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Financial Frictions and Monetary Policy Effectiveness in Türkiye



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Abstract

Financial friction affects the real economy through cyclical fluctuations. Therefore, financial friction must be considered when conducting monetary policy. This situation became even more pronounced with the 2008 financial crisis. As a result, many central banks, including the Central Bank of Turkey (CBRT), added a financial stability target alongside their price stability target. However, studies considering the impact of financial friction in Türkiye are quite limited, both in academic research and for policymakers. This study aims to investigate how financial friction affects monetary policy in Türkiye. In this context, the New Keynesian (NK) DSGE model, designed by Gertler and Karadi (2011) and including financial friction originating from the banking sector, has been extended for Turkey and estimated using Bayesian methods for the quarterly period 2011–2024. The findings of the model show that negative shocks originating from the financial system negatively affect investment, consumption, and output. It was observed that monetary policy responds to these shocks with a limited and delayed response. In contrast, an external interest rate shock is strongly transmitted to the real economy through financial friction. These results indicate that financial friction increases the effectiveness of internal monetary policy in Türkiye while strengthening the transmission of an external interest rate shock.

Keywords

Financial Frictions • Monetary Policy • DSGE Model • Bayesian Estimation • Monetary Transmission

Author Note

This article is based on the unpublished doctoral dissertation titled “The Effect of Financial Frictions on Monetary Shocks in Turkey” authored by the first author and supervised by the second author.



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Both global and local crises have clearly demonstrated that the healthy functioning of the financial system is vital for macroeconomic stability. The 2008 global financial crisis, in particular, showed that the concept of financial friction has micro-level effects and needs to be considered at the macro level. These developments revealed that macroeconomic models must more realistically incorporate the interaction between the real economy and the financial block. Accordingly, studies integrating financial frictions generated by information asymmetries, moral hazard, collateral constraints, and agency problems into macroeconomic models have proliferated.

Financial friction, simply defined, is the difference between the cost of financing an investment and the market return on capital. However, this simple definition does not reflect the impact of financial friction on macroeconomic stability. Post-global crisis economic literature shows that financial friction is not only a disruption affecting financial markets but also has wide-ranging macroeconomic effects on credit volume, investment decisions, and aggregate demand.

The increase in global liquidity following the global crisis contributed to credit expansion by increasing short-term capital flows to developing economies like Turkey. This increase in short-term capital flows, combined with exchange rate volatility, increased macroeconomic vulnerabilities and made ensuring financial stability imperative. As a result, the Central Bank of the Republic of Turkey (TCMB) reshaped its monetary policy framework after the 2008 crisis, adopting a new approach that also included financial stability. However, despite the implicit relationship between credit expansion and financial friction, this newly designed policy framework does not formally include a structure that considers financial friction in the TCMB's financial stability objective.

However, unlike the international literature, studies on financial friction are quite limited in the national literature. Existing studies also focus on how financial friction amplifies the impact of cyclical fluctuations and do not address its interaction with monetary policy. Nevertheless, both international studies and the relationship between financial friction and cyclical fluctuations imply that financial friction should be taken seriously by policymakers.

Against this backdrop, this study examines the relationship between financial frictions and monetary policy in Turkey within a NK DSGE framework using Bayesian estimation. The DSGE model incorporates financial frictions arising from the agency problem between banks and depositors, following the framework developed by Gertler and Karadi (2011). This model was selected primarily because of the dominance of the banking sector in the Turkish financial system and the fact that it makes the credit channel one of the most important monetary transmission mechanisms. Furthermore, the dominant role of the banking sector in private-sector financing aligns well with the bank-based structure of the Gertler and Karadi model. The model is extended to reflect Turkey's specific structural and institutional characteristics and calibrated using Turkish data.

The posterior distributions and impulse response functions obtained from the estimation of the DSGE model indicate that financial frictions affect monetary policy behaviour in diverse ways. In response to shocks from the financial system, monetary policy exhibits weak responses. Furthermore, financial shocks are found to constrain the signalling effectiveness of monetary policy. Conversely, in the presence of external interest rate shocks, monetary policy is strengthened through the channel of financial frictions. Based on these findings, it is concluded that in the presence of financial frictions, monetary policy becomes more effective when it is conducted proactively rather than reactively.

Literature Review

In the theoretical literature, it is possible to mention that the concept of financial frictions follows three main strands. Each is based on the emergence of asymmetric information, agency problems, and moral hazard between borrowers and lenders. These three approaches appear in the literature as the costly state verification model proposed by Bernanke et al. (1989, 1999), the collateral constraint framework proposed by Kiyotaki and Moore (1997), and the models related to the supply of external finance introduced by Gertler and Kiyotaki (2010), along with their various extensions.

The common implication of all three models is that shocks occurring in the economy are amplified by financial frictions. However, the 2008 global financial crisis demonstrated in practice that financial frictions are not merely a mechanism that amplifies shocks but must also be considered in the conduct of monetary policy.

Fligstein et al. (2017) conducted an in-depth examination of the FOMC meeting transcripts between 2000 and 2008 and identified macroeconomic and financial language patterns in the meeting records by applying a machine learning-based topic modelling method. The study argues that the excessive reliance on pre-crisis macroeconomic theory led to an underestimation of the effects of the financial sector. In addition, Bertocco and Kalajzic (2024) measured how economists and academic circles evaluated the shortcomings of macroeconomic models in explaining the financial system and crises after the crisis, based on a survey conducted in 2009 among central bank economists and academic economists in the United States and Western Europe. Based on the analysis of the survey, 73% of the participants acknowledged that pre-crisis New Keynesian DSGE models did not sufficiently incorporate the financial system and therefore failed to predict the crisis.

The incorporation of post-crisis financial frictions into macroeconomic models has paved the way for studies assessing the magnitude of financial frictions' effects on business cycle fluctuations. Christiano et al. (2011) examined the role of financial frictions in the fluctuations of the Swedish economy using a small open economy DSGE model that incorporates both labour market frictions and financial frictions. In the model, financial frictions were incorporated in the style of Bernanke et al. (1999). The results of the model estimated for the Swedish economy using a calibration method indicate that financial frictions are the primary driver of investment and GDP fluctuations. Findings from the study show that net wealth shocks explain 75% of investment fluctuations and 25% of GDP fluctuations. On the other hand, there are also studies showing that financial frictions affect business cycle fluctuations through risk shocks. Christiano et al. (2014) examined the interaction between risk shocks and business cycle fluctuations in the United States by linking credit spreads to risk shocks. The results of the study indicate that 60% of fluctuations in the U.S. economy can be explained by risk shocks. In addition, the study findings show that debt repayment capacity decreases during periods of increased risk, which in turn reduces investment, and that credit spreads move inversely to cyclical fluctuations.

Financial friction is examined through its macro-level effects and micro-level effects. For example, Lee et al. (2021) examined the effect of financial friction by dividing households with different wealth and income levels into three groups. The findings of the study show that high-income households earn interest income when risk premiums rise due to their higher savings levels; therefore, their consumption is less affected by friction. In contrast, low-income households are more exposed to financial friction, resulting in more fluctuations in consumption. In conclusion, the study emphasises that most consumption fluctuations stemming from financial frictions originate from the consumption behaviour of low-income households. Bratsiotis and Kalubowila (2025) examined the cyclical nature of the risk premium arising from financial frictions by analysing it within two distinct frameworks. The study's most striking finding is that the cyclical

behaviour of the risk premium is largely driven by the leverage effect. However, the study notes that the leverage effect is influenced not only by credit market dynamics but also by monetary policy behaviour.

The Post-Crisis Monetary Policy Framework: Related Empirical Literature

The identification of a relationship between financial frictions and business cycle fluctuations has led to an increase in studies arguing that financial frictions must be considered in the conduct of monetary policy.

Agenor and Alper (2012) examined the effects of financial frictions on monetary policy using a model in which monetary policy is determined within the framework of the Taylor rule and the central bank can also adjust liquidity. Findings from the model indicate that a monetary policy shock increases banks' costs, which in turn leads to higher credit interest rates. The rise in credit interest rates, in turn, increases financial frictions, and this increase in financial frictions reduces the output gap, thereby lowering the probability of debt repayment. This outcome in the study demonstrates that financial frictions amplify the effects of monetary policy.

Agenor and Alper (2012) is empirically supported by Aysun et al. (2013). In their study, Aysun et al. (2013) analyse the effect of financial frictions on the monetary transmission mechanism using a structural VAR model with data from 56 countries covering the period 1984–2008. Impulse response functions indicate a negative and statistically significant relationship between the monetary transmission mechanism and the bankruptcy resolution rate. This finding provides empirical support for the hypothesis proposed by Agenor and Alper (2012) that financial frictions amplify the effects of monetary policy through changes in debt repayment probabilities.

Another study arguing that the impact of monetary policy is amplified through financial frictions is Palgic (2018), who employed both DSGE and VAR models to analyse the Croatian economy. The results obtained from both models agree with previous studies indicating that financial frictions amplify the impact of monetary policy.

However, the impact of financial frictions on monetary policy varies depending on how these frictions are modelled. In his 2018 study, Lieberknecht investigated why the contraction in the price level did not occur to the same extent as the contraction in output during the global financial crisis. To this end, he proposed a model in which cycles in credit spreads create fluctuations in firms' marginal costs through changes in their borrowing capacity. According to the model proposed in the study, a tightening monetary policy affects aggregate demand and firms' marginal costs through borrowing, causing the Phillips curve to shift to the right. This situation indicates that financial frictions weaken the impact of monetary policy on inflation.

On the other hand, there are studies supporting the claim that financial friction reduces the effectiveness of monetary policy through the marginal cost channel and the leverage and capital structures of financial intermediaries. For example, Li (2024), using quarterly US data covering the period 1970–2017, examines the effects of the capital structures of financial intermediaries on the monetary policy transmission mechanism through an interactive VAR model. The findings of the study show that the impact of interest rate decisions on the real economy is stronger during periods when the capital ratios of financial intermediaries are high, whereas the transmission of monetary policy weakens during periods when the leverage ratio is high. These findings reveal that financial friction affects monetary policy and may be another channel arising from financial intermediaries.

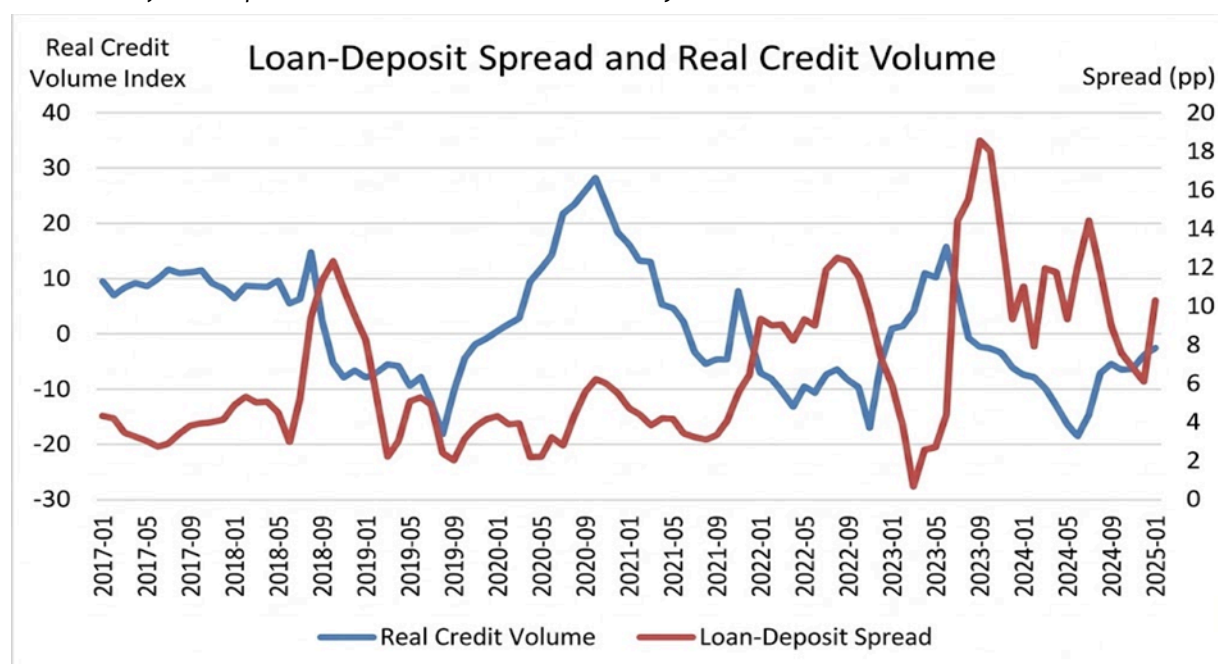
In summary, there is no consensus in the literature regarding the effects of financial frictions on monetary policy. It appears that the interaction between financial frictions and monetary policy varies depending on both how financial frictions are conceptualised and the design of the monetary policy transmission mechanism.

In this context, the relationship between monetary policy and financial frictions has also attracted increasing attention in the case of emerging market economies. Following the global financial crisis, central banks in many emerging economies have increasingly incorporated financial stability considerations into the conduct of monetary policy. The Turkish economy provides a particularly relevant case in this regard, given the growing importance of credit markets and financial intermediaries in the transmission of monetary policy. Therefore, the following section reviews the literature examining the interaction between monetary policy and financial frictions in the Turkish economy, particularly in the post-crisis period.

Post-Crisis Monetary Policy and Financial Stability in Turkey

Following the 2008 global financial crisis, short-term capital flows to developing countries increased significantly with the rise in global liquidity. This increase in short-term capital movements led to a substantial increase in the credit volume of many developing economies, including Türkiye. This increase in credit volume, combined with exchange rate volatility, fuelled financial vulnerabilities. As a result, the CBRT designed a new monetary policy to address these vulnerabilities. In this context, the CBRT added a series of macroprudential tools to its policy set, such as the interest rate corridor, reserve option mechanism, and reserve requirements, to manage credit growth and exchange rate volatility simultaneously (Kara, 2012; Başçı and Kara, 2011). However, the emphasis on financial friction was addressed within the context of credit volume volatility, and financial friction was not explicitly given importance in policy design.

The fact that the CBRT aims to control credit growth underscores the importance of financial friction, even if it is implicit. Studies such as those by Gertler and Kiyotaki (2010) and Agénor et al. (2012) show that imbalances arising from financial friction can be limited using macroprudential policies. However, the CBRT's approach focuses more on restricting the volume of credit than on addressing financial friction. Although the new monetary policy design does not emphasise financial friction, there is a strong correlation between financial friction and credit expansion in Türkiye. [Figure 1](#) shows the interaction of credit spreads and real credit growth in Turkey over time.

Figure 1*Interaction of Credit Spreads and Real Credit Growth in Turkey*

Source: Author's calculations, data obtained from CBRT

Figure 1 shows that increases in credit volume occur during periods when the spread is relatively low. Conversely, significant decreases in credit volume are observed following an increase in the spread. Indeed, the figure clearly shows that the highest increase in real credit volume occurs during periods when the spread is lowest.

Credit spreads directly influence banks' lending behaviour because they reflect the costs of financial intermediation. This implies that, especially in economies like Turkey, where the banking sector is heavily weighted within the financial system, financial friction can have strong effects on the real economy by influencing banking sector behaviour.

However, despite the impact of financial friction on credit supply and the macroeconomy, the emphasis placed on financial friction by both policymakers and national economic literature is quite insufficient. Yıldırım and Sanyal (2021) examined the relationship between financial stress and real economic activity in Turkey during the 2003–2018 period using a threshold vector autoregression approach. Their findings show that increases in the credit-deposit interest rate spread restrict credit supply and increase its effects on investment, consumption, and GDP during periods of high stress, whereas this effect is weaker during periods of low stress. However, in this study, the relationship between financial friction and credit supply was examined through the financial stress proxy, and a systematic structure expressing financial friction was not used.

In his study, Ünal (2020) estimated a DSGE model based on the costly state verification model proposed by Bernanke et al. (1999). As a result, he concluded that financial friction amplifies shocks. However, this study does not reflect the structure of the banking sector, but rather relies on modelling the relationship between borrowers and lenders. On the other hand, the study focuses more on the macroeconomic consequences of financial friction rather than its impact on monetary policy.

Although studies examining the interaction between financial friction and monetary policy have rapidly increased since the global crisis, there is no consensus on the direction of this interaction. According to many studies, financial friction strengthens policy effects, while others argue that it weakens them. Secondly,

although financial friction primarily represents irregularities in the debt market, and debt markets in emerging economies are relatively less deep, studies examining the impact of financial friction in the context of emerging economies are relatively limited. However, while the Central Bank of Turkey (TCMB) prioritised credit growth within its new monetary policy framework designed after the crisis, it did not explicitly include the impact of financial friction on credit supply in its monetary policy. These gaps highlight the need for a study specifically examining the impact of financial friction, reflecting the structure of Turkey's banking sector, on monetary policy.

Based on this, this study aims to adapt the Gertler and Karadi (2011) model, which reflects the frictions occurring in the banking sector, to the Turkish economy and examine the effect of financial friction on monetary policy.

The DSGE Model

The model is grounded in the monetary New Keynesian DSGE framework, which incorporates nominal rigidities. The financial sector with frictions is added to this base structure following Gertler and Karadi (2011). The model consists of seven blocks: households, the banking (financial intermediation) sector, capital goods producers, retail firms, intermediate goods firms, the public sector, and the central bank (Christiano et al. (2005); Smets and Wouters (2007); Gertler and Karadi (2011)).

Households

The representative household maximises expected lifetime utility:

$$\max E_t \sum_{i=0}^{\infty} \beta^i \left[\ln(C_{t+i} - hC_{t+i-1}) - \frac{\chi}{1+\varphi} L_{t+i}^{1+\varphi} \right] \quad (1)$$

where β is the discount factor, C_t is consumption, h is the habit persistence parameter, χ measures the disutility of labour supply, L_t is labour supply, and φ is the inverse Frisch elasticity of labour supply. The habit persistence term introduces inertia into consumption dynamics.

The household budget constraint is:

$$C_t = W_t L_t + \Pi_t + T_t + R_t B_t - B_{t+1} \quad (2)$$

where W_t is the real wage, Π_t represents profits transferred from banking activities, T_t denotes government transfer payments, and R_t is the gross real interest rate on deposits B_t . The first-order conditions from this optimisation problem yield the labour supply condition:

$$\rho_t W_t = \chi L_t^\varphi \quad (3)$$

and the marginal utility of consumption:

$$\rho_t = (C_t - hC_{t-1})^{-1} - \beta h E_t [(C_{t+1} - hC_t)^{-1}] \quad (4)$$

Together with the Euler equation:

$$E_t [\beta \Lambda_{t,t+1} R_{t+1}] = 1 \quad (5)$$

where $\Lambda_{t,t+1} = \rho_{t+1}/\rho_t$ is the stochastic discount factor.

Financial Intermediation

Financial intermediaries (banks) collect deposits from households and channel them to non-financial firms as credit. The bank's balance sheet identity is:

$$Q_t S_{jt} = N_{jt} + B_{jt+1} \quad (6)$$

where Q_t is the market value per unit of bank assets (credit), S_{jt} is the quantity of claims on non-financial firms, N_{jt} is the bank's net worth (equity), and B_{jt+1} is the quantity of deposits. The evolution of bank net worth is:

$$N_{jt+1} = R_{t+1}^k Q_t S_{jt} - R_{t+1} B_{jt+1} + (R_{fx,t} - R_{t-1}) E_t \cdot \overline{NFX} \quad (7)$$

where R_{t+1}^k is the stochastic return on capital, R_{t+1} is the deposit rate, $R_{fx,t}$ is the return on foreign-currency assets, E_t is the exchange rate, and $\overline{NFX}$ is the bank's net foreign exchange position. Rearranging:

$$N_{jt+1} = (R_{t+1}^k - R_{t+1}) Q_t S_{jt} + R_{t+1} N_{jt} + (R_{fx,t} - R_{t-1}) E_t \cdot \overline{NFX} \quad (8)$$

The spread between the return on capital and the deposit rate, $(R_{t+1}^k - R_{t+1})$, serves as the model's measure of financial friction.

The banker's optimisation problem is to maximise expected terminal net worth:

$$\begin{aligned} V_{jt} &= \max E_t \sum_{i=0}^{\infty} (1 - \theta)^i \beta^{i+1} \Lambda_{t,t+1+i} \kappa(N_{jt+1+i}) \\ &= \max E_t \sum_{i=0}^{\infty} (1 - \theta)^i \beta^{i+1} \Lambda_{t,t+1+i} [(R_{t+1+i}^k - R_{t+1+i}) Q_{t+i} S_{jt+i} + R_{t+1+i} N_{jt+i}] \end{aligned}$$

,

where θ is the banker's survival probability, implying an average tenure of $1/(1 - \theta)$. If the risk premium is positive, the banker optimally expands assets as long as she survives. However, a moral hazard problem between the banker and depositors constrains the bank's ability to attract external funds: depositors will only supply funds up to the point at which the bank's incentive compatibility constraint is satisfied. This constraint generates an endogenous leverage limit.

The leverage ratio is given by

$$\phi_t = \frac{1}{1 - \psi_t} \cdot \frac{\eta_t}{\lambda - \nu_t} \quad (9)$$

where λ is the maximum leverage level, η_t and ν_t are model-internal variables, and ψ_t is the financial friction transmission degree, which measures how the friction propagates through the banking system. This specification extends the original Gertler and Karadi (2011) model by making leverage endogenously responsive to credit tightening, reflecting Turkey's bank-based financial system.

The financial friction transmission degree is modelled as

$$\psi_t = \kappa \cdot (R_{t+1}^k - R_t - R_{ss}^k) + \text{shock}_{\psi,t} \quad (10)$$

This mechanism is not part of the original framework of unconventional monetary and credit policies and is introduced to allow the transmission strength of financial frictions to vary with deviations of the credit spread from its steady-state level. In bank-based financial systems, such as Turkey, fluctuations in credit spreads can significantly affect how strongly financial frictions propagate to the real economy. In this specification ψ_t represents the degree of financial friction transmission and is defined as a function of the deviation of the credit spread from its steady-state value. This mechanism allows financial frictions to directly affect the effectiveness of monetary policy transmission. The parameter κ captures the sensitivity of this transmission degree to such deviations, while $\text{shock}_{\psi,t}$ represents exogenous disturbances and follows an AR(1) process:

$$\text{shock}_{\psi,t} = \rho_{\psi} \cdot \text{shock}_{\psi,t-1} + \varepsilon_{\psi,t} \quad (11)$$

Total bank credit supply is:

$$Q_t S_t = \phi_t N_t \quad (12)$$

and aggregate banking sector net worth evolves as

$$N_t = Ne_t + Nn_t \quad (13)$$

where Ne_t is the net worth of incumbent bankers and Nn_t is the net worth of entering bankers.

Intermediate Goods Firms

Intermediate good firms produce output using capital and labour subject to the production function:

$$Y_t = A_t(U_t \xi_t K_t)^\alpha L_t^{1-\alpha} \quad (14)$$

where A_t is total factor productivity, U_t is the capacity utilisation rate, ξ_t is capital quality, K_t is the capital stock, L_t is labour, and α is the capital share of output. Capital quality ξ_t , following Merton (1973), captures exogenous changes in the value of capital and follows an AR(1) shock process:

$$\xi_t = \rho_\xi \cdot \xi_{t-1} - e_\xi \quad (15)$$

The first-order conditions from profit maximisation yield the optimal capacity utilisation rate, the labour demand condition, and capital return equation:

$$R_{k,t+1} = \frac{\left[P_{m,t+1} \cdot \alpha \cdot \frac{Y_{t+1}}{\xi_{t+1} K_{t+1}} + Q_{t+1} - \delta(U_{t+1}) \right] \cdot \xi_{t+1}}{Q_t} \quad (16)$$

Capital Good Producers

Capital goods producers purchase depreciated capital from intermediate firms and transform it into new capital. The profit maximisation problem involves investment adjustment costs:

$$\max E_t \sum_{\tau=t}^{\infty} \beta^{\tau-t} \Lambda_{t,\tau} \left\{ (Q_\tau - 1) I_{n,\tau} - f\left(\frac{I_{n,\tau} + I_{ss}}{I_{n,\tau-1} + I_{ss}}\right) (I_{n,\tau} + I_{ss}) \right\} \quad (17)$$

where $I_{n,\tau}$ is net capital formation and $f(\cdot)$ is the investment adjustment cost function satisfying $f(1) = f'(1) = 0$ and $f''(1) > 0$. The first-order condition gives Tobin's Q:

$$Q_t = 1 + f(\cdot) + \frac{I_{n,t} + I_{ss}}{I_{n,t-1} + I_{ss}} f'(\cdot) - E_t \beta \Lambda_{t,t+1} \left(\frac{I_{n,t+1} + I_{ss}}{I_{n,t} + I_{ss}} \right)^2 f'(\cdot) \quad (18)$$

Retail Firms and Price Dynamics

Retail firms operate under monopolistic competition and repackage intermediate goods for sale to households. Nominal rigidities are introduced following Christiano, Eichenbaum, and Evans (2005): each period, a fraction $(1 - \gamma)$ of firms can reset their prices optimally, while the remaining fraction γ indexes prices to past inflation. The optimal pricing condition yields the New Keynesian Phillips curve. The aggregate price level evolves as

$$P_t = \left[(1 - \gamma)(P_t^*)^{1-\epsilon} + \gamma(\Pi_{t-1}^p P_{t-1})^{1-\epsilon} \right]^{\frac{1}{1-\epsilon}} \quad (19)$$

Resource Constraints and the Central Bank

The aggregate resource constraint is:

$$Y_t = C_t + I_t + f\left(\frac{I_{nt} + I_{ss}}{I_{nt-1} + I_{ss}}\right) (I_{nt} + I_{ss}) + G + \bar{\tau} \psi_t Q_t K_{t+1} \quad (20)$$

Capital accumulation follows:

$$K_{t+1} = \xi_t K_t + I_{n,t} \quad (21)$$

Monetary policy is specified as a generalised Taylor rule:

$$i_t = \rho_i i_{t-1} + (1 - \rho_i) \kappa_\pi \pi_t + (1 - \rho_i) \kappa_y X_t - (1 - \rho_i) \log(\beta) - (1 - \rho_i) \kappa_y \log\left(\frac{\epsilon - 1}{\epsilon}\right) + e_{i,t} \quad (22)$$

where i_t is the nominal interest rate, ρ_i is the interest rate smoothing coefficient, κ_π is the inflation response coefficient, κ_y is the output gap response coefficient (measured through the price mark-up X_t following Christiano et al. (2005) and Smets and Wouters (2007)), and $e_{i,t}$ is a monetary policy shock modelled as white noise. The Fisher equation links the nominal and real interest rates:

$$1 + i_t = R_{t+1} \frac{E_t P_{t+1}}{P_t} \quad (23)$$

Estimation Method and Data

Bayesian Estimation

The model is estimated using Bayesian methods, which combine prior information derived from economic theory and the existing empirical literature with the likelihood of the observed data. The posterior distribution is obtained via Bayes' theorem:

$$p(\theta | Y) = \frac{p(Y | \theta) p(\theta)}{p(Y)} \quad (24)$$

where $p(\theta | Y)$ is the posterior distribution of the parameter vector θ , $p(Y | \theta)$ is the likelihood function computed using the Kalman filter applied to the linearised state-space representation of the model, and $p(\theta)$ is the prior distribution. Since the posterior distributions of DSGE models are generally not available in closed form, simulation-based inference is conducted using the Markov chain Monte Carlo technique, specifically the Metropolis–Hastings algorithm. The acceptance probability for the proposed parameter vector θ' is:

$$\alpha(\theta, \theta') = \min\left(1, \frac{p(Y | \theta') p(\theta') q(\theta | \theta')}{p(Y | \theta) p(\theta) q(\theta' | \theta)}\right) \quad (25)$$

Estimation was performed using Dynare 5.4. Two Markov chains of 20,000 draws were generated using the blocked Metropolis–Hastings algorithm.

Calibration

A number of parameters governing the steady-state properties of the model are calibrated to values consistent with Turkish data and the existing literature, rather than estimated. Table 1 presents the calibrated parameter values.

Table 1

Parameter Calibration

Parameter	Description	Value	Source
β	Household discount factor	0.98	Jia (2020)
σ	Risk aversion coefficient	2	Gertler and Karadi (2011)
h	Habit persistence level	0.6	Iacoviello (2005)
φ	Labour supply elasticity	1	Alp & Elekdağ (2011)
ζ	Capacity use elasticity	1.5	Gertler and Karadi (2011)
θ	Bank survival rate	0.8	Gertler et al. (2010)
α	Capital share in production	0.4	Alp & Elekdağ (2011)
G/Y	Government expenditure to GDP ratio	0.15	TURKSTAT

Parameter	Description	Value	Source
η_i	Investment adjustment cost	2	Smets and Wouters (2007)
ϵ	Demand elasticity	6	Christiano et al. (2005)
γ	Calvo price stickiness	0.5	Bari (2013)
γ_p	Price indexation rate	0.5	Ünal (2020)
κ_π	Inflation response coefficient	1.5	Alp & Elekdag (2011)
κ_y	Output gap response coefficient	0.5	Sekmen & Şıklar (2016)
ρ_i	Interest rate smoothing	0.8	Ünal (2020)
λ	Maximum leverage level	0.5	BRSA
δ_c	Capital depreciation rate	0.025	Gertler and Karadi (2011)

The household discount factor (β) was calibrated to 0.98, referencing the study by Jia (2020), to reflect the high consumption propensity seen in the Turkish economy. The bank survival rate θ was set at 0.8, lower than the 0.9 used for developed economies by Gertler and Kiyotaki (2010) and Gertler and Karadi (2011), to reflect the greater fragility of emerging market banking sector balance sheets. The Calvo price rigidity parameter was calibrated to 0.5, consistent with Bari (2013) and the observed average contract duration of six months in Turkey's fee setting environment. The maximum leverage parameter λ was set at 0.5, corresponding to an average leverage ratio of approximately six to seven times that of the Turkish banking sector, as reported by the Banking Regulation and Supervision Agency. Other parameters have been calibrated based on the studies indicated in the table.

Prior Distributions

Prior distributions for the structural parameters that define the dynamic responses and shocks of the model were determined based on the literature. Parameters were estimated using the Bayesian method within the determined prior distribution ranges. Table 2 shows the prior distributions of the estimated parameters.

Table 2

Prior Distributions of the Estimated Parameters

Parameter	Description	Distribution	Mean	Std. Dev.
ρ_ξ	Capital quality shock persistence	Beta	0.66	0.10
σ_ξ	Capital quality shock volatility	Inv. Gamma	0.05	0.10
ρ_a	Technology shock persistence	Beta	0.50	0.10
σ_a	Technology shock volatility	Inv. Gamma	0.05	0.10
ρ_g	Government spending shock persistence	Beta	0.50	0.10
σ_g	Government spending shock volatility	Inv. Gamma	0.10	0.10
σ_{Ne}	Net worth shock volatility	Inv. Gamma	0.05	0.10
σ_i	Monetary policy shock volatility	Inv. Gamma	0.05	0.10
ρ_ψ	Financial friction shock persistence	Beta	0.50	0.10
σ_ψ	Financial friction shock volatility	Inv. Gamma	0.05	0.10
κ	Risk premium sensitivity	Gamma	0.30	0.20

Data

Since the model includes 7 structural shocks, 7 observable data points were used. The series covers the period from Q1 2011, when the CBRT began implementing its new monetary policy design, to Q2 2024. The observable data used in the model are listed in [Table 3](#).

Table 3

Observable Variables and Data Sources

Variable	Model Counterpart	Data Series	Source
Y_t	Output	Real GDP (chain-linked volume), log, and HP-filtered	TURKSTAT
$I_{n,t}$	Investment	Gross fixed capital formation, log, and HP-filtered	TURKSTAT
C_t	Consumption	Household consumption, log, and HP-filtered	TURKSTAT
$infl_t$	Inflation	Consumer price index, log, and HP-filtered	CBRT
$R_{k,t}$	Capital return	Net operating surplus, log, and HP-filtered	CBRT
N_t	Bank net worth	Banking sector equity, log, and HP-filtered	BRSA
E_t	Exchange rate	USD/TRY nominal rate, log, and HP-filtered	CBRT

All series were detrended using a Hodrick-Prescott (HP) filter after logarithmic transformation to obtain the cyclical component. While the use of the HP filter allows impulse response functions to be interpreted as deviations from the trend, it is consistent with capturing the cyclical fluctuation dynamics in DSGE models.

Empirical Results

Posterior Distributions

The posterior distributions of the estimated parameters, together with the 90% highest posterior density (HPD) intervals, are reported in [Table 4](#).

Table 4

Posterior Distributions of the Estimated Parameters

Parameter	Description	Posterior Mean	90% HPD Interval
ρ_ξ	Capital quality shock persistence	0.6637	[0.6600–0.6673]
σ_ξ	Capital quality shock volatility	0.0465	[0.0418–0.0517]
ρ_a	Technology shock persistence	0.5846	[0.5794–0.5904]
σ_a	Technology shock volatility	0.0286	[0.0185–0.0395]
ρ_g	Government spending shock persistence	0.6114	[0.6059–0.6177]
σ_g	Government spending shock volatility	0.0534	[0.0411–0.0656]
σ_{Ne}	Net worth shock volatility	0.0208	[0.0153–0.0287]
σ_i	Monetary policy shock volatility	0.1753	[0.1706–0.1802]
ρ_ψ	Financial friction shock persistence	0.8906	[0.8807–0.9007]
σ_ψ	Financial friction shock volatility	0.1023	[0.0975–0.1083]
κ	Risk premium sensitivity	0.3041	[0.2559–0.3499]

According to the posterior distribution results obtained from the Bayesian estimation, the persistence parameter of the financial friction shock ($\rho_\psi = 0.8906$) indicates that shocks that increase financial friction are persistent. This finding is consistent with Türkiye's banking-intensive financial system and the role of

credit in the economy. Indeed, during the period examined, unconventional monetary policy tools, credit policies directed by public banks, and regulatory changes were frequently applied.

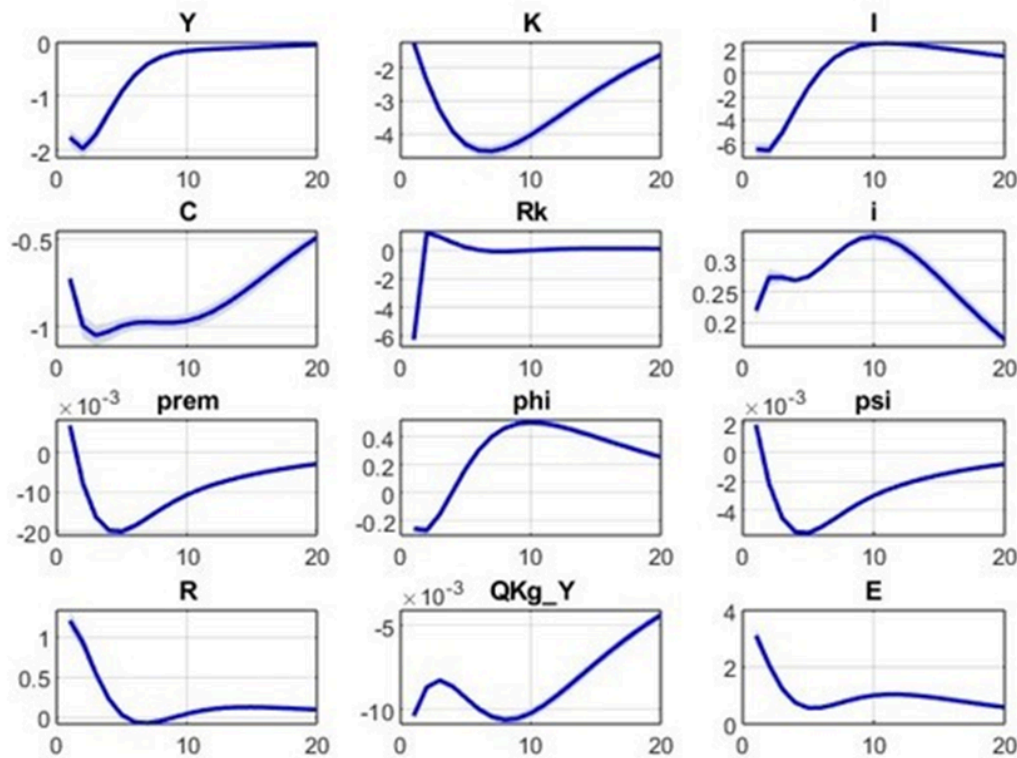
The volatility of the monetary policy shock ($\sigma_i = 0.1753$) was estimated to be close to the upper limit of 0.18. The relatively high estimate of the interest rate shock reflects the central bank's behaviour outside the Taylor rule in monetary policy decisions during the period under review. This is also consistent with the study by Villaverde et al. (2011), which states that monetary policy shocks in emerging markets are larger and less predictable compared to developed economies.

The fact that the risk premium sensitivity parameter ($\kappa = 0.3041$) is estimated to be in the middle of the lower and upper limits specified in the prior distribution indicates that financial friction arising from spread changes is moderately transmitted to the economy. However, the relatively high values estimated for ρ_ψ and σ_ψ imply that credit conditions in Turkey are shaped more by external shocks to the financial structure than by spreads.

Impulse Response Analysis

Figure 2

Responses to a Negative Capital Quality Shock



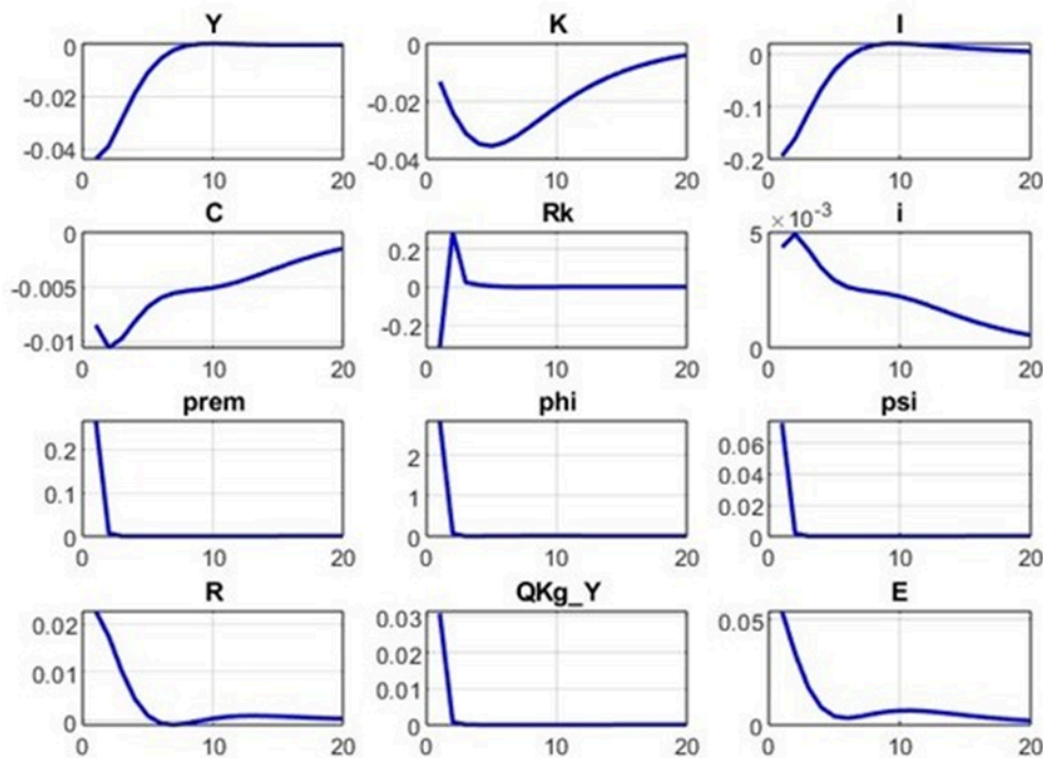
A negative capital quality shock (ξ_t), representing an unexpected decrease in the productivity of physical capital used by firms, elicits a sharp decline in the return on capital (R_k). However, the decrease in the return on capital begins to dampen from the second period onward. On the other hand, the real interest rate (R) positively reacts to the capital quality shock, but this reaction dampens after approximately 6 periods. Furthermore, the spread (prem) and the transmission of financial friction (ψ) initially react positively to the shock, but this reaction turns positive from the second period onward. Both reactions begin to dampen after approximately the 5th period. Unexpected declines in capital quality lead to a negative reaction in the

leverage ratio (φ), and this reaction turns positive from approximately the 5th period onwards and dampens after the 10th period. However, output (Y), capital (K), investment (I), and consumption (C) react negatively to the negative capital quality shock. Monetary policy responds by tightening in response to the tightening of financial conditions. This tightening response is dampened after the 10th period due to the recovery in output. Consequently, monetary policy responds to negative capital quality shocks by accompanying financial conditions rather than monetary policy driving these responses.

The dynamics observed following the capital quality shock are consistent with the financial accelerator mechanism described by Kiyotaki and Moore (1997) and Bernanke, Gertler, and Gilchrist (1999). The rapid recovery of the capital return notwithstanding, the delayed recovery of the risk premium and leverage ratio reflects the slower adjustment of financial frictions, an outcome consistent with the findings of Sekmen and Şıklar (2016) on the limited guidance capacity of the interest rate instrument in the presence of financial frictions.

Figure 3

Responses to a Negative Net Worth Shock

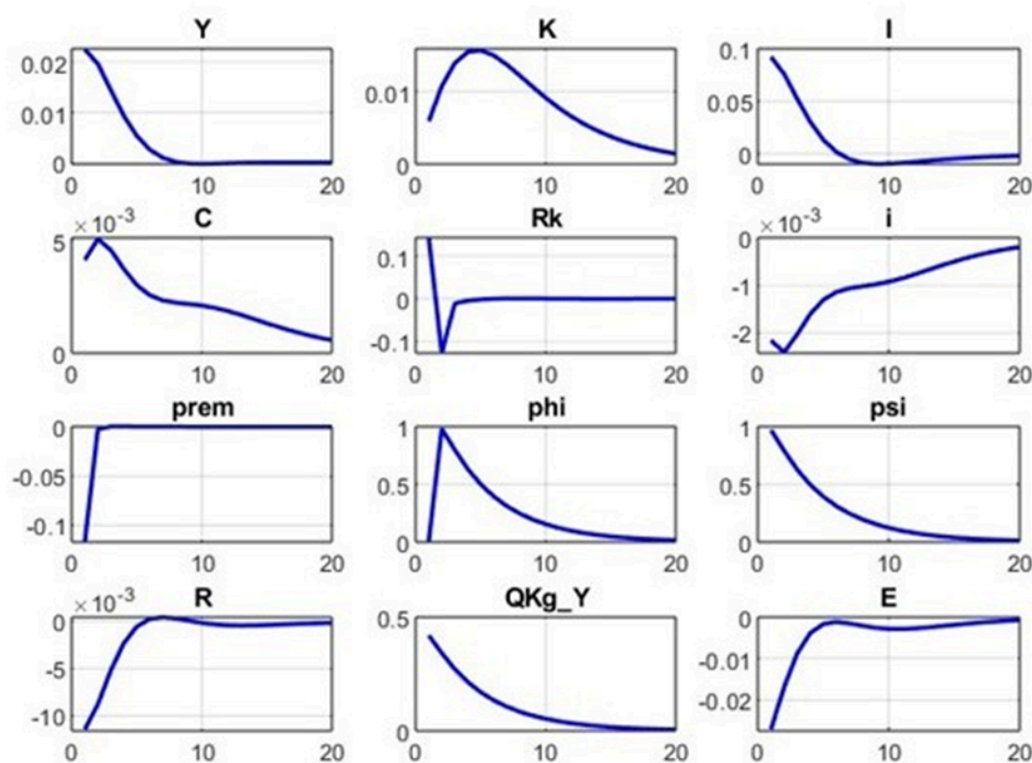


The leverage ratio (φ) initially reacts positively to the negative net wealth shock, representing an unexpected decrease in banks' equity, but this reaction extinguishes around the third period. This indicates that banks temporarily maintain their current liability levels before restricting their credit supply. Financial friction (ψ) increases due to the decrease in net worth. While the real interest rate (R) positively reacts to the shock, the return on capital (R_k) initially reacts negatively, but the reaction becomes positive from the second period onward due to the contraction in credit supply. The spread (prem) reacts sharply and positively in the first period but loses its effect after approximately the fourth period. Monetary policy appears to have a relatively low and positive response to the net wealth shock. While a negative reaction from monetary policy would be expected in response to the tightening of conditions for financial interme-

diaries, it instead responds by tightening due to the risk-free interest rate (R) remaining high as banks' funding needs increase. In this case, monetary policy is unable to respond appropriately to the decreases in output, investment, and consumption and is instead driven by financial conditions.

Figure 4

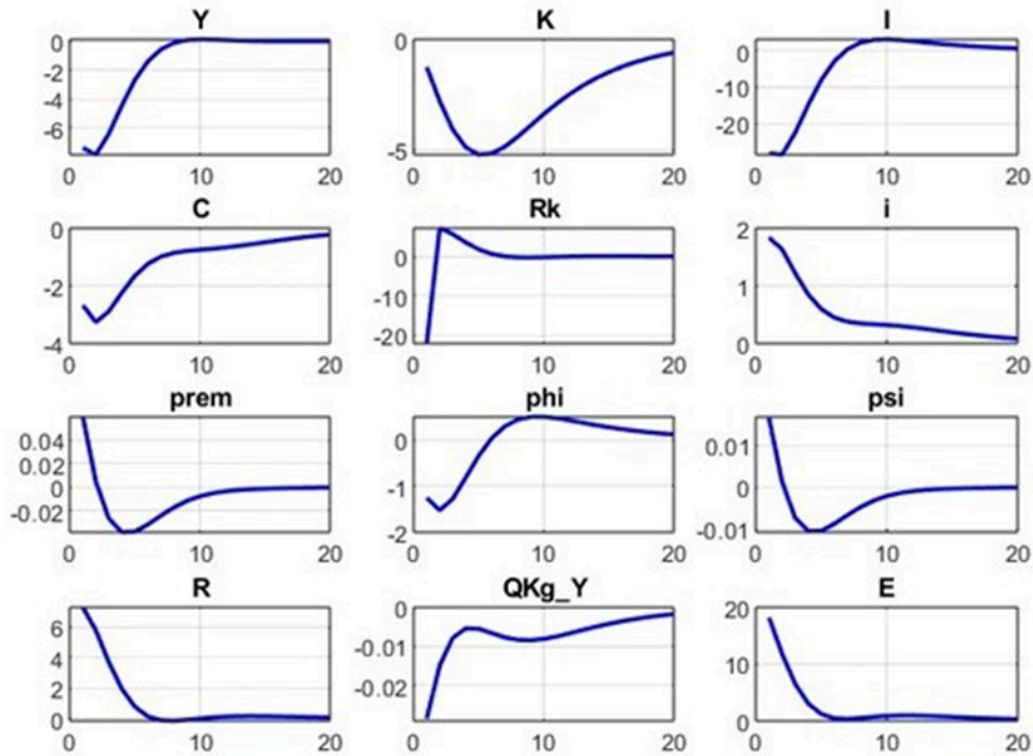
Responses to a Positive Financial Friction Transmission Shock



A positive exogenous shock (σ_ψ) that accelerates the transmission of financial friction represents an effect other than the spread sensitivity coefficient, indicating the speed at which financial friction spreads to the real sector. For example, this can be expressed as a long period of loose monetary policy, a decrease in banks' risk perception, and a loosening of global financial conditions. Production (Y), investment (I), and capital stock (K) respond positively to such a shock. Conversely, the risk premium (prem) and the risk-free interest rate (R) respond negatively to the shock. As a result, banks' leverage ratio (φ) increases, and loans to the real sector respond positively.

The positive response of output (Y) to the shock shows that the financial accelerator mechanism proposed by Kiyotaki and Moore (1997), Bernanke et al. (1999), and Gertler and Karadi (2011) also works for Turkey.

Although production, investment, and consumption increase as a result of increased financial friction, monetary policy negatively reacts to the shock. The acceleration of the transmission of financial friction lowers banks' borrowing costs (R), decreasing the spread. The decrease in the spread does not create additional tightening pressure on monetary policy. This is consistent with the study by Gambacorta and Ibanez (2011), which states that banks' lending behaviour is driven by funding costs (R) rather than return opportunities in the real sector, and that banks that are more dependent on market funding restrict lending more sharply during financial crises.

Figure 5*Responses to a Positive Interest Rate Shock*

A positive exogenous interest rate shock produces results consistent with standard NK model predictions. Output (Y) contracts significantly, investment (I) falls sharply due to its high sensitivity to credit-financed fixed capital formation, and consumption (C) declines, though with lower magnitude than investment. The capital stock (K) decreases gradually.

The capital return (R_k) falls more rapidly and sharply than the real interest rate (R), causing the risk premium (prem) to temporarily increase in the initial periods. The leverage ratio (ϕ) exhibits a positive initial response attributable to the mechanical effect of the temporary rise in ψ , while the credit supply indicator (QKg_Y) simultaneously declines, demonstrating that even as banks' technical leverage capacity increases, actual credit use is constrained by deteriorating real economy conditions.

These results demonstrate that when the interest rate is imposed as an exogenous shock, the classical monetary transmission mechanism operates effectively, and the shock is transmitted strongly to the real economy through financial friction channels. By contrast, when the interest rate is determined endogenously through the Taylor rule, financial frictions distort the policy signals, producing insufficient, delayed, or incorrectly directed responses. This finding is consistent with the risk-shock models of Christiano, Motto, and Rostagno (2011, 2014), which demonstrate that financial frictions simultaneously explain a large share of business cycle fluctuations and render the credit channel of monetary transmission fragile.

Conclusion And Policy Implications

This study investigates the effects of financial frictions on monetary policy effectiveness in Turkey using a New Keynesian DSGE model based on the Gertler and Karadi (2011) framework estimated using Bayesian methods over the period 2011Q1–2024Q2. In this context, a structure reflecting banks' net foreign exchange

assets and the transmission of exchange rate and financial friction to the real economy, as well as financial friction shocks, has been added to the original Gertler and Karadi (2011) model.

The findings of the study show that shocks originating from the financial system increase credit spreads, thereby raising banks' borrowing costs and affecting credit supply. Furthermore, shocks from the financial system, by impacting credit supply, lead to a significant decrease in investment, consumption, and output. In contrast, it was observed that the policy interest rate responded to shocks from the financial system. However, this response was limited and lagged. Therefore, it appears that the monetary policy's response to financial shocks is insufficient to drive the shocks. This finding is consistent with Abadi, Brunnermeier, and Koby (2023) and the results obtained by Sekmen and Şıklar (2016).

In contrast, the findings show that an external monetary policy shock is strongly transmitted to the real economy by increasing financial friction through its effect on leverage. This reveals that the effectiveness of monetary policy depends not only on the presence of financial friction but also on whether the shock is endogenous or exogenous determined by Taylor's rule. Therefore, shocks affecting financial friction impair the signalling function of monetary policy while strengthening transmission when monetary policy is implemented exogenously.

The posterior distribution of the persistence parameter of the financial friction shock ($\rho_\psi = 0.8906$) indicates that external shocks reflecting financial conditions in Turkey have had quite persistent effects. This result reflects the credit-driven growth structure of the Turkish economy. It also reflects the macroprudential interventions implemented in the credit market during the forecast period. On the other hand, the relatively high posterior distribution of monetary policy shock volatility ($\sigma_i = 0.1753$) confirms that a significant portion of the CBRT interest rate change during this period reflects non-systematic factors. This is consistent with the institutional fragility of monetary policy in Turkey documented by Gürkaynak, Kısacıkoglu, and Lee (2023).

All these findings indicate that the CBRT faces many challenges in determining its monetary policy response and timing when financial frictions are considered. Standard Taylor Rule constraints monetary policy to prevent central bank from financial shocks. Instead, it responds indirectly to financial shocks through inflation and output. This results in a delayed and weak response to financial conditions.

The CBRT, anticipating this situation, developed new macroprudential policy tools following the financial crisis. Thus, albeit indirectly, the CBRT expanded its capacity to influence the spread and credit supply without using interest rates. This study tests this by applying a negative shock (σ_ψ) that externally affects the transmission of financial friction. The monetary policy response to such a shock implies insufficient influence on banks' funding costs (R). This is consistent with studies reflecting that in environments where changes leading to deterioration of the financial structure occur in the Turkish economy, the transmission of monetary policy to deposit and loan interest rates weakens.

In contrast, the findings from the model show that an external interest rate shock strongly impacts the real economy through banks' funding costs and leverage ratios. This result reveals that when financial frictions are considered in Türkiye, monetary policy effectiveness is strengthened when implemented more proactively rather than simply reacting to financial shocks. In practice, central banks should consider forward-looking financial indicators, such as credit spreads or balance sheet conditions, more directly in their policy decisions, rather than relying solely on output and inflation gaps.



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