CREDIT SUPPLY, REAL ESTATE PRICES, AND MACROECONOMIC FLUCTUATIONS

by
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ABSTRACT

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Thesis Supervisor: Assoc. Prof. Inci Gümüş

Keywords: Dynamic stochastic general equilibrium model, Housing prices, Macroeconomic variables, Commercial credits

This paper empirically and theoretically analyzes the impact of commercial credit movements on macroeconomic fluctuations in Turkey for the period 2010Q1-2023Q4, especially focusing on the housing market. For this purpose, in the empirical part, I use the local projection instrumental variable approach where a credit supply shock is an instrument, derived from the micro-data. Results imply a significant increase in consumption and house prices in response to the credit supply shock while investment, labor hours worked, and capital price responses are lagged. In the theoretical part, I augment Liu, Wang, and Zha (2013) with a credit supply shock, which affects the saving decision of a household. I compare the similarities and differences of impulse response functions of the credit supply shock with the empirical ones. Finally, variance decomposition analysis points out the importance of the credit supply shock.

ÖZET

KREDİ ARZI, GAYRİMENKUL FİYATLARI VE MAKROEKONOMİK DALGALANMALAR

TARIK AYDOĞDU

EKONOMİ YÜKSEK LİSANS TEZİ, TEMMUZ 2024

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Anahtar Kelimeler: Dinamik stokastik genel denge modeli, Konut fiyatları, Makroekonomik değişkenler, Ticari krediler

Bu çalışma, 2010Q1-2023Q4 dönemi için Türkiye'de ticari kredi hareketlerinin makroekonomik dalgalanmalar üzerindeki etkisini özellikle konut piyasasına odaklanarak ampirik ve teorik olarak analiz etmektedir. Bu amaçla, ampirik kısımda, mikro verilerden türetilen bir kredi arzı şokunun araç olduğu yerel projeksiyon araç değişken yaklaşımı kullanılmaktadır. Sonuçlar, kredi arz şokunun tüketim ve konut fiyatlarında önemli bir artışa yol açtığına işaret ederken, yatırım, çalışılan işgücü saati ve sermaye fiyatı tepkisinin gecikmeli olduğunu göstermektedir. Teorik kısımda, Liu, Wang ve Zha (2013) modeli, hanehalkının tasarruf kararını etkileyen bir kredi arzı şoku eklenerek genişletilmekte ve kredi arzı şokunun etki tepki fonksiyonlarının benzerlikleri ve farklılıkları ampirik sonuçlarla karşılaştırılmaktadır. Son olarak, varyans ayrıştırma analizi kredi arzı şokunun önemine işaret etmektedir.

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To my family

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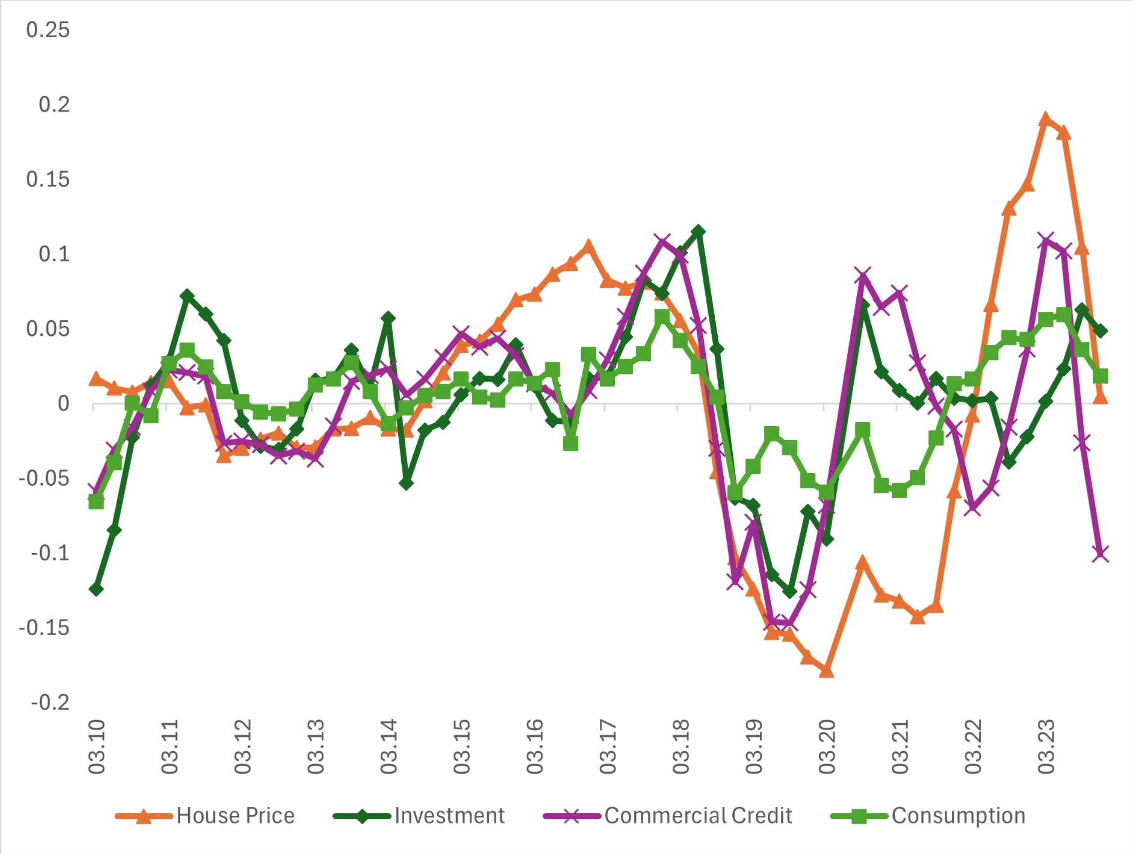
1. INTRODUCTION

Beginning from the debt-deflation theory of Fisher (1933) which outlines the role of credit in the business cycle, the literature demonstrates that the credit cycle dynamics play a vital role in the fluctuations of macroeconomic aggregates. Kiyotaki and Moore (1997), Bernanke, Gertler, and Gilchrist (1999), and Iacoviello (2005) emphasize the propagation and amplification mechanism of credit markets after the macroeconomic shocks affect asset prices. Since the borrowers are constrained to borrow up to some fraction of their assets, after the shock they struggle to borrow, crucial for production. This puts downward pressure on the asset prices. Therefore, credit markets accelerate and transmit the effects of macroeconomic shocks. Beyond this transmitting property of credit (collateral channel), recent works, after the 2008 global financial crises, demonstrate the role of disturbance in credit markets on macroeconomic fluctuation (Gerali et al. (2010), Christiano, Motto, and Rostagno (2010), Justiniano, Primiceri, and Tambalotti (2019), Greenwald and Guren (2021), Favara and Imbs (2015), and Eggertsson and Krugman (2012)).

This paper empirically and theoretically analyzes the impact of commercial credit movements on macroeconomic fluctuations in Turkey for the period 2010Q1-2023Q4, especially focusing on the housing market. In the empirical part, I analyze the credit expansion effects on house prices and macroeconomic fluctuations using the local projection instrumental variable (LP-IV, hereafter) approach where a credit supply shock is an instrument, derived from the micro-data. In the theoretical part, I construct a dynamic stochastic general equilibrium (DSGE) model augmented with a housing market and a credit supply shock. The credit supply shock is introduced to the model as a shock affecting the household's saving decision. Then, I use the Bayesian estimation method to set the parameter values of the model and to estimate the moments.

Figure 1.1 demonstrates the last 14 years of business cycles in Turkey. We observe the sudden downturn and high variance in all variables following the currency shock in 2018Q3. The downturn continued with the interest rate hike and the pandemics

Figure 1.1 Business Cycles in Turkey



Note: All variables are logged, seasonally adjusted, and HP-filtered with smoothing parameter 1600. Cyclical components of the HP-filtered series are shown. The pandemic period (2020Q2) is excluded from the analysis.

until the 2020Q3. Then, it reversed in 2020Q3 with expansionary policies, especially in the credit markets, after the pandemic. The house price reversion takes a longer time and then demonstrates a sharper incline, drawing attention to its possible effects on macroeconomic fluctuations. While struggling with the higher variance due to the inflationary pressures, we observe the downward effects of the interest rate hike in the last two quarters. The reason for focusing specifically on the housing market when studying credit and the macroeconomic cycle is that the housing market creates the link between them. In the literature, it has been shown that house price increases can affect consumption (Mian, Rao, and Sufi (2013)) and investment (Liu, Wang, and Zha (2013)). Given the prevailing argument in the literature that an expansion in credit supply leads to higher house prices, controlling the housing market in our setting can be seen as an additional accelerator for the effect of the credit supply shock on the economy.

The effects of housing credit disturbance on house prices are extensively discussed in the literature. On the other hand, since the firms also use land and real estate as production factors, we also expect that the disturbance in commercial credit affects house prices. The other reason why commercial credit is analyzed while focusing on the housing market is that in Turkey, commercial credit accounts for about 74 percent of total credit while the share of housing credit is 8 percent for our estimation period.

Analyzing the interaction of credit and business cycles requires disentangling the supply-side and demand-side credit dynamics, both in the empirical and theoretical analysis, which may lead to different conclusions. Associating the borrowing decision of agents and the credit dynamics aims to explain the demand side of credit. This relation is mostly driven by the disturbance in income, which may arise from productivity or technology shock. Therefore, the demand side is more endogenous to macroeconomic developments, which does not leave much room for policy (Mian, Sufi, and Verner (2017)). On the other hand, analyzing the relation between the availability of credit and the credit dynamics aims to analyze the supply side of credit. From a policy perspective, intermediaries can exogenously shape credit cycles through their expectations or intermediate dynamics and distort agents' economic decisions. Since the demand side is more endogenous to macroeconomic variables and the supply side is more subject to policy, I analyze the supply side of credit after the disentangling process.

The disentangling process has been practiced in the literature in various ways. In our empirical setting, partitioning into the demand and supply side is based on the methodology of Amiti and Weinstein (2018) (AW, hereafter), derived from proprietary credit registry micro-data, a large sample of matched bank-firm loans. This methodology uses bank-time and firm-time fixed effects in the loan-level framework, which leads to the assessment of the credit supply shock at the bank level as the way different banks adjust their lending to the same firm (within-firm comparison). I then analyze the impact of exogenous credit variation on the economy using the LP-IV setting which directly estimates the impulse response functions (IRF) of house prices, consumption, investment, capital prices, and labor hours worked.

Our empirical approach belongs to a strand of literature that focuses on the consequences of deterioration in credit dynamics to the macroeconomic aggregates by exploiting exogenous variations in credit (Favara and Imbs (2015), Glaeser, Gottlieb, and Gyourko (2012); Mian, Sufi, and Verner (2017), Adelino, Schoar, and Severino (2012), Loutskina and Strahan (2015)). They utilize quasi-natural experiments in mortgage credit to identify exogenous variation, such as the US banking deregulation in the 1980s (Mian, Sufi, and Verner (2017)), the federal preemption of state laws against predatory lending in 2004 (Di Maggio and Kermani (2017)), or the differential city-level exposure to changes in the conforming loan limit (Loutskina and Strahan (2015)). AW methodology, in that sense, can be useful in the absence of an exogenous event for identification. There is also literature employing macroeconometric techniques to identify the credit supply shock such as zero and sign restriction in a structural vector auto-regression (SVAR) framework (Hristov, Hülsewig, and Wollmershäuser (2012), Eickmeier and Ng (2015), Barnett and Thomas (2014), Moccero, Pariès, and Maurin (2014)). Our work differentiates from them in deriving the exogenous variation from the micro-data through fixed effects. Alfaro, García-Santana, and Moral-Benito (2021) also employs AW methodology to investigate the consequences of credit supply shock on the real economy by regressing it. Our work differentiates from them by employing this shock as an exogenous variation in the LP-IV setting and investigating business cycle properties.

Following Liu, Wang, and Zha (2013), I construct a general equilibrium model augmented with a credit supply shock, to be consistent with our empirical findings. Our theoretical model employs a macro-housing framework as in the Iacoviello (2005), Liu, Wang, and Zha (2013), Iacoviello and Neri (2010), Eggertsson and Krugman (2012), Greenwald and Guren (2021), Garriga, Kydland, and Šustek (2017). There are two types of agents-a representative household and a representative entrepreneur. The economy consists of two types of commodities: goods and real estate. There is a fixed amount of real estate and it is traded between the household and the entrepreneur. The household supplies labor. Production requires labor, real estate, and capital. In our model, the household finances the firms' investments. Their capacity to borrow is constrained by the collateral value, which combines real estate and capital stock as in Iacoviello (2005). Real estate is collateral to capture comovements between real estate prices and investment. Furthermore, in the spirit of Justiniano, Primiceri, and Tambalotti (2019), I also allow her to finance it through an exogenous credit shock. Beyond the collateral channel, our model tries to incorporate triggering in the credit supply decision of lenders. Our innovation is to introduce the credit supply shock into the household budget constraint as a shock that affects household saving decisions. The credit supply shock, then, affects the housing market and investment dynamics by lowering the interest rate. I associate the loan-to-value (LTV) shock with the demand side of the credit in the spirit of Justiniano, Primiceri, and Tambalotti (2019). They argue that an unprecedented boom and bust in house prices and its consequences for the economy can be explained not only by the loosening of borrowing constraints but also by the loosening of lending conditions. They argue that the loosening of collateral requirements is empirically associated with the demand side of credit, as it increases the demand for credit and creates upward pressure on interest rates. However, a credit supply shock can be defined as an increase in the availability of credit, which simultaneously leads to credit expansion and lowers interest rates. In their framework, the slackening of credit supply constraint triggers a fall in interest rates as well as an increase in house prices, leading to higher collateral values and hence borrowing capacity. In their model, a lender has an additional constraint to extend a loan and they investigate the relaxing of household credits. Our model differentiates from this by defining a shock to a household's saving decision that is interpreted as a credit supply shock and this shock affects the entrepreneur, so it is actually a shock to the commercial credit as in our empirical approach.

In the empirical results, first-stage regression results provide statistically significant positive coefficients with a high goodness of fit which points out a strong instrument. Then, I compute the IRFs in the LP-IV setting. Consumption and house prices significantly increase right after the credit supply shock and their responses are 3 and 6 percent at peak. Investment, total hours worked, and capital price responses are lagged and their responses are 10, 3, and 1 percent, respectively, at their peak. We observe that investment has the highest response to the exogenous commercial credit shock, however, since the occurrence of a sudden increase in consumption and house price rather than investment, we may interpret that an expansion in credit is firstly transmitted to them and the warming up in the economy creates investment demand. As a robustness check, direct OLS estimation of local projection without an instrument gives insignificant responses, meaning that our instrument may capture the exogenous variations in credit. The other robustness check, instrumenting the credit at the current period rather than at the lag, demonstrates that the statistically significant increases are robust, excluding the investment. We may interpret this as that our exogenous variation in commercial credit does not arise in the credit mostly related to the investment.

In our theoretical model results, impulse responses to the credit supply shock imply a more permanent heightening in consumption and house prices. However, a decrease in house prices in the first period contradicts our empirical result. Investment and labor hours worked responses behave hump-shaped with a significant increase in initial periods. These Bayesian DSGE IRFs differ from the empirical ones where investment and labor hours worked respond with lags. An initial negative effect of a household's real estate holding after a housing demand shock also implies a deficiency[1] in our model. On the other hand, the variance decomposition analysis

[1] This deficiency may arise because our model defines the closed economy where household saving decision dynamics determine the interest rate although Turkey is a small open economy. Since we are interested in the credit supply shock, it should be included in the saving decision of the bond issuer. To consider the small open economy dynamics, we need a sector whose borrowing is determined by the world interest rate,

points out the importance of the credit supply shock. It explains the sizeable fraction of the aggregates, and it is the most important one for investment, labor hours worked, and household's real estate holdings. The other interesting result is that the real estate price is explained not only by the housing demand shock but also by the TFP, labor disutility, and credit supply shock, in contrast to Liu, Wang, and Zha (2013). We also observe that the credit supply shock puts downward pressure on the interest rate while the LTV shock puts it upward. This may support the aforementioned claim that the LTV associates with the demand side and the defined credit supply shock may capture the supply side

To put it concisely, this paper makes two contributions to the literature. Firstly, in the empirical part, I use a novel instrument as a credit supply shock, rooted in the microeconometric framework to analyze the macroeconomic fluctuations in the LP-IV setting. In the theoretical part, I try to disentangle the credit supply and demand shocks by defining a shock to the saving decision of households who issue a bond.

The rest of the paper is organized as follows: In the following section, I discuss our empirical approach along with estimating the credit supply shock and introducing the LP-IV setting. In section 3, I introduce our theoretical model, and then, in the following section, I estimate and calibrate parameters thanks to literature, data, and a Bayesian estimation technique. In section 5, I discuss the theoretical model's propagation mechanism. Finally, I conclude the paper.

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however, it is beyond the scope of this paper.

2. EMPIRICAL APPROACH

This section introduces the empirical approach to constructing a causal effect of commercial credit expansion on macroeconomic aggregates such as consumption, investment, house prices, capital prices, and labor hours using an external instrument derived from the AW methodology. There are two different channels in the interaction of credit and macroeconomic fluctuations. One of them is the borrower-driven channel that analyzes the borrowing decisions of agents and their consequences. This channel is more endogenous to the disturbances in macroeconomic variables. The other is the lender-driven channel that analyzes a change in the lenders' willingness to extend loans. It is known that the type of credit expansion, lender or borrower-driven, may trigger the business cycles in different ways and give us separate intuition (Mian, Sufi, and Verner (2017)). Since the demand side is relatively more endogenous to macroeconomics and the supply side is more subject to macro-prudential regulations, I will examine the consequences of the credit supply expansion. To find the true effect of exogenous credit expansion on the economy, I disentangle the supply and demand side using the AW methodology in the following subsection. Then, I will examine the interaction between credit and macroeconomic conditions by instrumenting the credit in the LP-IV setting.

2.1 Credit Supply Shock

In the literature, to find a causal relation, exogenous variation in credit supply is defined in several ways. Mian, Sufi, and Verner (2017) exploit the relationship between credit supply shock on household debt and business cycles by employing the mortgage spread as an instrument, requiring the assumption that a lower spread implies a credit supply shock. Jordà, Schularick, and Taylor (2015) isolate exogenous credit supply shock by observing how the economies with pegged currencies behave in the face of monetary policy shifts in pegged countries. Again, they associate the spreads and source of variation in credit but such aggregated estimations fail to account for lender and borrower heterogeneity because of the lack of micro-level focus (Eickmeier and Ng (2015))

Later, the availability of bank-firm-loan level datasets (via sources like Credit Registry) and the implementation of micro-econometric techniques have significantly improved the validity of empirical analysis of credit shocks. The granularity of data combined with higher-order fixed effects and unforeseen events used within a quasi-natural experiment setting has allowed researchers to extract credit supply shocks by isolating the demand component (Khwaja and Mian (2008)). Basically, these studies integrate the firm's fixed effects into the loan level framework, which leads to the assessment of how different banks (with varying degrees of exposure to a specific external shock) adjust lending to the same firm (within-firm comparison). This brings a remedy to the aforementioned endogenous matching and confounding credit demand limitations. However, this approach also suffers from certain flaws including the inability to create proxies for supply and demand shocks jointly and the inability to account for new banking relationships (so not being able to replicate the aggregate credit dynamics) as well as having a restrictive assumption positing that a specific firm demonstrates the very same credit demand across multiple lenders.

The contribution of AW is to append this micro-econometric method by alleviating such limitations and capturing general equilibrium linkages. The AW method simply augments the specification with bank-time and firm-time fixed effects together with a weighted least squares procedure with weights defined to accommodate the relative importance of each loan in the total credit developments, while the need for an exogenous event for identification is also abandoned. Referring to AW, we disentangle corresponding credit supply and demand shocks in the following specification:

$$D_{fbt} = \alpha_{ft} + \beta_{bt} + \epsilon_{fbt} \tag{2.1}$$

where D_{fbt} is the percentage growth rate of the lending of a bank b to firm f at time t, defined as $L_{fb,t}/L_{fb,t-1} - 1$ where $L_{fb,t}$ is the total credit of a firm f using from bank b at time t. α_{ft} and β_{bt} are the time-varying fixed effects for firms and banks, respectively, and ϵ_{fbt} is the error term. However, this baseline method has deficiencies in identification, aggregation, and lending relation formation or termination. AW estimation deals with those in a well-constructed way.

To solve the aggregation problem that refers to the exact decomposition of the lending growth rate of loan relationship into the shocks, the AW method utilizes Weighted Least Square (WLS) estimation where the weights are lagged loan relations. Therefore, we need to have a positive lending relationship between the firm and the bank. The other drawback, regarding the formation or termination of lending relations, is overcome through adding new lending by the bank as a share of previous lending.

Later, we derive the bank-specific idiosyncratic supply, idiosyncratic demand, and common shocks by the following steps. First, we need to apply normalization by dropping the first firm and first bank observation from the estimation as mentioned in the AW method. Then, the corrected version of the Equation 2.1 is formed as follows:

$$D_{fbt} = c_t + \ddot{\alpha}_{ft} + \ddot{\beta}_{bt} + \epsilon_{fbt} \tag{2.2}$$

where c_t is a time-fixed effect defined as the sum of α_{1t} and β_{1t}, $\ddot{\alpha}_{ft} = \alpha_{ft} - \alpha_{1t}$ and $\ddot{\beta}_{ft} = \beta_{ft} - \beta_{1t}$. Then, we can construct the aforementioned WLS estimation as follows:

$$D^B_{bt} = \hat{c}_t + \hat{\ddot{\beta}}_{bt} + \sum_f \phi_{fb,t-1} \hat{\ddot{\alpha}}_{ft} \tag{2.3}$$

where D^B_{bt} is a bank-specific lending growth rate, $\phi_{fb,t-1} = L_{fb,t-1} / \sum_b L_{fb,t-1}$ is the weight parameter for aggregation, and the hatted terms are the WLS estimates of equation 2.2. The formation of new lending relations is inserted into the model as a share of existing lending relations at $t-1$ after some algebraic manipulation. Then, this process allows us to obtain an exact match between the aggregation of shocks and loan growth. Equation 2.3 gives us the shocks at the bank level. Then, we can also aggregate this equation across banks to get overall shocks that decompose total credit growth into idiosyncratic, supply, and demand shocks respectively as:

$$D_t = \hat{c}_t + \sum_b \omega_{b,t-1} \hat{\ddot{\beta}}_{bt} + \sum_b \omega_{b,t-1} \sum_f \phi_{fb,t-1} \hat{\ddot{\alpha}}_{ft} \tag{2.4}$$

where D_t is the total credit growth at time t and $\omega_{b,t-1} = \sum_f L_{bf,t-1} / \sum_{bf} L_{bf,t-1}$. $\hat{c}_t$ represents the total common shock that hits all financial institutions, therefore, it can be seen as a macroeconomic shock, for instance, an interest rate shock.

2.2 Local Projection Instrumental Variable (LP-IV)

Conventional macroeconometric techniques such as structural vector autoregressions (SVAR) utilize identification restrictions that produce internal instruments to capture the dynamic causal effect. However, identifying the exogenous variation in a relevant variable that is not correlated with the other economic shocks yields a more compelling causal effect and ensures the source of the variation (Stock and Watson (2018)).

Inferring causal effects through exogenous shocks from the macroeconomic dynamics received growing attention in the literature. Stock and Watson (2012) use the SVAR technique to analyze the 2008 crisis by inserting several exogenous shocks that come from outside of the SVAR environment such as Romer and Romer (2004) monetary policy shock, Ramey (2011) fiscal policy shock, and so on. Mertens and Ravn (2013) develop an external instrument using narratively identified[1] tax changes for structural tax shock, and then investigate its effect on the economy. Gertler and Karadi (2015) use the high-frequency identification of monetary policy to identify the external instrument for monetary policy shock, and then find some evidence for the response of inflation. The Local Projection, equivalent to SVAR for the shorter horizon, is the other technique to estimate the impulse responses. They also can be obtained from Cholesky's identification of SVAR while using an instrument (Plagborg-Møller and Wolf (2021)). This method estimates the impulse response directly by regressing all variables to others for each horizon. The local projection instrument variable (LP-IV) dates to Jordà, Schularick, and Taylor (2015). They find evidence of a link between short-term interest rates and house prices by assigning monetary policy changes in countries where they pegged currencies as an external shock to the domestic monetary policy. Ramey and Zubairy (2018) uses narrative identification for government spending by exploiting historical news. Then, they analyze the government spending multiplier's differentiation through time with LP-IV. Greenwald and Guren (2021) employ the shift-share instrument to the conforming loan limits[2] to identify the instrument for the credit supply shock and insert it in the LP-IV where the outcome variables are price-rent ratio, house prices, and home-ownership rate.

In our setting, I use the supply shock from the AW disentangling process as an instrument for credit expansion at the first stage. LP-IV is built on the following

[1] Narrative methods use the variable's historical data and identify its particular and exogenous changes.

[2] This represents the maximum loan size eligible for securitization by Fannie Mae and Freddie Mac. It was developed by Loutskina and Strahan (2015)

two-stage least square estimation:

$$\Delta log(Y_{t+h}) = \alpha_h + \beta_h \Delta log(B_{t-3}) + \Psi_h(L)\Delta log(X_t) + \epsilon_{Y,t+h} \tag{2.5}$$

$$\Delta log(B_{t-3}) = \beta_0 + \gamma AW_{t-4} + \Gamma_h(L)\Delta log(X_t) + \epsilon_{B,t-3} \tag{2.6}$$

where h specifies the horizon, Y_t is the variable of interest, X_t is the vector of control variables that also includes the other lags of the commercial credit, $\Psi_h(L)$ and $\Gamma_h(L)$ are polynomial in the lag operators, B_{t-3} is the third lag of the commercial credit stock, β_h is our coefficient of interest, and AW_{t-4} $(= \sum_b \omega_{b,t-4}\hat{\hat{\beta}}_{b,t-3})$ is the credit supply shock. All endogenous variables are included as a control. Equation 3.5 and Equation 3.6 are our second-stage and first-stage regression, respectively. The second stage's set of variables is also used in the first stage. Since the local projection method concerns the serial correlation problem in the error terms induced by the successive leading of the dependent variable, I use the Newey-West correction for the standard errors. According to Akaike Information Criteria (AIC), I include four lags of each variable in the estimation equation.

The instrument has to satisfy the following three conditions to be used in the model, described in Stock and Watson (2018). The first condition is the relevance $(E(\epsilon_{B,t-3}AW_{t-4}) \neq 0)$ that requires the positive correlation between the instrument and treatment variable. I report the first-stage regression result in the following subsection to evaluate the relevance. The considerably high value of F-statistics (Table 3.1) implies the validity of relevance. The second one is the contemporaneous exogeneity condition $(E(\epsilon_{Y,t}AW_{t-4}) = 0)$ that requires the uncorrelated instrument with the other structural shocks. Since the AW methodology's credit supply shock arises from the relation between the banks and firms, and the common shock derived from the AW method also captures the macroeconomic shocks, this exogeneity condition would be satisfied. The last condition is the lead-lag exogeneity $(E(\epsilon_{Y,t+j}AW_{t-4}) = 0$ for $j \neq 0)$ that requires the instrument to be uncorrelated with all shocks at all leads and lags. Since the macroeconomic variables include all their shocks, in this way, we ensure that the instrument solely explains the treatment variable. Stock and Watson (2018) asserts that the lead exogeneity assumption generally is not restrictive because the shock is unanticipated by definition. On the other hand, this condition can also be assessed by regressing the instrument on the lagged values of endogenous variables. The lower F-statistics imply that the macroeconomic variables cannot explain the shock, which is desired. When I do this regression, I get 1.13 F-statistic. I also add the endogenous variables and lagged values of the outcome variable as controls to mitigate concerns about the failure of this condition.

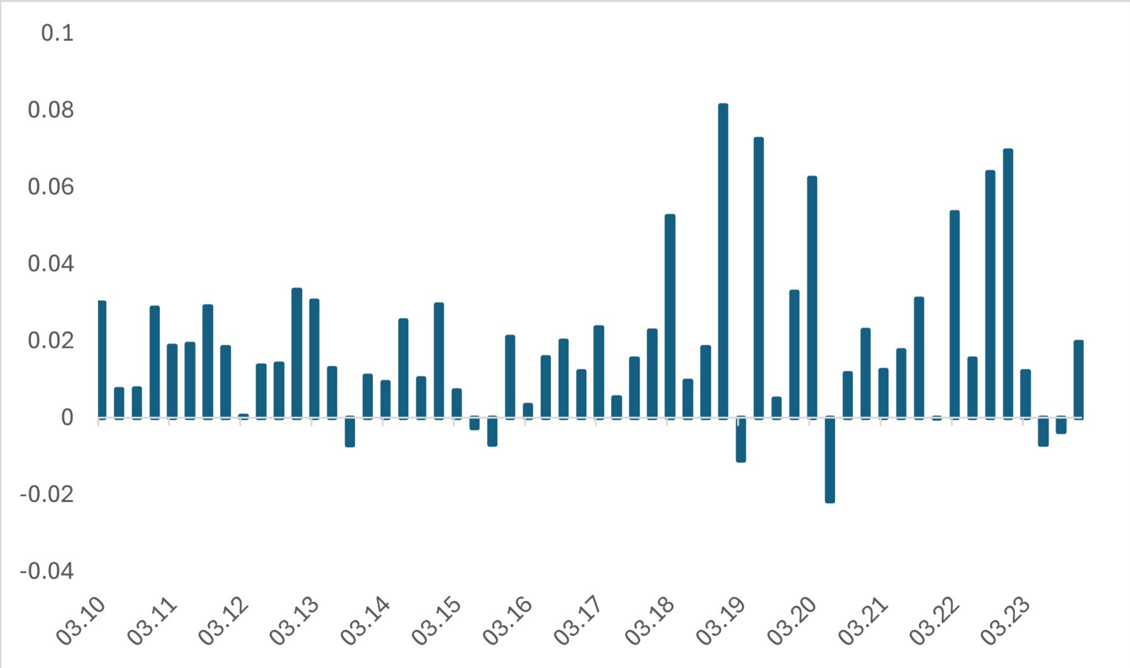
Which lag should be used as an instrument? Hazell et al. (2022) suggests that instrumenting the lagged treatment variable may mitigate the lag exogeneity assumption because it decreases the correlation between the instrument and past shocks of outcome variables. I also obtain F-statistics, after regressing each lag (the first to the fourth) of the shock variable onto lagged values of endogenous variables, as follows: 0.86, 1.73, 1.28, and 1.13, respectively. As suggested in Hazell et al. (2022), since the lagged variable will be uncorrelated with the past error term of the outcome variable, and combining this with the F-statistics results, I use the fourth lag of the credit supply shock as an instrument, AW_{t-4}. Since the AW_{t-4} represents the supply shock that comes to the growth rate of commercial credit stock between $t-3$ and $t-4$, this instrument is regressed onto $\Delta log(B_{t-3})$. Then, in the robustness check part, I control for the changes in responses if the first lag, which has the lowest F-statistics, is instrumented.

2.3 Data and Empirical Results

To identify commercial credit supply shocks, the overall quarterly sample period includes the interval between 2010Q1 and 2023Q4, based on all banks in Turkey. We use a proprietary Credit Registry database that contains matched bank-firm level observations. I only keep non-financial TL performing and cash loans using this quarterly dataset. Each firm's loan balance at the matched bank is aggregated for the end of each month. Then, observations with no loan relation within two-quarter periods are excluded. Moreover, as in the AW method, firms with a single bank loan relationship are dropped from the dataset. Having obtained the supply shock, I present (commercial) loan-weighted time series of the credit supply shock for Turkey in Figure 2.1. We observe that after 2018, the supply shock demonstrated excessive movements that may be due to the financial turmoil in August 2018 (% 91 depreciation in Turkish lira compared to the beginning of the year) and pandemics that started in early 2020. Between 2021Q1 and 2022Q1 we observe a decrease in credit supply shock that may be due to the turmoil in the construction sector. Then, by 2023Q1, there is a higher credit supply shock because of increased inflation, distorting expectations. In the last four quarters, the tightening in monetary policy has led to normalization in credit supply movements.

Our response variables of interest are five quarterly series obtained from the Turkish Statistical Institute (TURKSTAT) for the period 2010Q1-2023Q4: real house price

Figure 2.1 Credit Supply Shock



Note: This series is derived from the AW methodology, using the credit registry data.

index, real price of capital[3], real per capita consumption, real per capita investment, and hours worked index. I exclude 2020Q2 from all data, as well in the theoretical part, because of the COVID-19 pandemic, as suggested in the Lenza and Primiceri (2022) Our instrumented variable is real per capita commercial credit data from the Banking Regulation and Supervision Agency (BRSA). Getting the real series for the house price and commercial credit is done through the consumer price index (CPI). I use the chained volume index values of TURKSTAT for investment and consumption. All variables are seasonally adjusted after taking their logarithm. Then, I take the first difference for the empirical analysis.

To evaluate the relevance of our instrument, I report the simple first-stage regression results for each horizon in Table 2.1. In this stage, the third lag of the commercial credit is regressed on our instrument and control variables. The F-statistic for each horizon is considerably high ensuring the statistical significance as expected because the credit supply shock essentially is part of the commercial credit growth. The goodness of fit is also high.

[3]Capital price comes from the division of the nominal value of the machinery equipment investment to the real value. Then, this variable is converted to the real term by using the CPI.

Table 2.1 First-Stage Regression Results

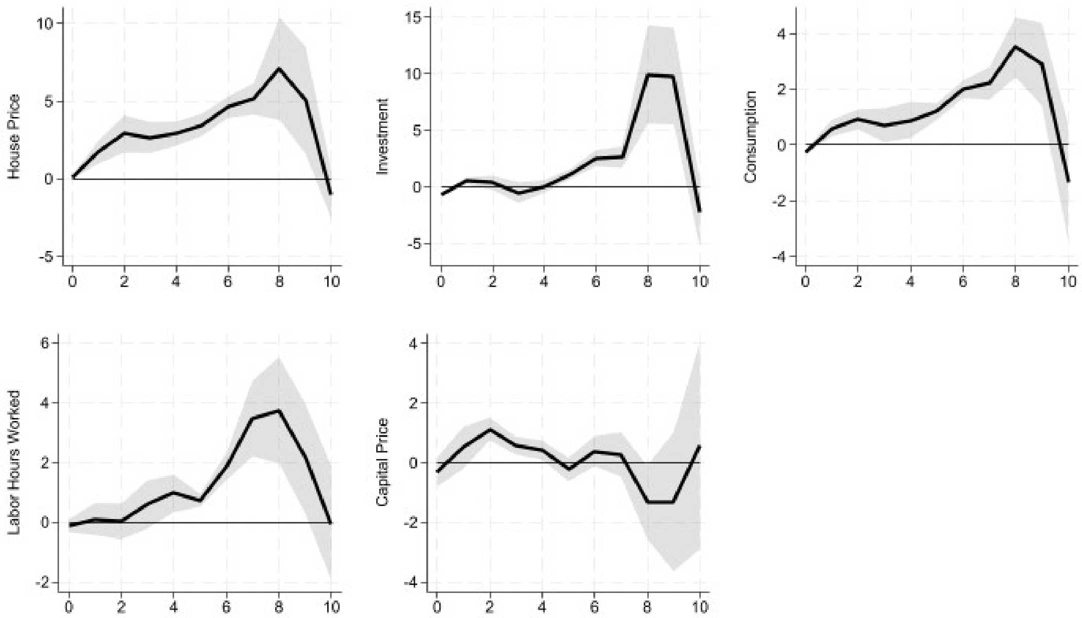
Horizon	1	2	3	4	5	6	7	8
IV Coefficient	0.72***	0.72***	0.74***	0.82***	0.79***	0.85***	0.66***	0.58***
	(0.16)	(0.28)	(0.28)	(0.32)	(0.32)	(0.28)	(0.21)	(0.26)
R^2	0.88	0.88	0.88	0.88	0.88	0.92	0.94	0.93
F-Statistic	657.73	599.62	966.57	1328.07	1143.62	2370.59	2262.82	3177.20
Observations	49	48	47	46	45	44	43	42

Note: Robust standard errors are in parentheses. Our variables of interest (consumption per capita, investment per capita, hours worked index, capital price, and house price index) and their lags are included after taking logged differences as control variables. $^{*}p < 0.1$; $^{**}p < 0.05$; $^{***}p < 0.01$

Figure 2.2 demonstrates the cumulative impulse responses of our outcome variables to credit growth in percentage (β_h in equation 3.5) in the LP-IV setting where the instrument is derived from the AW methodology. Their horizontal axis is in terms of the quarters. We observe an immediate statistically significant increase in real house prices and real consumption, starting from the first quarter. They reach their peaks in the eighth quarter, approximately 6 and 3 percent, respectively. The capital price's significant response is relatively small, with 1 percent at its peak, just between the second and fourth quarters. After the fourth quarter, we do not observe any significant movement. The hours worked index and investment respond to the credit supply shock with about a four-quarter lag, after that, we observe significant effects. While investment increases by approximately 10 percent at its peak, the hours worked index increases by 3 percent. In our setting, we are interested in the total commercial credit, including the credit used for working capital and investment. Considering the share of credit used for investment in total commercial credit is approximately 6%[4] for our estimation period and lagged response to the credit supply shock, we may interpret that our exogenous variations in credit do not arise on the investment credit side. Also, since we investigate the TL-denominated credits, this result is consistent with Küçük, Özlü, and Yüncüler (2022), discussing a fluctuation in FX-denominated credits affects investment more in Turkey. Rather, investment may be responding to a warming up in the economy, in our setting.

[4]This ratio is derived from the BRSA database for the period 2010Q1-2023Q4

Figure 2.2 Impulse Responses to Credit Shock

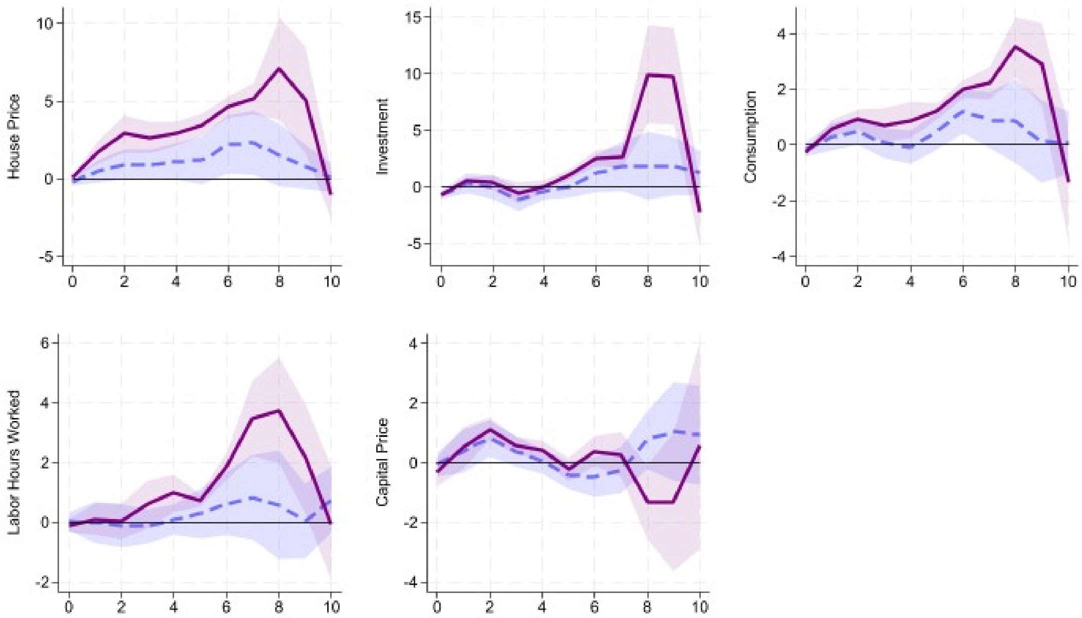


Note: The grey shaded areas represent the 90 percent confidence bands. All variables are in the form of log differences. The Y-axis indicates the percentage deviations and the X-axis indicates the quarters.

2.4 Robustness

As a robustness check for the validity and usefulness of our instrumental variable, I compare the OLS estimation of equation 3.5 with the IV estimation in Figure 2.3. Since the used macroeconomic aggregates heavily suffer from the endogeneity problem, the OLS estimation yields biased estimation. Therefore, we do not observe any statistically significant effect on the variables. We can conclude that IV estimation performs better as it captures the exogenous variation.

Figure 2.3 Impulse Responses to Credit Shock: OLS (dash blue) vs. IV (solid purple)



Note: Purple and blue shaded areas represent the 90 percent confidence bands. All variables are in the form of log differences. The Y-axis indicates the percentage deviations and the X-axis indicates the quarters.

Our baseline estimation uses instruments for the third lag of the commercial credit to mitigate concern about the lag exogeneity assumption. However, since there is no consensus on which lag should be instrumented, I modify our base specification for this purpose as follows:

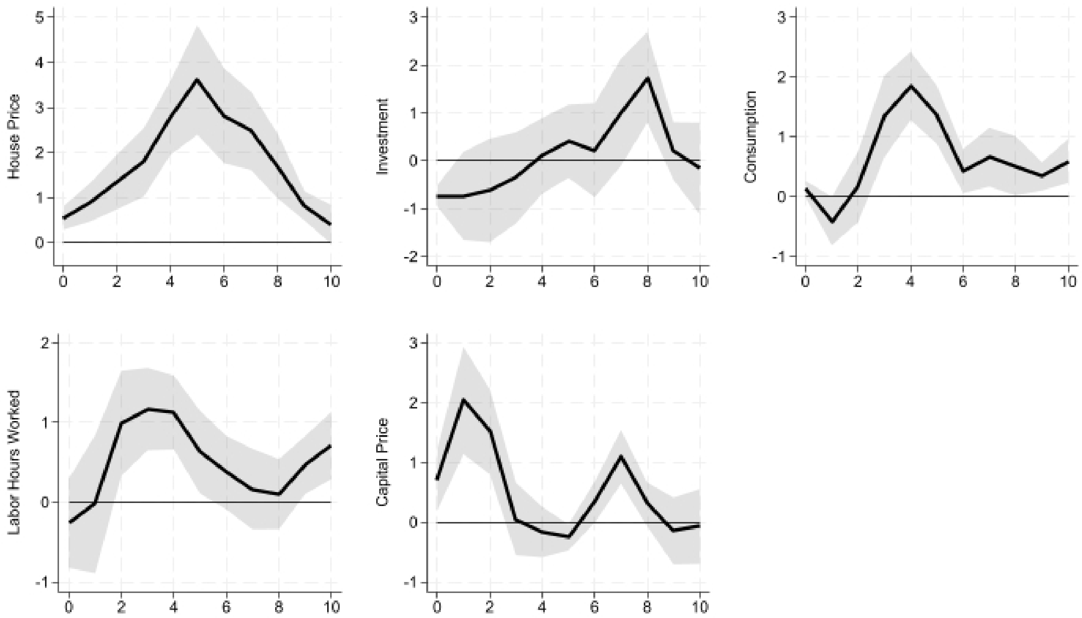
$$\Delta log(Y_{t+h}) = \alpha_h + \beta_h \Delta log(B_t) + \Psi_h(L)\Delta log(X_t) + \epsilon_{t+h} \tag{2.7}$$

$$\Delta log(B_t) = \beta_0 + \gamma AW_{t-1} + \Gamma_h(L)\Delta log(X_t) + \epsilon_t \tag{2.8}$$

In this specification, our coefficient of interest (β_h) gives us the impact of exogenous variation in credit at time t rather than $t-3$. Up to four lags of credit are included as control variables in both first and second-stage regression.

In Figure 2.4, results demonstrate that the house price, consumption, labor hours worked, and capital price are robust to a misspecification concern. In particular, we do not observe any deterioration in house price response, it is positive and significant for each period. While the labor hours worked and the capital price have faster response times, we observe the lag in consumption response, compared to our base results. On the other hand, investment is not robust to this change in the

Figure 2.4 Impulse Responses to Credit Shock - Alternative Specification



Note: The grey shaded areas represent the 90 percent confidence bands. All variables are in the form of log differences. The Y-axis indicates the percentage deviations and the X-axis indicates the quarters.

specification. Beyond the above discussion that our exogenous variation in commercial credit may not capture the variation in investment credits, in the shorter-term relation with the credit and the investment we do not observe a significant effect excluding the eighth period.

3. MODEL

Following Liu, Wang, and Zha (2013), I construct a general equilibrium model augmented with a credit supply shock. There are two types of agents-a representative household and a representative entrepreneur. The economy consists of two types of commodities: goods and real estate. There is a fixed amount of real estate and it is traded between the household and the entrepreneur. The household supplies labor. Production requires labor, real estate, and capital. The household issues a loanable fund to the entrepreneur. The entrepreneur also finances her investment by borrowing from the household. The entrepreneur's borrowing is constrained by the collateral assets, combining real estate and capital stocks, furthermore, in the spirit of Justiniano, Primiceri, and Tambalotti (2019), I also allow her to finance it through an exogenous credit shock.

3.1 *The Household*

The representative household maximizes the following lifetime utility function

$$E\sum_{t=0}^{\infty}\beta_h^t\{log(C_{h,t}-\gamma_h C_{h,t-1})+\phi_t log(H_{h,t})-\psi_t N_{h,t}\} \tag{3.1}$$

where E is a mathematical expectation operator, $\beta_h \in (0,1)$ is a subjective discount factor, C_h is consumption, H_h denotes real estate holdings, N_h denotes labor hours, and γ_h measures the degree of habit persistence. The terms ϕ_t and ψ_t represent the housing demand shock and the labor disutility shock, respectively, and they follow the stationary processes

$$ln\phi_t = (1-\rho_\phi)ln\bar{\phi}+\rho_\phi ln\phi_{t-1}+\epsilon_{\phi,t} \tag{3.2}$$

$$(3.3) \qquad ln\psi_t = (1-\rho_\psi)ln\bar{\psi} + \rho_\psi ln\psi_{t-1} + \epsilon_{\psi,t}$$

where $\bar{\phi}$ and $\bar{\psi}$ are steady-state values of these shocks, $\rho_\phi, \rho_\psi \in (-1,1)$ measure the persistence, $\epsilon_{\phi,t}$ and $\epsilon_{\psi,t}$ are i.i.d. standard normal processes. $\bar{\psi}$ is also the parameter that allows me to calibrate the steady-state value of labor hours. The budget constraint for the household is as follows

$$(3.4) \qquad C_{h,t} + q_{H,t}(H_{h,t} - H_{h,t-1}) + \frac{S_t}{R_t} = w_t N_{h,t} + \tau_t S_{t-1}$$

where $q_{H,t}$ is the price of real estate, R_t is the gross real loan rate, w_t is the real wage, S_t is the loanable bond in period t that pay offs one unit of consumption good in period $t+1$. This budget constraint includes transitory credit supply shocks (τ_t) differently from the Liu, Wang, and Zha (2013). A positive credit supply shock gives an incentive to save and lend more by increasing the amount received on the bond in the next period. Hence, this shock implies that relaxing lending conditions negatively affect the interest rate and increases real estate prices consequently, in line with the observable facts of credit supply shock effects on the economy (Justiniano, Primiceri, and Tambalotti (2019)). It follows the stationary process

$$(3.5) \qquad ln\tau_t = \rho_\tau ln\tau_{t-1} + \epsilon_{\tau,t}$$

where $\rho_\tau \in (-1,1)$ measures the persistence, $\epsilon_{\tau,t}$ is an i.i.d. standard normal process. The household chooses $C_{h,t}$, $H_{h,t}$, $N_{h,t}$, and S_t to maximize 3.1 subject to 3.2-3.5.

3.2 *The Entrepreneur*

The representative entrepreneur maximizes the following lifetime utility function, containing only the consumption good $C_{e,t}$ with the habit persistence parameter γ_e.

$$(3.6) \qquad E\sum_{t=o}^{\infty} \beta_e^t \{log(C_{e,t} - \gamma_e C_{e,t-1})\}$$

where $\beta_e \in (0,1)$ is a subjective discount factor. The entrepreneur's production function is as

$$(3.7) \qquad Y_t = z_t [H_{e,t}^{\upsilon} K_t^{1-\upsilon}]^{\alpha} N_{e,t}^{1-\alpha}$$

where Y_t is the output, $H_{e,t}$ is the entrepreneur's real estate holdings, K_t is the total capital stock, and $N_{e,t}$ is the labor hours. The parameters υ and α denote the output elasticity of these production factors. The total factor productivity, z_t, follows the transitory shock process

$$lnz_t = \rho_z lnz_{t-1} + \epsilon_{z,t} \tag{3.8}$$

where $\rho_{z,t}$ is the persistence parameter. Capital accumulates by following the accumulation equation

$$K_t = (1-\delta_k)K_{t-1} + [1 + \frac{\Omega}{2}(\frac{I_t}{I_{t-1}} - 1)^2]I_t \tag{3.9}$$

where I_t is investment, δ_k is the depreciation rate, and $\Omega > 0$ is the adjustment cost parameter. The budget constraint for entrepreneurs is as follows

$$C_{e,t} + q_{H,t}(H_{e,t} - H_{e,t-1}) + B_{t-1} = z_t[H_{e,t}^{\upsilon} K_t^{1-\upsilon}]^{\alpha} N_{e,t}^{1-\alpha} - \frac{I_t}{\chi_t} - w_t N_{e,t} + \frac{B_t}{R_t} \tag{3.10}$$

where B_t is the amount of debt and χ_t is the investment-specific technology shock that follows the stochastic process

$$ln\chi_t = \rho_\chi ln\chi_{t-1} + \epsilon_{\chi,t} \tag{3.11}$$

The borrowing constraint in this model is a reinterpreted version of Kiyotaki and Moore (1997). Entrepreneur can borrow up to a fraction of their real estate and capital assets. A representative household discounts futures more than the entrepreneur ($\beta_h > \beta_e$) satisfying the borrowing constraint binds around the steady state equilibrium. So, the constraint is as follows

$$B_t = \theta_t(q_{H,t+1}H_{e,t} + q_{k,t+1}K_t) \tag{3.12}$$

where $q_{k,t+1}$ is the price of capital, and θ_t is the loan-to-value ratio, also named the "collateral shock", viewed as a macro-prudential policy tool. The collateral shock follows the stochastic process

$$ln\theta_t = (1-\rho_\theta)ln\bar{\theta} + \rho_\theta ln\theta_{t-1} + \epsilon_{\theta,t} \tag{3.13}$$

where $\bar{\theta}$ is the steady-state value of the collateral shock, $\rho_\theta \in (0,1)$ is the persistence parameter, and $\epsilon_{\theta,t}$ is an i.i.d. standard normal process. The entrepreneur chooses $C_{e,t}, N_{e,t}, I_t, K_t$, and B_t to maximize 3.6 subject to 3.7-3.13.

3.3 Market Clearing Conditions and Equilibrium

The market clearing conditions are as follows: The goods market, $Y_t = C_t + \frac{I_t}{\chi_t}$ where $C_t = C_{h,t} + C_{e,t}$; the labor market, $N_{e,t} = N_{h,t} \equiv N_t$; the real estate market, $H_{e,t} + H_{h,t} = \bar{H}$ where $\bar{H}$ is an arbitrary value that represents the total real estate; and the bond market, $S_t = B_t$. The competitive equilibrium is an allocation $\{C_{h,t}, C_{e,t}, I_t, N_{h,t}, N_{e,t}, H_{h,t}, H_{e,t}, S_t, B_t, K_t, Y_t\}_{t=0}^{\infty}$, together with the sequence of prices $\{w_t, q_{H,t}, q_{k,t}, R_t\}_{t=0}^{\infty}$ such that satisfying the allocations solve the optimization problems for the household and the entrepreneur, and all markets clear.

4. ESTIMATION AND CALIBRATION

While some model parameters are calibrated through the data and the model, some of them are borrowed from the literature. The sample covers the period 2010Q1-2023Q4 in Turkey for calibration and estimation. The discount factor of household is set to $\beta_h = 0.988$, implying the steady-state value of the real interest rate is 4.6% which is calculated by subtracting expected U.S. GDP deflator inflation from the nominal interest rate series (U.S. safe rate plus EMBIG-Turkey) as in Neumeyer and Perri (2005). The entrepreneur's discount factor equals 0.92 to ensure that the borrowing constraint binds around the steady state as in the literature. The capital share is set to 0.3 which is borrowed from the literature. At the steady state, the model equates the steady-state value of the investment-to-capital ratio (I/K) to the capital's depreciation rate (δ_k). After obtaining the capital series from the perpetual inventory method by using the machinery equipment investment data, the investment-to-capital ratio implies that $\delta_k = 0.035$. The average fraction of discretionary time spent working $(\bar{N})$ is 0.165, from the data.

Model calibration needs to have steady-state values of the ratios of nominal real estate value to the nominal GDP of the household and the entrepreneur. Therefore, we need data on the real estate holdings of agents. Since Turkey does not have total real estate stock data, I construct it through the perpetual inventory method using the following equation

$$H_t = (1 - \delta_{H,t})H_{t-1} + \Delta_{H,t} \tag{4.1}$$

where H_t is the total real estate at time t, $\delta_{H,t}$ is the depreciation rate of real estate at time t, and $\Delta_{H,t}$ is the investment for real estate at time t. The depreciation rate of the real estate is $\delta_H = 0.035$, which comes from the amortization rate of real estate. The investment for the real estate series is obtained from the TURKSTAT which gives it at the breakdown of the investment series in the GDP.

After obtaining the total real estate, we need to determine the real estate holding shares of agents. For this purpose, I use the Building Permits Statistics from TURKSTAT, as a proxy for the ratio of real estate holdings of the entrepreneur and household, where we observe the quantity of residential and non-residential building permits. I multiply the share of residential building permits by the total real estate for each month to obtain the household's real estate holding. Then subtract it from the total real estate to obtain the entrepreneur's. I obtain their nominal values by multiplying them with the house price index. The household and the entrepreneur's holdings of nominal real estate value to nominal GDP ratios are 2.27 and 0.69, respectively.

The remaining parameters; persistence and standard deviation parameters of shocks, the adjustment cost parameter of investment (Ω), and the habit persistence parameters of the household (γ_h) and the entrepreneur (γ_e) are estimated by the Bayesian estimation technique. The adjustment cost parameter of investment (Ω) and the habit persistence parameters of the household (γ_h) and the entrepreneur (γ_e), cannot calibrated from the data, therefore, we estimate them. To estimate the parameters, we need the observable variables that are the same as the empirical part of the analysis: real house price index, real capital price, real per capita consumption, real per capita investment, real per capita commercial credit, and hours worked index. We fit these observable variables to the model after they are seasonally adjusted and HP-filtered for the period 2010Q1-2023Q4.

The parameters' priors and posteriors are summarized with their 90% intervals in Table 4.1. According to this table, the entrepreneur's estimated habit persistence is much larger than the household's. The estimated adjustment cost parameter is 1.40, relatively smaller than the literature in line with Liu, Wang, and Zha (2013). The labor supply shock is highly persistent ($\rho_\psi = 0.90$) and has a large standard deviation ($\sigma_\psi = 0.17$). The credit supply shock (ρ_τ and σ_τ) is more persistent and volatile than the collateral shock (ρ_θ and σ_θ). The possible explanation for this observation is that the credit supply shock is directly related to the smooth persistent credit series, while the collateral shock is also affected by the asset movements affecting the LTV ratio's movements. The housing demand shock is less persistent than the literature, which the recent excessive movements in house prices may explain.

Table 4.1 Prior and Posterior Distributions

		Prior				Posterior		
Parameter	Distribution	a	b	Low	High	Mode	Low	High
γ_h	Beta(a, b)	3.0000	12.0000	0.0256	0.7761	0.0349	0.0088	0.0838
γ_e	Beta(a, b)	3.0000	12.0000	0.0256	0.7761	0.1495	0.0321	0.3291
Ω	Gamma(a, b)	1.0000	0.5000	0.102	5.994	1.4021	1.0281	2.5840
ρ_z	Beta(a, b)	1.0000	2.0000	0.0256	0.7761	0.9400	0.6651	0.9861
ρ_ϕ	Beta(a, b)	1.0000	2.0000	0.0256	0.7761	0.8794	0.7590	0.9304
ρ_θ	Beta(a, b)	1.0000	2.0000	0.0256	0.7761	0.4780	0.4561	0.7227
ρ_ψ	Beta(a, b)	1.0000	2.0000	0.0256	0.7761	0.9054	0.8390	0.9887
ρ_τ	Beta(a, b)	1.0000	2.0000	0.0256	0.7761	0.8093	0.8550	0.9895
ρ_χ	Beta(a, b)	1.0000	2.0000	0.0256	0.7761	0.9920	0.6629	0.9396
σ_z	Inv-Gam(a, b)	0.3261	1.45e-04	0.0001	2.0000	0.0186	0.0153	0.0214
σ_ϕ	Inv-Gam(a, b)	0.3261	1.45e-04	0.0001	2.0000	0.0138	0.0078	0.0282
σ_θ	Inv-Gam(a, b)	0.3261	1.45e-04	0.0001	2.0000	0.0138	0.0123	0.0175
σ_ψ	Inv-Gam(a, b)	0.3261	1.45e-04	0.0001	2.0000	0.1703	0.1472	0.2032
σ_τ	Inv-Gam(a, b)	0.3261	1.45e-04	0.0001	2.0000	0.0386	0.0326	0.0609
σ_χ	Inv-Gam(a, b)	0.3261	1.45e-04	0.0001	2.0000	0.0248	0.0168	0.0456

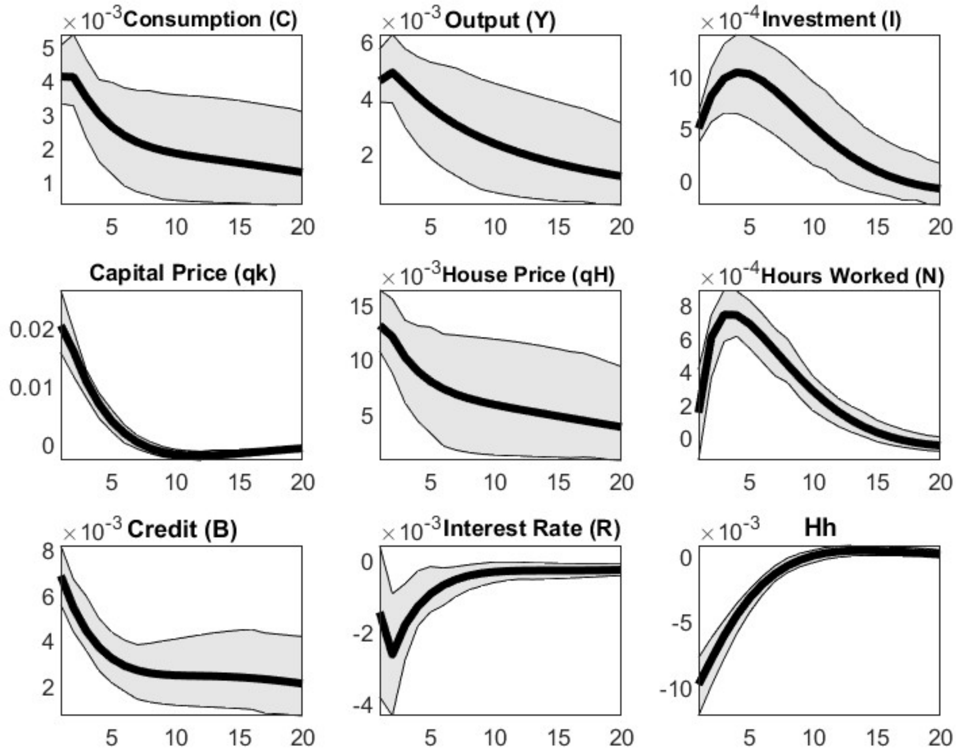
Note: "Low" and "High" denote the bounds of the 90% probability interval for the prior and the posterior distribution.

5. RESULTS

In this section, I discuss the quantitative implications of the model through the shocks' propagation mechanism and the variance decomposition analysis. Firstly, I discuss the impulse responses of the shocks, specifically focusing on the empirical evidence and quantitative outcome of the macroeconomic aggregates' impulse response to the credit supply shock. The main shocks (TFP, credit supply, LTV, and housing demand) are discussed in this section, and the impulse responses to investment-specific technology shock and labor disutility shock are in the appendix. Then, I quantify the relative importance of shocks by documenting variance decomposition results. Finally, I compare the moments of the model with the data.

Figure 5.1 shows the impulse response of the macroeconomic aggregates to a 1% shock to TFP. In line with the literature, this shock increases output, labor hours, consumption, and investment as expected. The increase in the investment drives the capital price up. Since the TFP shock positively affects the entrepreneurs' productivity, they demand real estate, a production factor. They buy real estate from households, which leads to a decline in household's real estate holdings (H_h) and drives up real estate prices. The amount of credit increases but the decline in the interest rate shows that loan supply increases more than loan demand, resulting in an increase in credit together with a decrease in the interest rate.

Figure 5.1 Impulse Responses to 1% Shock to TFP

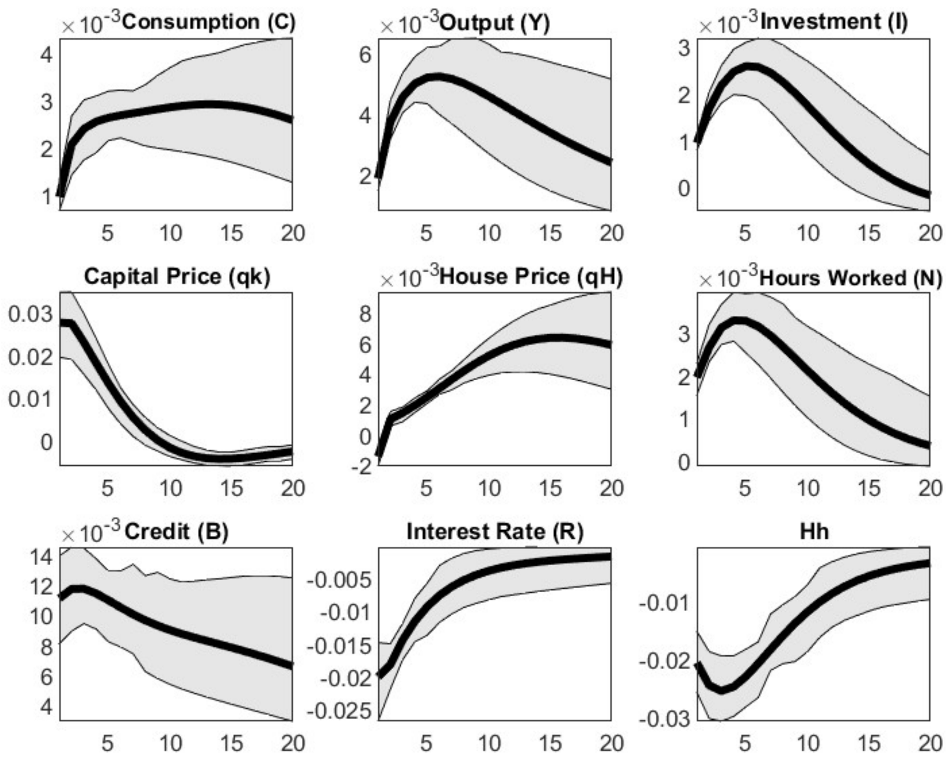


Note: The grey shaded areas represent the 90 percent confidence bands. All variables are logged, seasonally adjusted, and HP-filtered with smoothing parameter 1600. The Y-axis indicates the percentage deviations from the steady state and the X-axis indicates the quarters.

Figure 5.2 demonstrates the impulse responses to a 1% shock to credit supply, our main interest. The credit supply shock means that the household saves more and extends more loanable funds. One of the most important outcomes of the model is that as the amount of loanable funds increases the interest rate decreases, meaning the amplification in credit amount comes from the supply side, in line with the stylized fact of the credit supply shock. Entrepreneurs' access to credit leads them to produce more, increasing the requirement for production factors. Hence, labor hours, investment, and real estate holdings increase. This also puts upward pressure on asset prices, q_H and q_k. The entrepreneur's demand for real estate leads households to sell theirs. Higher production leads to an increase in consumption as well.

The increase observed in consumption is in line with our empirical result, however, our empirical results indicate a delayed response in investment and labor hours worked, whereas these variables increase in the initial period in the model. The other similarity of the model with the empirical analysis is the quicker return of capital price to a steady state than the investment. The first-period outcome of the real estate response contradicts our empirical analysis where the real estate price elevates.

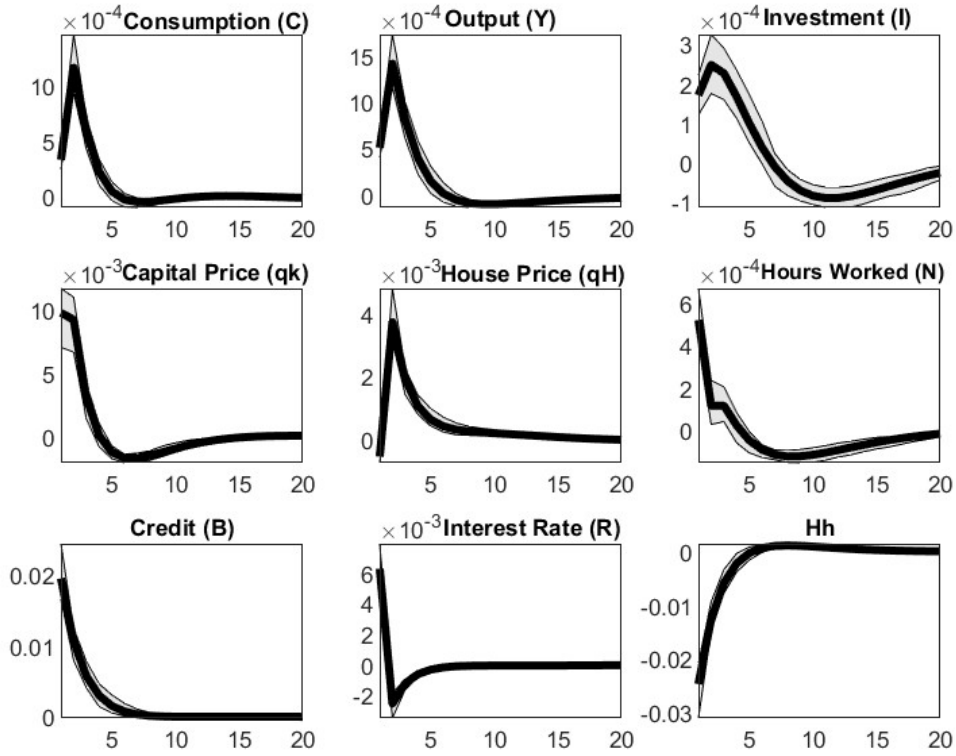
Figure 5.2 Impulse Responses to 1% Shock to Credit Supply



Note: The grey shaded areas represent the 90 percent confidence bands. All variables are logged, seasonally adjusted, and HP-filtered with smoothing parameter 1600. The Y-axis indicates the percentage deviations from the steady state and the X-axis indicates the quarters.

Figure 5.3 demonstrates the impulse responses to a 1% shock to LTV. An increase in the borrowing capacity heightens the output, consumption, and investment. An increase in credit leads to an entrepreneur producing more that increases real estate and capital demand, as in the credit supply shock. The households sell their real estate, and the entrepreneur demands more, amplifying the prices. The other observation is that the responses to LTV shock demonstrate sharper and temporal movements, compared to credit supply shock. Simultaneous increases in the amount of loanable funds and the interest rate support the aforementioned claim that LTV associates with the demand side of credit, in line with the Justiniano, Primiceri, and Tambalotti (2019) who asserts that the relaxing collateral constraint becomes meaningful after convincing the saver to extend the credit. Therefore, the saver demands more return for credit in the short term. Since the increase in loanable bonds after the credit supply shock and LTV shock points out a different sign for the interest rate response, our model may capture the disentangling process of credit to the supply and the demand.

Figure 5.3 Impulse Responses to 1% Shock to LTV



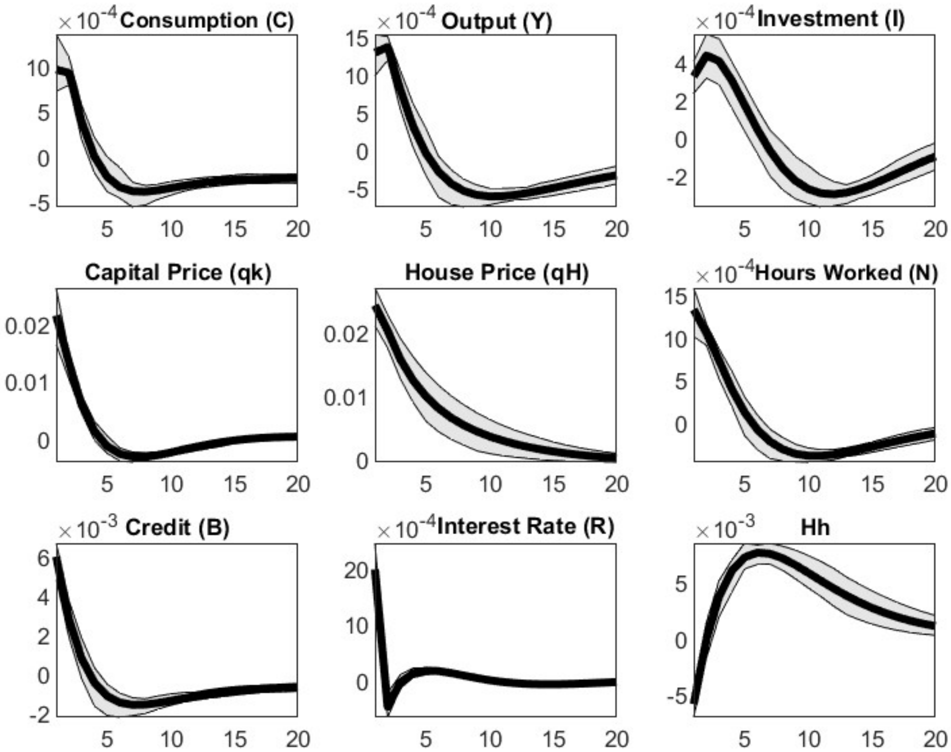
Note: The grey shaded areas represent the 90 percent confidence bands. All variables are logged, seasonally adjusted, and HP-filtered with smoothing parameter 1600. The Y-axis indicates the percentage deviations from the steady state and the X-axis indicates the quarters.

Figure 5.4 demonstrates the impulse responses to a 1% shock to housing demand. As expected, the house price demonstrates a sudden increase. It amplifies the amount of credit through the collateral channel which leads to an increase in consumption and investment, as well as output. Observe that the interest rate increases, meaning that the amplification in credit arises from the demand side[1]. An upward pressure on production creates a demand for real estate from entrepreneurs. This demand dominates the households' demand for the short term where the households sell their real estate. This unexpected result may imply that there is a deficiency in the model. Having a higher adjustment cost parameter provides a slower capital accumulation that implies a higher demand for real estate to produce. Therefore, the entrepreneurs

[1] Since the model separates the supply and demand side of credit, we can assume that the model captures the following stylized fact: An increase in credit supply means a decrease in the interest rate, and vice versa.

may demand more after the shock. Since we also estimate the adjustment cost parameter through the investment data of a small open economy, Turkey, we have to have a higher adjustment cost parameter. Therefore, this deficiency would be mitigated if we estimate the parameter in the closed economy.

Figure 5.4 Impulse Responses to 1% Shock to Housing Demand



Note: The grey shaded areas represent the 90 percent confidence bands. All variables are logged, seasonally adjusted, and HP-filtered with smoothing parameter 1600. The Y-axis indicates the percentage deviations from the steady state and the X-axis indicates the quarters.

In Table 5.1, the relative importance of shocks for the fluctuations in macroeconomic aggregates is reported through the variance decomposition. Our forecasting horizon is 20 quarters. The credit supply shock provides a significant contribution to almost all variables. It explains most of the fluctuations in the interest rate while the LTV shock contributes much less. The credit supply shock is also the most important shock for the investment, the real estate holding of the household, and the loanable bond. As expected, labor disutility shock explains a sizeable fraction of fluctuations in labor hours worked. The credit supply shock also contributes to this by affecting the investment decision of the entrepreneur. Since the labor disutility shock affects the expected income of the household, it also affects consumption significantly. In Liu, Wang, and Zha (2013), the housing demand shock drives most (%90) of the fluctuations in house prices, however, in our setting, labor disutility, productivity, and credit supply shock also contribute to the prices; %35, %16, and %10, respectively. The collateral shock does not much explain the aggregates, except for the contributions to real estate holding and loanable bonds; %12 and %15, respectively. In contrast to Justiniano, Primiceri, and Tambalotti (2010), who asserts that if the relative price of investment (q_k) is one of the observable then an investment-specific-technology (investment) shock would not be much more important, in our model, the investment shock explains a sizeable fraction of the relative price of investment even if it is our observable.

Table 5.1 Variance Decomposition

	Productivity	Housing	LTV	Labor	Investment	Credit Supply
C	20.18	0.63	0.33	40.14	8.93	29.79
Y	19.46	0.94	0.39	37.60	5.12	36.48
I	8.13	1.51	0.33	13.28	26.24	50.50
Q_k	4.94	3.14	1.26	5.21	69.85	15.61
Q_H	16.57	28.41	0.31	35.07	8.95	10.70
N	1.01	2.99	0.16	67.43	2.82	27.10
B	7.78	1.02	15.84	13.75	10.58	50.33
R	1.59	0.50	3.27	0.94	0.69	93.29
H_h	3.16	8.26	12.62	3.21	7.71	65.04

Note: The first column indicates our macroeconomic variables. Other columns report contributions of productivity shock, housing demand shock, collateral shock, labor disutility shock, investment-specific technology shock, and credit supply shock, respectively. While quantifying the variance decomposition, the pandemic period (2020Q2) is excluded from the analysis.

6. CONCLUSION

In this paper, I analyze the macroeconomic impacts of fluctuations in the credit supply, both empirically and theoretically. In the empirical analysis, I derive a credit supply shock from the matched bank-firm micro-data by employing the AW methodology, and then aggregate it into the macro level. I assign this as an exogenous variation for credit growth. The relevance of this instrument is evaluated through the first-stage regression that implies it is relevant. The validity of the exogeneity of this instrument comes from the nature of AW methodology. This method disentangles the structural and supply shocks and proves those are orthogonal. The LP-IV results reveal the macroeconomic importance of credit supply shock. We observe the upward shifts in housing prices and consumption while this shift lagged in investment, capital price, and labor hours worked. The OLS results of local projection also support that our instrument captures the exogenous variation in credit. As a robustness check, instrumenting the credit at the current period rather than lag shows that the investment may not be robust. We interpret this result as the exogenous variation in commercial credit may not arise in the investment-related credit. On the other hand, the need to drop firms with single-bank relations is argued as a drawback of AW methodology. The method in Degryse et al. (2019) can also be employed as an extraction process of the credit supply shock to mitigate this concern as further analysis.

Our theoretical framework is fitted to the same macroeconomic variables in the empirical analysis. This model combines the real estate and the capital for collateral constraint, as in Liu, Wang, and Zha (2013), therefore, it considers the joint dynamics of credit and housing. As an extension, I also assign a shock to a household's saving decision, which may be interpreted as a credit supply shock because of its behavior. After the credit supply shock, the interest rate decreases while the amount of credit amplifies, which is the stylized fact of the credit supply shock. Then, by borrowing, the entrepreneur produces more which puts upward pressure on the real estate holding of the entrepreneur, labor hours, and investment. Therefore, real estate and capital prices increase as well. Higher production leads to an increase in consumption as well. The longer-lasting increase in consumption and house prices is consistent with our empirical results. However, our empirical results indicate a delayed response in investment and labor hours worked, whereas these variables increase in the initial period in the model. This shock explains most of the fluctuations in the interest rate. The variance decomposition analysis points out the importance of credit supply shock. The positive credit supply shock also decreases the interest rate while the LTV shock increases it. This finding supports the argument that it associates with the demand side of credit as in Justiniano, Primiceri, and Tambalotti (2019). One concern arises because the credit supply shock and the LTV shock have to be fed by the same observable, the credit. Solving this technical problem may be challenging but it would improve the analysis. The other concern in this analysis is that the housing demand shock ends up with the household selling her real estate for the first period. Since we estimate the parameters through a small open economy, Turkey, we expect there would be some deficiencies in quantitative implications. This model also would be enriched by inserting a housing construction sector in further analysis, which is out of the scope of this paper.

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APPENDIX A

Data Description

All quarterly series between 2010Q1-2023Q4, excluding 2020Q2, are seasonally adjusted using the X-13ARIMA-SEATS Seasonally Adjustment Program.

Population: Annual population estimates are obtained from the World Bank-World Development Indicators database and linearly interpolated to derive quarterly estimates.

Output: Gross Domestic Product in 2009 prices divided by population from the TURKSTAT.

Consumption: Private final consumption expenditure in 2009 prices divided by population from the TURKSTAT.

Investment: Gross fixed capital formation in 2009 prices divided by population from the TURKSTAT.

Total hours: Weekly hours worked in manufacturing index. Since it began in 2014Q1, from that and onward, I used the TURKSTAT database. For previous periods, I used the FRED database's weekly hours index which ends in 2021Q1.

House Prices: Quality-adjusted house price index from the TURKSTAT.

Commercial Credit: Total credit minus total retail credit from the BRSA.

Amortization Rate of Real Estate: Amortization rates From Turkish Revenue Administration for 2022.

Investment for Real Estate: Gross fixed construction formation in 2009 prices from the TURKSTAT.

Building Permits Statistics: Residential and non-residential building permits area according to building license (square meter) from TURKSTAT.

Construction of Real Interest Rate

The real interest rate series is calculated following Neumeyer and Perri (2005). The U.S. safe rate is a quarterly average 3-month treasury bill rate. A country risk premium is the quarterly average J.P. Morgan Emerging Markets Bond Index Global Turkey. The nominal interest rate is obtained by adding the U.S. safe rate and EMBIG-Turkey. Then, real interest rate series are calculated by subtracting expected U.S. GDP deflator inflation from nominal interest rate series. Expected inflation in period t is defined as the average of quarterly inflation in period t and three preceding periods (Neumeyer and Perri (2005)). Then, I find that the steady-state value of the real interest rate is %4.6.

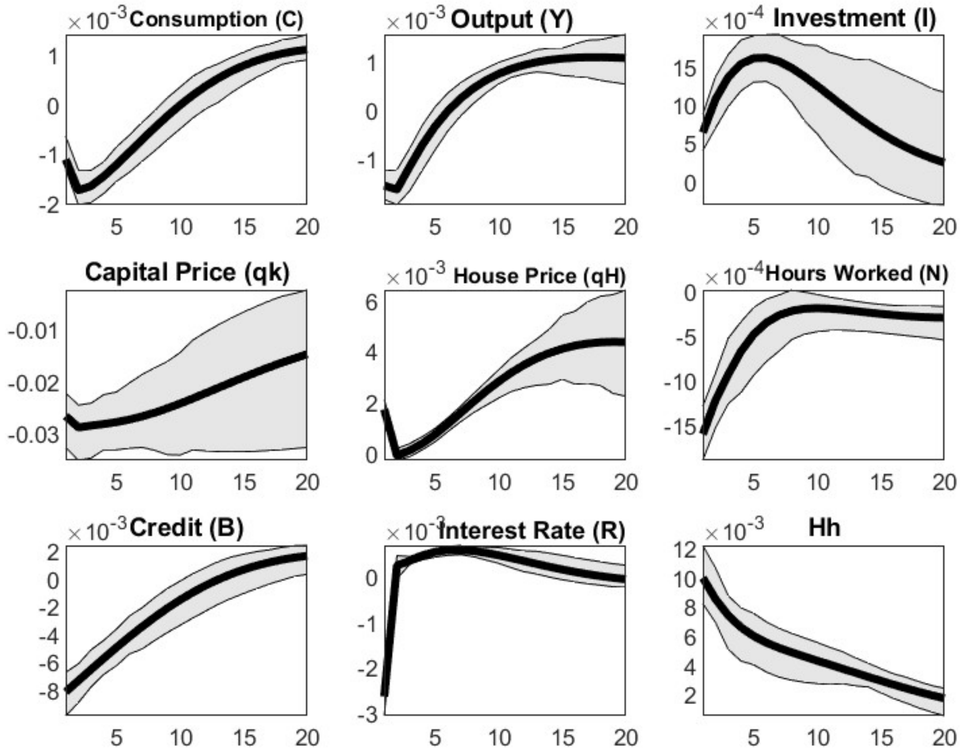
World interest rate: Quarterly average 3-month treasury bill yield from U.S. Department of the Treasury website.

U.S. inflation rate: Implicit price deflator of Gross Domestic Product of the U.S. from U.S. Bureau of Economic Analysis.

Country risk premium: J.P. Morgan Emerging Markets Bond Index Global-Turkey.

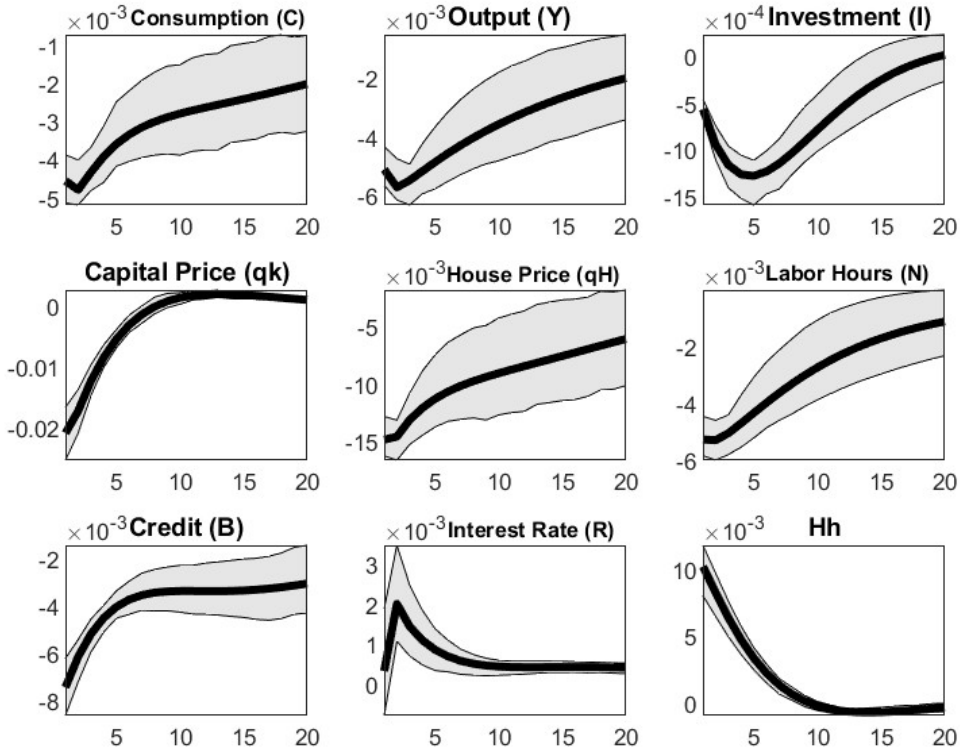
APPENDIX B

Figure B.1 Impulse Responses to 1% Shock to Investment Specific Technology



Note: The grey shaded areas represent the 90 percent confidence bands. All variables are logged, seasonally adjusted, and HP-filtered with smoothing parameter 1600. The Y-axis indicates the percentage deviations from the steady state and the X-axis indicates the quarters.

Figure B.2 Impulse Responses to 1% Shock to Labor Disutility



Note: The grey shaded areas represent the 90 percent confidence bands. All variables are logged, seasonally adjusted, and HP-filtered with smoothing parameter 1600. The Y-axis indicates the percentage deviations from the steady state and the X-axis indicates the quarters.

APPENDIX C

C.1 First Order Conditions

The Household

Denote by $\mu_{h,t}$ the Lagrangian multiplier for the flow of funds constraint, equation (3.4). Then the first-order conditions are as follows:

$$\mu_{h,t} = \frac{1}{C_{h,t} - C_{h,t-1}} - E_t \frac{\beta_h \gamma_h}{C_{h,t+1} - C_{h,t}} \tag{C.1}$$

$$w_t = \frac{\psi_t}{\mu_{h,t}} \tag{C.2}$$

$$q_{H,t} = \beta_h E_t \frac{\mu_{h,t+1}}{\mu_{h,t}} q_{H,t+1} + \frac{\phi_t}{\mu_{h,t} H_{h,t}} \tag{C.3}$$

$$\frac{1}{R_t} = \beta_h E_t \frac{\mu_{h,t+1}}{\mu_{h,t}} \tau_{t+1} \tag{C.4}$$

Equation (C.1) equates the marginal utility of income and consumption; equation (C.2) equates the real wage and the marginal rate of substitution (MRS) between leisure and income; equation (C.3) equates the relative price of the real estate to the real estate's discounted future resale value plus the MRS between housing and consumption; and equation (C.4) is the Euler equation for the loanable bond, augmented with the credit supply shock.

The Entrepreneur

Denote by $\mu_{k,t}$, $\mu_{e,t}$, and $\mu_{b,t}$ the Lagrangian multipliers for the capital accumulation, equation (3.9), the flow of funds constraint, equation (3.10), the borrowing constraint, equation (3.12), respectively. I also define the shadow price of capital in consumption units as $q_{k,t} = \frac{\mu_{k,t}}{\mu_{e,t}}$. Then, the first-order conditions are as follows:

(C.5)
$$\mu_{e,t} = \frac{1}{C_{e,t} - C_{e,t-1}} - E_t \frac{\beta_e \gamma_e}{C_{e,t+1} - C_{e,t}}$$

(C.6)
$$w_t = (1-\alpha) Y_t / N_{e,t}$$

(C.7)
$$\frac{1}{\chi_t} = q_{k,t}\Big(1 - \frac{3}{2}\Omega(\frac{I_t}{I_{t-1}})^2 + 2\Omega(\frac{I_t}{I_{t-1}})^2 - \frac{\Omega}{2}\Big) + \beta_e E_t q_{k,t+1}\Big(\Omega(\frac{I_t}{I_{t-1}})^3 - \Omega(\frac{I_t}{I_{t-1}})^2\Big)$$

(C.8)
$$q_{k,t} = \beta_e E_t \frac{\mu_{e,t+1}}{\mu_{e,t}}[\alpha(1-\upsilon)\frac{Y_{t+1}}{K_t} + (1-\delta_k) q_{k,t+1}] + \frac{\mu_{b,t}}{\mu_{e,t}}\theta_t E_t q_{k,t+1}$$

(C.9)
$$q_{H,t} = \beta_e E_t \frac{\mu_{e,t+1}}{\mu_{e,t}}[\alpha\upsilon\frac{Y_{t+1}}{H_t} + q_{H,t+1}] + \frac{\mu_{b,t}}{\mu_{e,t}}\theta_t E_t q_{H,t+1}$$

(C.10)
$$\frac{1}{R_t} = \beta_e E_t \frac{\mu_{e,t+1}}{e,t} + \frac{\mu_{b,t}}{\mu_{e,t}}$$

Equation (C.5) equates the marginal utility of income to the marginal utility of consumption; equation (C.6) is the labor demand equation which equates the real wage to the marginal product of labor; equation (C.7) is the investment Euler equation, which equates the cost of purchasing an additional unit of investment good and the benefit of having an extra unit of new capital; equation (C.8) is the capital Euler equation, which equates the shadow price of capital to the present value of future marginal product of capital and the resale value of the un-depreciated capital, plus the value of capital as a collateral asset for borrowing; equation (C.9) is the land Euler equation, which equates the price of the land to the present value of the future marginal product of land and the resale value, plus the value of land as a collateral asset for borrowing; equation (C.10) is the bond Euler equation for the entrepreneur.