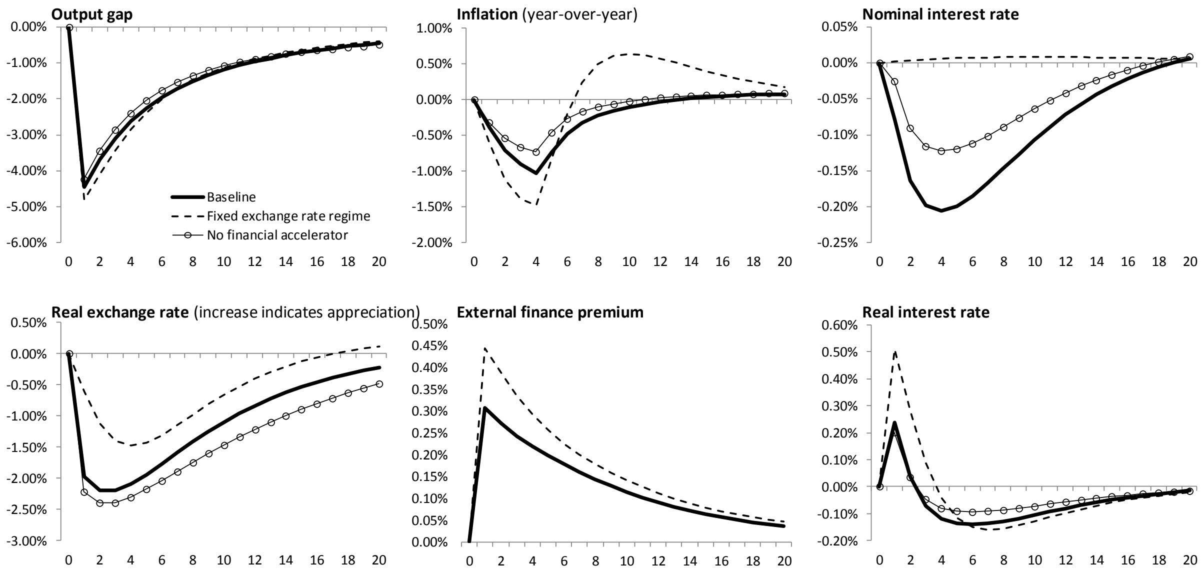
Appendix Figure 5b. Impulse Reponses: Foreign Inflation Shock[1]



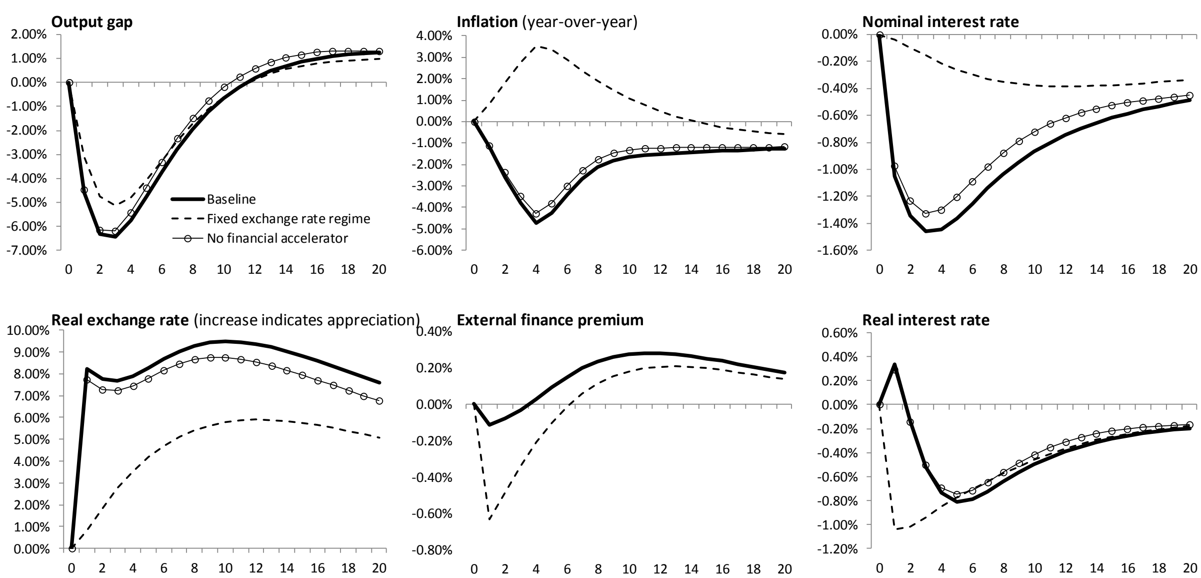
Source: Authors' calculations.

[1] Interest rates, inflation rates, and the external finance premium are shown as absolute deviations from their steady states, while the other variables are percentage deviations from their steady states.

Appendix Figure 6a. Impulse Responses: Government Spending Shock



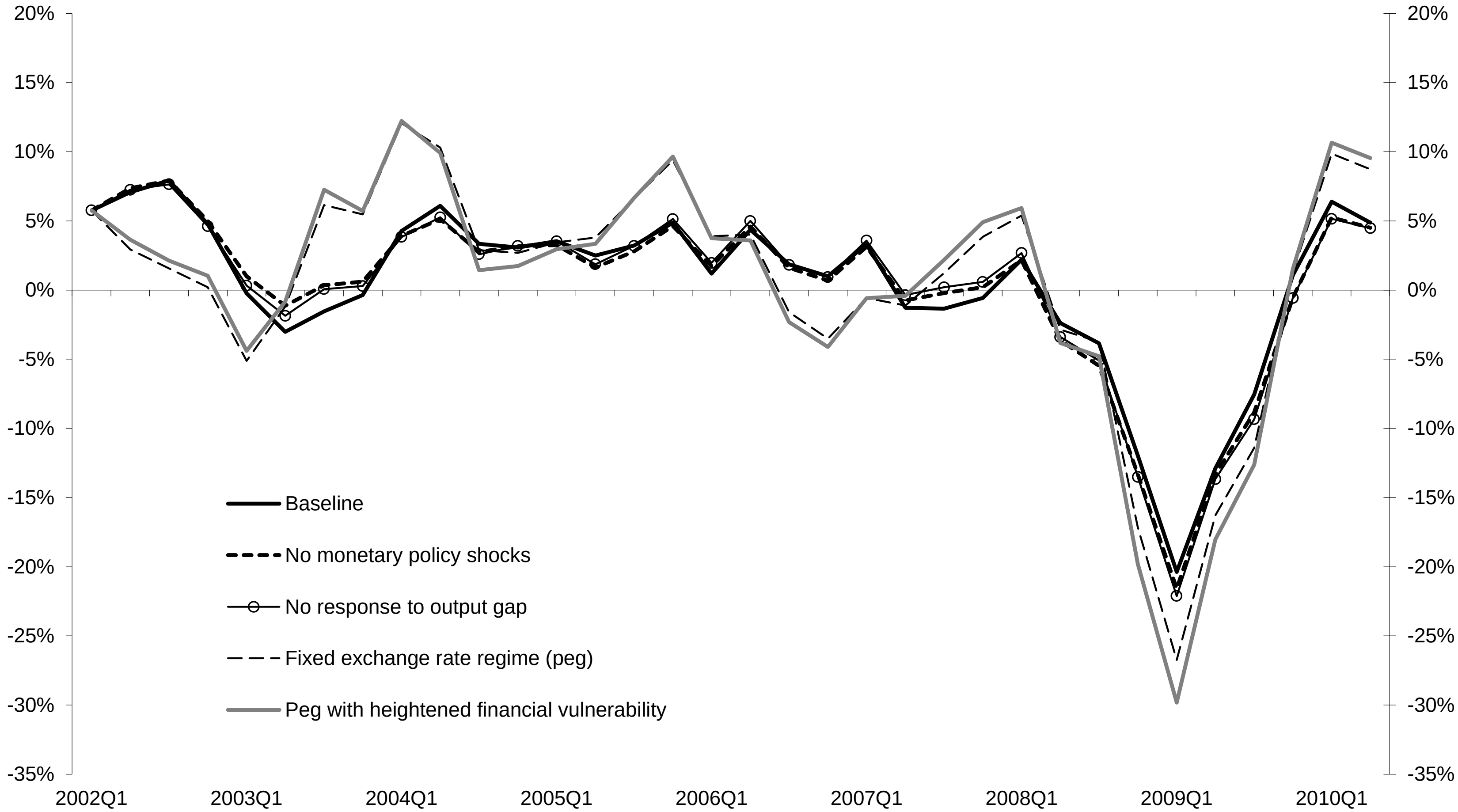
Appendix Figure 6b. Impulse Responses: Preference Shock[1]



Source: Authors' calculations.

[1] Interest rates, inflation rates, and the external finance premium are shown as absolute deviations from their steady states, while the other variables are percentage deviations from their steady states.

Appendix Figure 7. Counterfactual Scenarios: Monetary Policy and Growth
(Year-over-year growth rates)



Source: Authors' calculations.

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