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Credit decomposition and business cycles in emerging market economies☆

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ABSTRACT

This paper analyzes the differential effects of household and business credit dynamics on business cycles in emerging market economies. We first provide evidence that existing results relating credit expansions to economic expansions, real exchange rate appreciations and trade deficits hold more strongly for household credit than business credit. Then, using a two-sector real business cycle model of a small open economy, we study the model dynamics generated by shocks to household credit and business credit, the latter further divided into credit to tradable and nontradable sectors. The results show that the three types of credit shocks generate different dynamics in sectoral input and output levels as well as the real exchange rate. The model successfully generates the comovement between the cycle and different credit types, matching the strong positive correlation of household credit with output and real exchange rate, and the negative correlation with net exports. Our results underline the importance of distinguishing between household and business credit in studying credit dynamics.

1. Introduction

The literature on credit cycles, including Mendoza and Terrones (2008, 2012) and Tornell and Westermann (2002, 2003), has established that credit expansions in emerging market economies are associated with large macroeconomic expansions, widening current account deficits and real exchange rate appreciations. The standard measure of credit used in this literature is total private credit which includes all types of credit to the private sector without differentiating between lending to households and lending to firms. These two types of credit, however, may generate different business cycle patterns given that household credit expansions are likely to affect the economy through an increase in consumption and demand for goods and services whereas business credit has the potential to increase investment and labor demand. Furthermore, the allocation of business credit between tradable and nontradable sectors is another factor that may affect business cycle dynamics.

Recent developments in credit markets underline the importance of distinguishing between household and business credit in emerging markets. Fig. 1 shows the evolution of household and business credit-to-GDP ratios for eight emerging market economies and Table 1 shows the average values of these ratios for the sample period. The two types of credit exhibit different patterns: while lending to households has grown substantially over the period, the growth in business credit has been much slower in most cases. As a result, household credit has become an important component of overall private credit with potentially important consequences for business cycles. On average, household credit constitutes about 35% of total private credit in our sample. Despite the increased importance of household credit, existing models that study emerging market business cycles abstract from household credit dynamics.

In this paper, we distinguish between household and business credit, as well as the sectoral allocation of business credit, and analyze the dynamics generated by different types of credit over the

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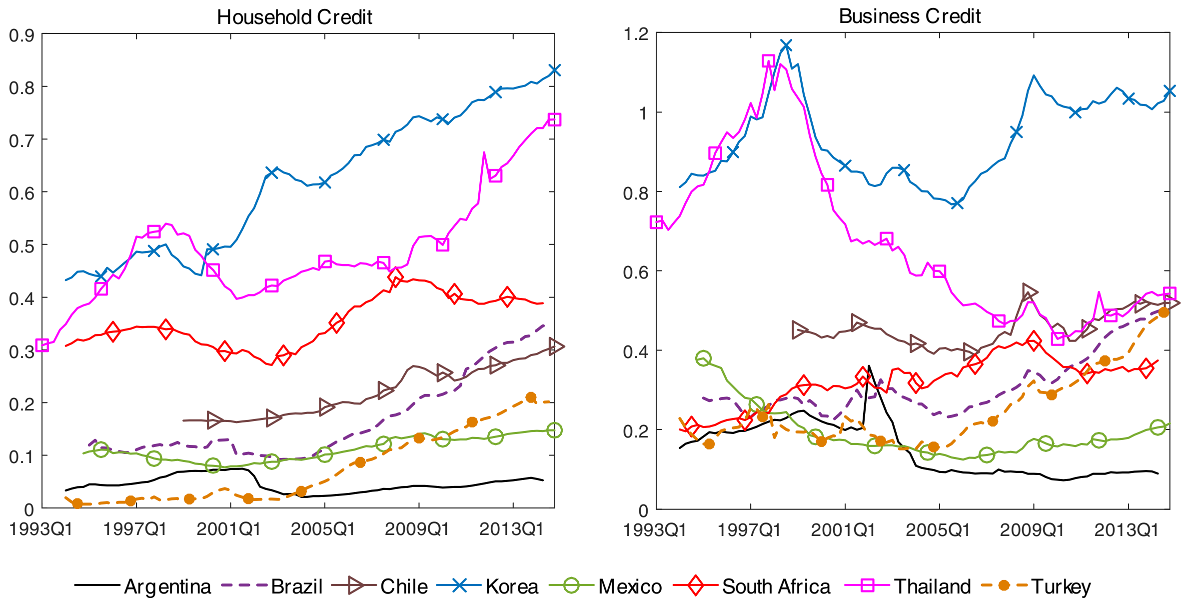

Fig. 1. Credit-to-GDP ratios in emerging market economies.

business cycle. To this end, first we re-examine the documented stylized facts regarding credit cycles differentiating between household and business credit. Using data from a group of emerging market economies, we show that the patterns documented in the literature with respect to credit and key macroeconomic variables are stronger for household credit: household credit exhibits a strong positive comovement with output, consumption and investment, showing a stronger comovement with the cycle in general; it has a strong correlation with real exchange rate appreciation, and on average a negative correlation with net exports. Business credit, on the other hand, has weaker correlations with all of these variables. These facts underline the importance of decomposing private sector credit into household and business credit in studying the credit dynamics.

We then construct a two-sector small open economy real business cycle model to understand the mechanisms that lead to the credit dynamics observed in the data. In the model, households and both the tradable and the nontradable sectors are credit constrained, and firms face a working capital requirement. Credit limits are modeled as time-varying fractions of labor income and capital stock for households and firms, respectively, and are subject to exogenous shocks. The credit shocks we use are similar to the financial sector shocks studied by Jermann and Quadrini (2012) who analyze the effects of these shocks in a closed economy setting. Modeling all sectors as credit constrained and using sectoral credit shocks allow us to study the model dynamics for each type of credit expansion separately. We calibrate our model to Turkey for the period 1999Q1–2011Q4 and solve the model using

Table 1
Household and business credit in emerging markets.

Countries	$\frac{HC}{GDP}$	$\frac{BC}{GDP}$	$\frac{HC}{TC}$
Argentina	4.52	14.95	23.23
Brazil	12.58	31.12	28.78
Chile	20.77	44.59	31.77
Korea	61.98	93.27	39.92
Mexico	11.09	19.15	36.68
South Africa	35.31	32.09	52.40
Thailand	49.04	67.32	42.14
Turkey	7.79	25.02	23.73
Average	25.39	40.94	34.83

Note: *HC*, *BC* and *TC* denote household, business and total credit, respectively. See the appendix for data sources.

productivity shocks in tradable and nontradable sectors, shocks to the interest rate and credit shocks.

The impulse response analysis shows that the three types of credit shocks generate different macroeconomic dynamics. The sectoral input and output levels and the real exchange rate respond differently depending on the credit shock, which shows that the allocation of credit is important in understanding how the economy moves with the credit cycle. In terms of moments, the model successfully generates the comovement between the key macroeconomic variables and different credit types observed in the data. Household credit exhibits a strong positive correlation with the real exchange rate, whereas for business credit the correlation is weaker. The strong correlation between household credit and real exchange rate is the result of increased demand for nontradable output following a household credit expansion. In the case of business credit, an increase in nontradable sector credit leads to a real depreciation whereas an increase in tradable sector credit leads to an appreciation. Therefore, the real exchange rate-business credit correlation depends on which sector receives more of the credit, which is consistent with the weaker correlations observed in the data for business credit.

With respect to credit–output correlations, household credit again has a stronger correlation compared to business credit. The strength of the comovement of output with different types of credit is determined by a two-way interaction: the credit-to-output channel and the output-to-credit channel. The credit-to-output channel captures the positive response of output to credit shocks, which partly explains the positive correlations between credit and output. The output-to-credit channel, on the other hand, captures the fluctuations in credit as a result of a change in output. This channel is stronger for household credit compared to business credit. Two factors generate the difference. First, the borrowing capacity of households is tied to their income, whereas the credit access of entrepreneurs is tied to the capital stock of the firm. Therefore, any factor that leads to an income expansion generates a rise in household credit, increasing the household credit–output correlation. Business credit to each sector, on the other hand, increases with higher investment in that sector, which is only affected by sector-specific shocks, reducing the correlation of business credit with the general cycle. The second factor that generates a stronger comovement between household credit and output is the relative importance of productivity shocks in determining access to credit for households. In the spirit of Neumeyer and Perri (2005), who model the interest rates as affected by productivity shocks, we tie the stochastic processes that determine credit access to productivity. The estimation of stochastic processes for credit limits reveals that the effect of productivity shocks is especially strong for the borrowing capacity of households. These two factors that determine the output-to-credit channel, as well as the positive response of output to household credit shocks, generate the strong correlation between household credit and output in the model.

The model generates a strong negative correlation between all types of credit and net exports, with household credit having a higher correlation. The extent to which net exports-to-GDP ratio responds to credit shocks depends on the share of each type of credit in the economy. When the credit limits are adjusted such that all agents on average borrow equal amounts, the negative correlation between household credit and net exports-to-GDP ratio gets stronger while the correlations of business credit get weaker.

In the absence of credit shocks, the model performs poorly in matching the business cycle patterns observed in the data. Credit shocks are important in matching the volatilities of consumption, net exports and credit. The correlations of different types of credit with other key macroeconomic variables also deteriorate considerably when credit shocks are excluded.

The role of credit shocks in macroeconomic fluctuations has been recently investigated mainly in closed economy models. This literature, including Christiano et al. (2010), Jermann and Quadrini (2012) and Khan and Thomas (2013), find that financial shocks are important for the dynamics of real and financial variables. One recent study by Perri and Quadrini (2014) studies the implications of credit shocks in a two-country model and focuses on international comovement in real and financial variables. The contribution of the current paper is to show that, for emerging markets, shocks to different types of credit are important for understanding business cycle phenomena, such as macroeconomics expansions, real exchange rate behavior, and net exports.

Our paper is further related to the empirical studies on the distinction between household and business credit. These papers underline the importance of differentiating between the types of borrowers for analyzing the effects of private sector credit on different macroeconomic variables. Büyükkarabacak and Krause (2009) show that household credit leads to a deterioration in the trade balance, whereas business credit has a small but positive effect. Büyükkarabacak and Valev (2010) find that household credit expansions have been a significant predictor of banking crises. Business credit expansions are also associated with banking crises but their effect is weaker. Beck et al. (2012) show that bank lending to firms is positively associated with growth, while the relationship between household credit and growth is insignificant. Another recent study by Mian et al. (2015) documents a strong and robust negative association between household debt and output growth over the medium-run whereas no such relationship exists between firm debt and output growth. The main conclusion of these papers is that the two types of credit serve different purposes and have distinct effects on the economy. Our paper complements these empirical studies by providing a general equilibrium model that helps understand the transmission mechanism through which each type of credit affects the business cycle properties in emerging market economies.

2. Credit and business cycles in emerging economies

2.1. Cross-sectional empirical regularities

This section documents business cycle regularities in relation to household and business credit for a sample of emerging market economies for which time series data of sufficient length are available. Due to the lack of credit data at the sectoral level for several countries in our sample, here we analyze total business credit rather than tradable and nontradable sector credit separately. In the next subsection, we present business cycle statistics related to tradable and nontradable sector credit for Turkey.

Table 2 shows the correlations between macroeconomic aggregates and the quarterly change in credit as a ratio of GDP for household and business credit. We report the statistics related to change in credit since this measure shows the cyclical pattern in credit more clearly. The relationship between fluctuations in economic activity and credit is better captured by a variable that measures newly created credit rather than the stock of credit. Since the level of outstanding credit is a stock variable, the new credit extended in a certain period is measured by the change in the credit balance.

The correlations in Table 2 overall show that a change in household credit is more strongly correlated with the business cycle compared to business credit. The correlation between change in household credit and output is 0.47 on average whereas for business credit this correlation is 0.27. In seven out of eight countries in our sample, household credit has a higher correlation with output compared to business credit. The average pattern holds for consumption and investment as well. With respect to the real exchange rate, household credit again has a stronger positive correlation than business credit. On average, the correlations are 0.34 for household credit and 0.10 for business credit. The business credit–real exchange rate correlation is close to zero in the majority of the countries and lower

Table 2
Business cycle statistics related to household and business credit.

	Correlations with household and business credit										Std. deviations	
	$\frac{\Delta HC}{GDP}$					$\frac{\Delta BC}{GDP}$					$\frac{\Delta HC}{GDP}$	$\frac{\Delta BC}{GDP}$
	GDP	*C*	*I*	*RER*	$\frac{NX}{GDP}$	*GDP*	*C*	*I*	*RER*	$\frac{NX}{GDP}$		
Argentina	0.73	0.60	0.80	0.26	−0.49	−0.14	−0.03	−0.21	−0.12	0.04	0.19	1.99
Brazil	0.14	0.07	0.08	0.22	0.02	0.28	0.16	0.27	0.08	−0.15	1.55	4.11
Chile	0.56	0.00	0.03	0.46	0.20	0.50	0.20	0.19	0.45	−0.07	0.76	3.94
Korea	0.58	0.67	0.44	0.36	−0.55	0.30	0.33	0.30	0.02	−0.29	4.10	7.03
Mexico	0.18	0.10	0.01	0.15	0.16	0.15	0.10	0.10	0.08	−0.11	1.83	5.00
S. Africa	0.35	−0.02	−0.20	0.19	−0.21	0.27	−0.04	0.04	0.01	−0.10	0.48	0.99
Thailand	0.50	0.60	0.58	0.47	−0.51	0.38	0.32	0.42	0.17	−0.29	2.29	7.77
Turkey	0.69	0.76	0.74	0.58	−0.79	0.45	0.36	0.43	0.13	−0.27	1.30	4.40
Mean	0.47	0.35	0.31	0.34	−0.27	0.27	0.18	0.19	0.10	−0.16	1.56	4.40
Median	0.53	0.35	0.26	0.31	−0.35	0.29	0.18	0.23	0.08	−0.13	1.43	4.26

Notes: Changes in household credit (*ΔHC*) and business credit (*ΔBC*) are $HC_t–HC_{t-1}$ and $BC_t–BC_{t-1}$. Net exports (*NX*) are exports minus imports. *GDP*, consumption (*C*), investment (*I*) and real exchange rate (*RER*) are in logs. All series have been seasonally adjusted and HP filtered. Standard deviations are reported as percentages. All statistics are based on quarterly data. See the appendix for data sources.

than the correlation with household credit in all of them except in Chile where the two correlations are very close. In the case of the net exports-to-GDP ratio, household credit has a stronger negative correlation than business credit on average. The last two columns of Table 2 show the volatilities of the change in credit-to-GDP ratios. In all countries, business credit is more volatile than household credit. Given that business credit mostly finances investment and household credit is used for consumption, the higher volatility of business credit is consistent with the higher volatility of investment compared to consumption. To summarize, the empirical regularities presented in Table 2 show that the stylized facts documented in the literature with respect to private credit are to a large extent driven by household credit rather than business credit in emerging markets.

It is possible that the relative strength of the comovement between output and the two types of credit depends on the timing of the correlations: while household credit has a strong contemporaneous correlation with output, business credit may have a strong correlation with lagged or future values of output. To explore this possibility, we show the cross-correlations of output with respect to business and household credit at different lags in Fig. 2 The figure shows that household credit mostly leads the cycle by one or two quarters. For business credit, the pattern is less clear but either the correlations are higher contemporaneously or business credit lags the cycle by one or two quarters. Finally, when the highest correlations of the two types of credit with output are compared, household credit has a higher correlation than business credit in each country. Therefore, we conclude that the stronger comovement of household credit and output holds independently of the timing of the correlations.

2.2. Credit and business cycles in Turkey

In this section, we provide a detailed presentation of credit dynamics in Turkey for the period 1999Q1–2011Q4. We analyze our model using data from the Turkish economy because of the availability of sectoral credit data at the quarterly frequency for a relatively long time period. In our analysis, we use data on business credit to the tradable and nontradable sectors, which are not available for most of the emerging market economies.

Table 3
Credit and business cycles in Turkey.

	Correlations			Std. deviations	
	$\frac{\Delta HC}{GDP}$	$\frac{\Delta BCN}{GDP}$	$\frac{\Delta BCT}{GDP}$		
GDP	0.69	0.38	0.46	*GDP*	3.99
C	0.76	0.30	0.35	$\frac{\Delta HC}{GDP}$	1.30
I	0.74	0.40	0.40	$\frac{\Delta BCN}{GDP}$	2.35
RER	0.58	0.14	0.11	$\frac{\Delta BCT}{GDP}$	2.38
$\frac{NX}{GDP}$	−0.79	−0.24	−0.26	$\frac{NX}{GDP}$	2.19

Notes: Changes in household credit (ΔHC), nontradable sector credit (ΔBCN) and tradable sector credit (ΔBCT) are $HC_t - HC_{t-1}$; $BCN_t - BCN_{t-1}$ and $BCT_t - BCT_{t-1}$, respectively. Net exports (*NX*) are exports minus imports. *GDP*, consumption (*C*), investment (*I*) and real exchange rate (*RER*) are in logs. All series have been seasonally adjusted and HP filtered. Standard deviations are reported as percentages. All statistics are based on quarterly data. See the appendix for data sources.

Turkey is a representative emerging market economy that features the standard business cycle properties observed in emerging economies documented by Aguiar and Gopinath (2007) and Neumeyer and Perri (2005): consumption is more volatile than output, net exports are countercyclical and business cycles are very volatile (see Table 5 for more details). Table 3 shows the moments related to different types of credit and key macroeconomic aggregates for Turkey. With respect to the correlations, Turkey displays the average pattern for emerging economies illustrated in Table 2 More specifically, the change in household credit is highly and positively correlated with output and real exchange rate, and negatively correlated with net exports. These correlations are weaker for both types of business credit. Similar differences are observed for consumption and investment as well, which shows that household credit is in general more correlated with the cycle than business credit.

These differences are also evident in Fig. 3 which plots the time series for GDP, real exchange rate, and the ratio of net exports to output, together with the change in credit-to-GDP ratios for the three types of credit. The first two rows show the close comovement of output and real exchange rate with the change in household credit, while the last row shows the strong negative relationship between net exports and household credit. For the nontradable and tradable sector credit, the comovement is weaker compared to household credit for all variables.

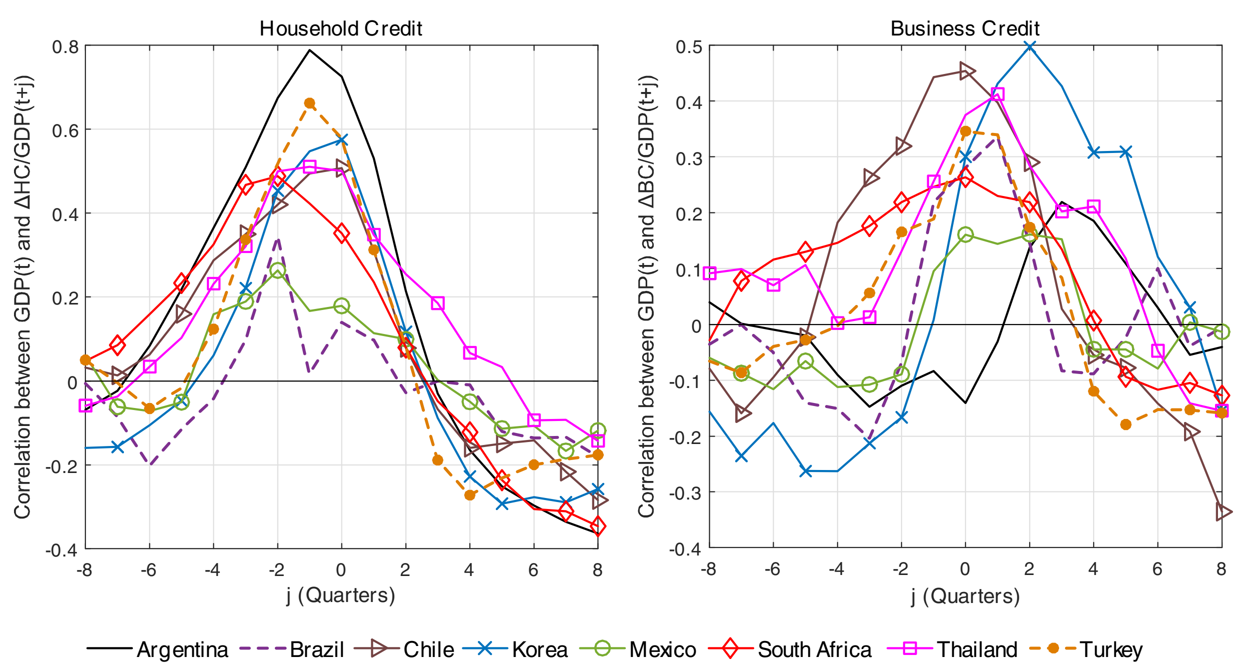

Fig. 2. Cross-correlations between GDP and change in credit-to-GDP ratios.

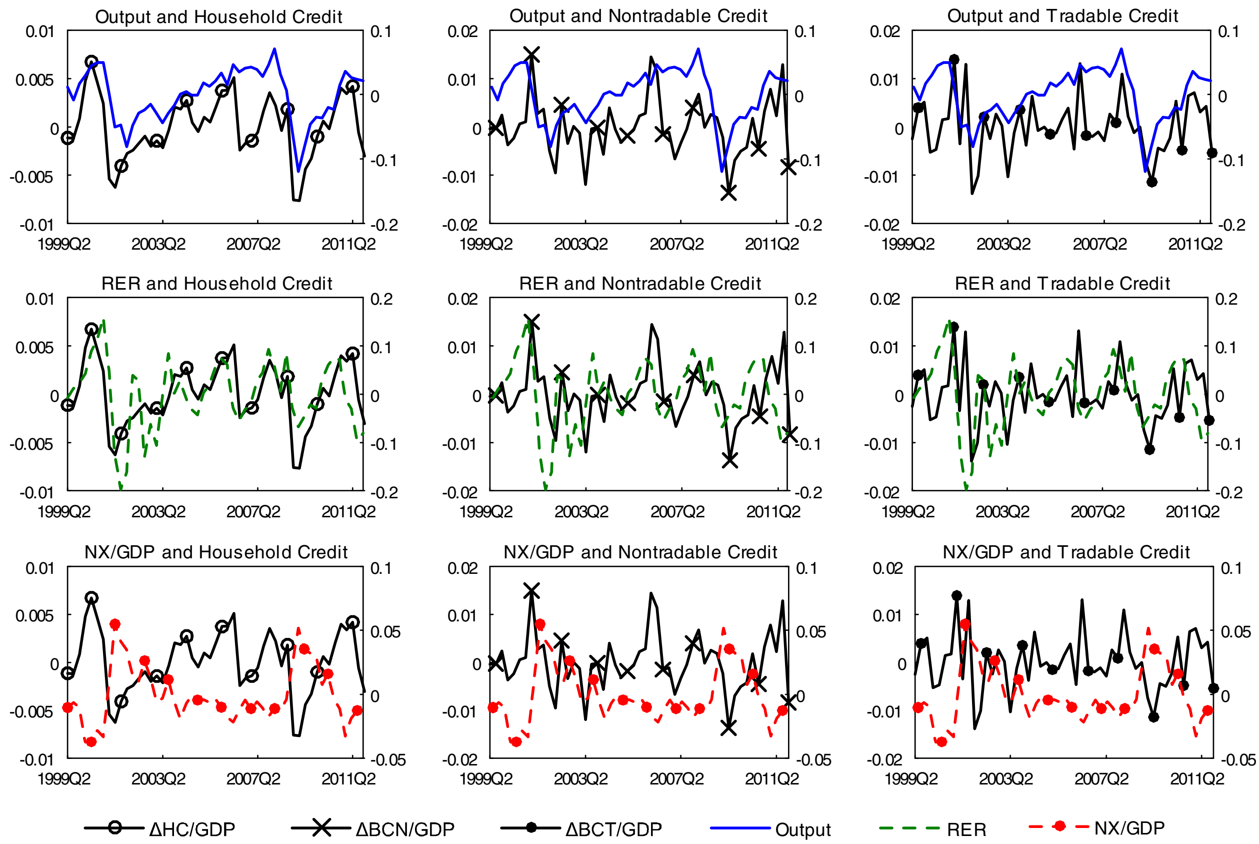

Fig. 3. Credit and business cycles in Turkey.

Table 3 also shows that the volatilities of the credit variables in Turkey are in line with the general pattern observed in other emerging economies. Both types of business credit have a higher volatility compared to household credit. Overall, the behavior of different types of private sector credit in Turkey is in line with the other emerging market economies in our sample.

3. The model

We use a two-sector small open economy model with tradable and nontradable goods. There are three types of agents in the model: households and entrepreneurs in the tradable and nontradable sectors. Entrepreneurs use capital and labor for production. Households provide labor services while capital is held by entrepreneurs. All agents have access to international financial markets, but face constraints on their borrowing. The only asset traded in international financial markets is a non-contingent real bond. For entrepreneurs there is also a working capital constraint that requires them to hold liquid assets in an amount proportional to the wage bill.

3.1. Households

Households choose consumption and labor to maximize their expected lifetime utility given by

$$E_0 \sum_{t=0}^{\infty} (\beta^h)^t \frac{\left(c_t^h(c_{t,N}^h, c_{t,T}^h) - \psi l_t^\eta\right)^{1-\sigma}}{1-\sigma}, \quad \eta > 1, \psi > 0, \tag{1}$$

where $\beta^h \in (0,1)$ is the discount factor, c_t^h is the consumption aggregator, l_t represents labor, σ is the risk aversion parameter, η is the parameter that governs the intertemporal elasticity of substitution in labor supply, and ψ is the measure of disutility from working. Consumption is an aggregate of the consumption of nontradable goods, $c_{t,N}^h$, and the consumption of tradable goods, $c_{t,T}^h$.

The budget constraint of households is given by

$$c_{t,T}^h + p_{t,N} c_{t,N}^h + R_{t-1} b_{t-1}^h = b_t^h + w_{t,T} l_{t,T} + p_{t,N} w_{t,N} l_{t,N}, \tag{2}$$

where b_t^h denotes the amount borrowed at time t and R_{t-1} is the gross interest rate on debt that matures at time t. The interest rate is exogenously determined by the stochastic processes for the world real interest rate and the country risk premium as specified in Section 4. The variables $l_{t,T}$ and $l_{t,N}$ denote labor supplied to tradable and nontradable sectors, respectively, $w_{t,T}$ and $w_{t,N}$ denote the wage rates in the two sectors and $p_{t,N}$ is the relative price of the nontradable good, where the price of the tradable good is normalized to one.

Households face a credit constraint in every period. The total value of their debt including both interest and principal cannot exceed a fraction of their expected income in the next period. As in Ludvigson (1999), we choose to tie borrowing to income because many banks require income statements before they provide funds to the borrowers since income is associated with the borrower's financial health. The credit constraint of households is of the form

$$R_t b_t^h \le m_t^h E_t \left(w_{t+1,T} l_{t+1,T} + p_{t+1,N} w_{t+1,N} l_{t+1,N}\right). \tag{3}$$

The loan-to-income (LTI) ratio, denoted by m_t^h, is modeled as a stochastic process. In the calibration of the model, β^h is chosen such that $\beta^h < 1/\bar{R}$, where $\bar{R}$ is the steady-state value of the real interest rate. This condition guarantees that the credit constraint is binding in and around the steady state.

3.2. Entrepreneurs

We present the entrepreneur's problem for both the tradable and the nontradable sectors in this section. In the rest of the section, we use j to specify the sectors, where $j=T$ denotes the tradable sector and $j=N$ denotes the nontradable sector.

Entrepreneurs combine the capital they own, $k_{t-1,j}$, with households' labor services and produce output with the following Cobb–Douglas technology:

$$y_{t,j} = e^{A_{t,j}} k_{t-1,j}^{\alpha_j} l_{t,j}^{1-\alpha_j}, \tag{4}$$

where $A_{t,j}$ is an exogenous stochastic productivity shock in sector j.

The capital accumulation decision is made by the entrepreneurs and the equation for capital accumulation is given by

$$i_{t,j} = k_{t,j} - (1-\delta)k_{t-1,j}, \tag{5}$$

where $i_{t,j}$ denotes investment in sector j. The investment good used in both sectors is assumed to be tradable and δ is the common depreciation rate.

Firms in both sectors have to pay a fraction θ of the wages before output becomes available and they need working capital loans from foreign lenders. Thus, tradable sector firms (nontradable sector firms) borrow $\theta w_{t,T} l_{t,T} (\theta p_{t,N} w_{t,N} l_{t,N})$ at the beginning of period t and repay $R_t \theta w_{t,T} l_{t,T} (R_t \theta p_{t,N} w_{t,N} l_{t,N})$ at the end of the period as in Neumeyer and Perri (2005). As households, entrepreneurs are also restricted in their borrowing due to enforceability problems. Following Mendoza (2010), we assume that the entrepreneur's total debt, which includes intertemporal debt, b_t^{ej}, and within-period working capital loans, cannot exceed a fraction of the collateral assets, which are capital holdings in our model. In the case of the tradable sector, the credit constraint takes the form

$$R_t b_t^{eT} + R_t \theta w_{t,T} l_{t,T} \le m_t^{eT} E_t \left(q_{t+1,T}^k k_{t,T} \right). \tag{6}$$

For the nontradable sector, the credit constraint takes the form

$$R_t b_t^{eN} + R_t \theta p_{t,N} w_{t,N} l_{t,N} \le m_t^{eN} E_t \left(q_{t+1,N}^k k_{t,N} \right). \tag{7}$$

The loan-to-capital (LTC) ratios, denoted by m_t^{ej}, are modeled as stochastic processes, and $q_{t+1,j}^k$ is the price of capital at time $t+1$. We use adjustment costs for capital accumulation to reduce the volatility of investment. Therefore, the price of capital in terms of tradable consumption differs from one and is given by

$$q_{t,j}^k = 1 + \frac{\partial \Phi(k_{t-1,j}, i_{t,j})}{\partial i_{t,j}}, \tag{8}$$

where $\Phi(k_{t-1,j}, i_{t,j})$ is the capital adjustment cost function.

The entrepreneur's problem is to maximize her expected utility

$$E_0 \sum_{t=0}^{\infty} (\beta^{ej})^t \frac{(c_t^{ej}(c_{t,N}^{ej}, c_{t,T}^{ej}))^{1-\sigma}}{1-\sigma} \tag{9}$$

subject to technology, borrowing and flow of funds constraints. The flow of funds constraint for the tradable sector is

$$c_{t,T}^{eT} + p_{t,N} c_{t,N}^{eT} + w_{t,T} l_{t,T} + i_{t,T} + \Phi(k_{t-1,T}, i_{t,T}) + R_{t-1} b_{t-1}^{eT} + (R_t - 1)\theta w_{t,T} l_{t,T} = y_{t,T} + b_t^{eT}, \tag{10}$$

and the flow of funds constraint for the nontradable sector is

$$c_{t,T}^{eN} + p_{t,N} c_{t,N}^{eN} + p_{t,N} w_{t,N} l_{t,N} + i_{t,N} + \Phi(k_{t-1,N}, i_{t,N}) + R_{t-1} b_{t-1}^{eN} + (R_t - 1)\theta p_{t,N} w_{t,N} l_{t,N} = p_{t,N} y_{t,N} + b_t^{eN}. \tag{11}$$

As in the case of households, consumption of the entrepreneurs, c_t^{ej}, is an aggregate of the consumption of nontradable and tradable goods, $c_{t,N}^{ej}$ and $c_{t,T}^{ej}$, respectively.

Similar to the household's discount factor, we assume that $\beta^{ej} < 1/\bar{R}$ so that the credit constraints are binding in and around the steady state.

3.3. Equilibrium

Given initial conditions b_0^h, $b_0^{eT}, b_0^{eN}, k_{0,T}, k_{0,N}$, the sequence of shocks to sectoral productivity levels, the world real interest rate, the country risk premium, the loan-to-income ratio of the household and the loan-to-capital ratios of the entrepreneurs, the competitive equilibrium is defined as a set of allocations and prices $\{y_{t,T}, y_{t,N}, l_{t,T}, l_{t,N}, k_{t,T}, k_{t,N}, i_{t,T}, i_{t,N}, c_t^h, c_{t,T}^h, c_{t,N}^h, c_t^{eT}, c_{t,T}^{eT}, c_{t,N}^{eT}, c_t^{eN}, c_{t,T}^{eN}, c_{t,N}^{eN}, b_t^h, b_t^{eT}, b_t^{eN}, p_{t,N}, w_{t,T}, w_{t,N}\}$ such that (i) the allocations solve the problems of the household and the entrepreneurs in the tradable and nontradable sectors at the equilibrium prices, (ii) factor markets clear, and (iii) the resource constraints for the tradable and nontradable sectors hold:

$$c_{t,T}^h + c_{t,T}^{eT} + c_{t,T}^{eN} + i_{t,T} + i_{t,N} + \Phi(k_{t-1,T}, i_{t,T}) + \Phi(k_{t-1,N}, i_{t,N}) + nx_t = y_{t,T} \tag{12}$$

$$c_{t,N}^h + c_{t,N}^{eT} + c_{t,N}^{eN} = y_{t,N} \tag{13}$$

where the net exports is defined as

$$nx_t = R_{t-1}\left(b_{t-1}^h + b_{t-1}^{eT} + b_{t-1}^{eN}\right) + (R_t - 1)\theta w_{t,T} l_{t,T} + (R_t - 1)\theta p_{t,N} w_{t,N} l_{t,N} - \left(b_t^h + b_t^{eT} + b_t^{eN}\right). \tag{14}$$

4. Calibration

The model is solved using quarterly Turkish data for the period 1999Q1–2011Q4. The construction of the series used in the model solution is explained in detail in the appendix. The parameter values of the model are summarized in Table 4. The steady-state value of the gross real interest rate, $\bar{R}$, is set equal to the average real interest rate in Turkey, which equals 1.0117. The real interest rate is calculated as the sum of the US real interest rate and the risk premium for Turkey measured by J.P. Morgan's Emerging Markets Bond Index Global (EMBIG). For the 1999Q1–2011Q4 period used in the calibration, the real interest rate for Turkey has an average of 4.82%, the average US real interest rate is 0.44% and the average risk premium for Turkey is 4.38%, all in annual terms. The average real interest rate we obtain for Turkey is lower than the average values previously used in the literature for emerging markets. This is mostly due to the low average US real interest rate we find for the sample period, which is a result of the expansionary monetary policy implemented by the Fed in response to the recessions in 2001 and 2008.

The discount factors are set such that the credit constraints bind in and around the steady state. The values for β^h and β^{eN} are set to 0.94, and the value for β^{eT} is set to 0.97, which are the highest possible values that guarantee binding credit constraints in the solution of the model. The value of η, which determines the intertemporal elasticity of substitution in labor supply, is set to 1.7 following

Table 4
Parameter values of the benchmark model.

Parameter	Value	Description			
β^h	0.94	Discount factor of households			
β^{eN}	0.94	Discount factor of nontradable sector entrepreneurs			
β^{eT}	0.97	Discount factor of tradable sector entrepreneurs			
σ	1	Relative risk aversion coefficient			
η	1.7	Labor curvature			
ψ	1.589	Labor weight in utility			
γ	0.54	Nontradable weight in the consumption aggregator			
α_T	0.35	Capital exponent in the tradable sector			
α_N	0.25	Capital exponent in the nontradable sector			
δ	0.08	Annual depreciation rate			
$\bar{R}$	1.0117	Real interest rate			
φ_T	5.244	Capital adjustment cost coefficient in the tradable sector			
φ_N	18.377	Capital adjustment cost coefficient in the nontradable sector			
θ	0.25	Working capital coefficient			
$\bar{m}^h$	0.423	Loan-to-income ratio			
$\bar{m}^{eN}$	0.265	Loan-to-capital ratio in the nontradable sector			
$\bar{m}^{eT}$	0.102	Loan-to-capital ratio in the tradable sector			
Stochastic processes					
ρ^{A_T}	0.662	ρ^h_T	0.697	$\sigma(\varepsilon^{A_T})$	0.0283
ρ^{A_N}	0.777	ρ^h_N	0.011	$\sigma(\varepsilon^{A_N})$	0.0148
ρ^h	0.824	ρ^{eT}_T	0.165	$\sigma(\varepsilon^h)$	0.0353
ρ^{eT}	0.668	ρ^{eN}_N	0.364	$\sigma(\varepsilon^{eT})$	0.0291
ρ^{eN}	0.808	ρ^d_T	−0.020	$\sigma(\varepsilon^{eN})$	0.0272
ρ^R	0.899	ρ^d_N	−0.008	$\sigma(\varepsilon^R)$	0.0010
ρ^d	0.566			$\sigma(\varepsilon^d)$	0.0021

Correia et al. (1995). The coefficient of relative risk aversion is set to 1, which corresponds to log-utility. The annual depreciation rate is set to 0.08 following Meza and Quintin (2007).

We cannot calibrate the capital share parameters in the tradable and nontradable sectors for Turkey due to unavailability of reliable data.[1] Different values have been used in the literature for these parameters and the general consensus is that the tradable sector is more capital intensive than the nontradable sector. Since the standard value used in real business cycle studies for the capital's share of income is 0.3, we set the capital share parameter equal to 0.35 in the tradable sector and 0.25 in the nontradable sector.[2]

The value of ψ is set to 1.589 so that the steady state labor supply equals the average fraction of discretionary time spent working in Turkey, which is 0.17. This value is lower than the values generally used in the literature but it is consistent with the studies on labor supply in Turkey. Adamopoulos and Akyol (2009) and Ungor (2014) point out that total hours worked is lower in Turkey compared to developed economies and the value that we use is close to the labor supply values they report.

The share of nontradable goods in the consumption aggregator, γ, is set equal to the average share of nontradable consumption in total consumption in Turkey. The steady-state value of the loan-to-capital ratio in the nontradable and tradable sectors, $\bar{m}^{eN}$ and $\bar{m}^{eT}$, are set to match the average value of business credit in each sector as a ratio of GDP for the sample period, which are 11.2% and 9.6%, respectively. Likewise, the steady-state value of the loan-to-income ratio, $\bar{m}^h$, is set to match the average value of the ratio of household credit to GDP in the data, which is 7.2%.

For the calibration of the parameter θ, we use data on short-term bank loans from the Company Accounts database of the Central Bank of Turkey. Total liabilities of firms are composed of intertemporal loans and working capital loans in our model, and the loans for working capital have a shorter duration compared to the other loans. Therefore, we choose to approximate the working capital loans with short-term bank loans. We calibrate θ by taking the average of the ratio of short-term loans to the compensation of employees, which is equal to 0.25. Since the data on short-term bank loans are not available at the sectoral level, we use the same value for both tradable and nontradable sectors.

The consumption aggregator is assumed to be of the Cobb–Douglas form for all agents:

$$c^s_t\left(c^s_{t,N}, c^s_{t,T}\right) = (c^s_{t,N})^{\gamma}(c^s_{t,T})^{1-\gamma}, 0 < \gamma < 1, \text{ for } s = h, eT, eN. \tag{15}$$

The form of the capital adjustment cost functions is given by

$$\Phi(k_{t-1,j}, i_{t,j}) = \frac{\varphi_j}{2} k_{t-1,j}\left(\frac{i_{t,j}}{k_{t-1,j}} - \delta\right)^2, \text{ for } j = T, N. \tag{16}$$

The parameters that determine the size of the adjustment costs, φ_j, are set to match the volatility of investment relative to output in each sector.

The stochastic processes used in the model are for total factor productivity in the two sectors, the LTI and LTC ratios, and the two components of the real interest rate, which are the world interest rate and the country risk premium. The processes for the productivity shocks are estimated using the Solow residuals for the tradable and nontradable sectors in Turkey as

$$A_{t,j} = \rho^{A_j} A_{t-1,j} + \varepsilon^{A_j}_t, \tag{17}$$

where $j = T, N$ and $\varepsilon^{A_j}_t$ are normally distributed and serially uncorrelated innovations.

The LTI and LTC ratios are characterized by the following law of motion

$$m^s_t = \bar{m}^s \exp(\tilde{m}^s_t), \tag{18}$$

[1] The sectoral labor income data in Turkey gives labor's share of income higher than one in some sectors, after adjusting the figures using the methods suggested by Gollin (2002). Since the available data give unrealistic labor share values, we follow the literature to set these parameters.

[2] As a robustness check, we tried two different combinations for capital shares: in one we set both shares equal to 0.30 and in the other we increased the share of capital to 0.45 in the tradable sector and decreased it to 0.15 in the nontradable sector. Our results mainly remained the same and are available upon request.

for $s = h, eT, eN$.

The stochastic processes for the LTI and LTC ratios are as follows

$$\tilde{m}_t^h = \rho^h \tilde{m}_{t-1}^h + \rho_T^h A_{t,T} + \rho_N^h A_{t,N} + \varepsilon_t^h, \tag{19}$$

$$\tilde{m}_t^{eT} = \rho^{eT} \tilde{m}_{t-1}^{eT} + \rho_T^{eT} A_{t,T} + \varepsilon_t^{eT}, \tag{20}$$

$$\tilde{m}_t^{eN} = \rho^{eN} \tilde{m}_{t-1}^{eN} + \rho_N^{eN} A_{t,N} + \varepsilon_t^{eN}, \tag{21}$$

where the innovations ε_t^s are normally distributed and serially uncorrelated for $j = h,eT,eN$. We model the shocks to credit availability as dependent on productivity shocks. It is a well-documented fact that emerging market economies borrow more when their output level is high and have limited access to international financial markets in low-output episodes. Based on this observation, we choose to incorporate the interaction between the productivity shocks, which are the main determinant of output fluctuations, and credit access. This formulation is similar to the way the country risk component of interest rates is modeled in Neumeyer and Perri (2005), as a decreasing function of expected productivity. Since there are two productivity shocks in our model, we assume that the credit limits of the firms depend on the productivity shock of their own sector and the household's credit access depends on both shocks.

The real interest rate is assumed to be of the following form:

$$R_t = \bar{R} \exp(r_t^*) \exp(d_t), \tag{22}$$

where $\exp(r_t^*)$ is the world interest rate and $\exp(d_t)$ is the country risk premium. Both the world interest rate and the risk premium are modeled as stochastic processes as follows:

$$r_t^* = \rho^r r_{t-1}^* + \varepsilon_t^r, \tag{23}$$

$$d_t = \rho^d d_{t-1} + \rho_T^d A_{t,T} + \rho_N^d A_{t,N} + \varepsilon_t^d, \tag{24}$$

where ε_t^r and ε_t^d are normally distributed and serially uncorrelated innovations. We again follow Neumeyer and Perri (2005) in modeling the risk premium as a function of the productivity shocks in the two sectors.

5. Results

5.1. Impulse response analysis

Fig. 4 shows the response of the economy to positive 1% shocks to household credit, tradable sector credit and nontradable sector credit, i.e. increases in m_t^h, m_t^{eT} and m_t^{eN}, respectively. Credit shocks lead to different responses in sectoral output and input levels as well as the real exchange rate.

For all types of shocks, higher credit availability leads to increased demand for both tradable and nontradable goods. With household and tradable sector credit shocks, higher demand for the nontradable good leads to an appreciation of the real exchange rate. Higher credit to the nontradable sector, on the other hand, raises production in this sector and real exchange rate depreciates. The difference in the real exchange rate response to credit shocks explains the different pattern observed in the correlations of the real exchange rate with household and business credit illustrated in Section 2.1. The appreciation of the real exchange rate with an increase in household credit is consistent with the high positive correlation between the real exchange rate and household credit observed in all countries. In the case of business credit, the correlations get weaker and even become negative. The impulse responses show that the real exchange rate can appreciate or depreciate with a business credit expansion depending on which sector receives a bigger part of the credit.

The response of total output to credit shocks depends on the sectoral output and real exchange rate dynamics. With a shock to household credit, the appreciation of the real exchange rate raises the relative return to labor in the nontradable sector and labor moves from the tradable sector to the nontradable sector. While tradable output declines, the expansion of the nontradable sector and the appreciation of the real exchange rate lead to an increase in total output measured in terms of tradables, followed by a decline in the second period. This decline is due to the effect of the borrowing constraint on the supply of labor. Since the borrowing limit of the household is tied to next period's labor income, an increase in m_t^h raises the direct return to labor in the next period. At the same time, the credit constraint becomes less binding, which reduces the return to labor. The sum of these two effects is negative and labor supply decreases in the second period.[3]

Positive shocks to business credit in the two sectors raise the demand for labor in each sector, since borrowing is required for part of the labor payments. While higher availability of tradable sector credit raises the demand for labor in the tradable sector, the real appreciation raises the return to labor in the nontradable sector at the same time and leads to an increase in labor supply to this sector as well. Hence, increased credit in the tradable sector leads to an expansion in both sectors. In the case of the nontradable sector credit shock, while total labor supply increases, the increase in labor demand in the nontradable sector is strong enough to lead to a decline in labor in the tradable sector. Hence, nontradable output expands while tradable sector labor and output decrease.

Overall, nontradable sector expands in response to all types of credit shocks, while tradable sector only expands after an increase in credit to that sector. An increase in household credit and nontradable sector credit leads to a contraction in the tradable sector. Therefore, the allocation of credit affects the sectoral composition of output. Total output measured in tradable units also increases in response to all shocks, resulting mostly from an expansion in nontradable output. The real exchange rate response contributes to this expansion in the case of shocks to household and tradable sector credit by raising the value of domestic output.

Consumption of both goods increase after each shock, while the magnitudes of the responses differ depending on the shock. This response is reversed in the second period as the credit constraints become more binding and the initial period's debt has to be repaid as well. Investment in each sector increases significantly with an increase in business credit to that sector, as expected.

Positive shocks to the credit limits raise the borrowing of the respective agent and lead to a decline in net exports on impact. The decline in net exports-to-GDP ratio is of similar magnitude for the business credit shocks and smaller for the household credit shock. This is mainly due to the credit limit of the household, determined by m_t^h, being less than those of the firms since the household credit is lower than the other two types of credit in the data. Hence, the change in debt as a ratio of output, which is the main determinant

[3] With the borrowing limit of the household tied to next period's labor income, the first order condition for labor supply from the household's problem takes the form $\frac{\partial U\left[c_t^h(c_{t,N}^h, c_{t,T}^h), l_t\right]}{\partial l_t} = w_{t,T}\left[\frac{\partial U\left[c_t^h(c_{t,N}^h, c_{t,T}^h), l_t\right]}{\partial c_{t,T}^h} + \lambda_{t-1}^h m_{t-1}^h\right]$, where λ_{t-1}^h is the Lagrange multiplier on the borrowing constraint. Since labor supply has the additional benefit of enabling a higher level of borrowing, labor supply response is not only determined by the wage rate, but also by changes in credit availability. A change in m_t^h affects the return to labor in the next period directly and also through λ_t^h. With an increase in m_t^h, the credit constraint becomes less binding and λ_t^h decreases. The decline in λ_t^h dominates the positive effect of an increase in m_t^h. As a result, total labor supply decreases in the second period leading to a decline in labor in both sectors.

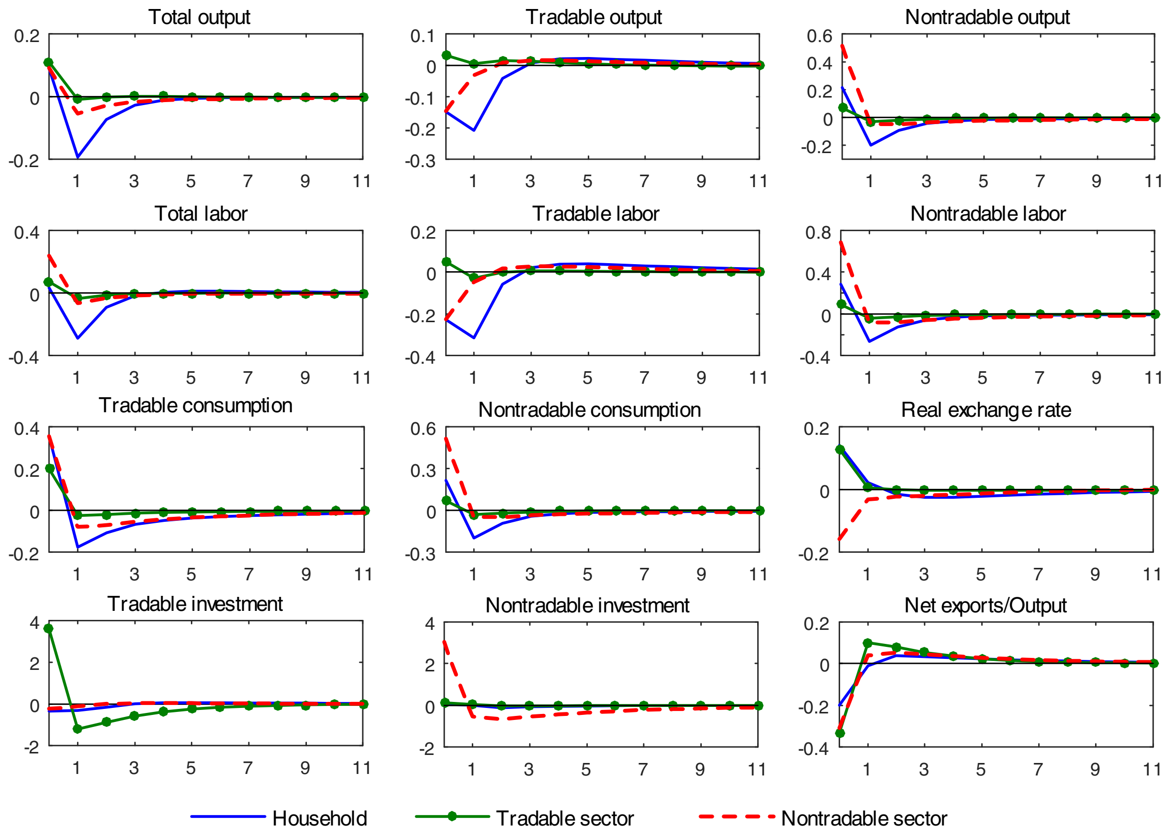

Fig. 4. Positive shocks to credit: percent deviation of variables from their steady-state values.

of the net exports-to-GDP ratio, is smaller in the case of a household credit shock.

The impulse responses for the credit shocks have a kink in the period after the shock and quick convergence to the steady state, which is due to the nature of these shocks. With a positive credit shock, the amount borrowed net of interest payments increases only for one period and falls down to a value slightly below the steady state in the following period. While the amount of new borrowing increases with the shock and slowly decreases back to its steady state value, the increase in borrowing net of interest payments lasts only one period. With new borrowing gradually decreasing after the initial increase and a constant interest rate, the previous period's debt payment including the interest exceeds the amount of new debt in every period except time 0. Therefore, borrowing net of interest payments falls sharply in the period after the shock and quickly converges to the steady state in the following periods, which leads to a short-lived response in the other variables as well.[4]

5.2. Business cycle statistics

In this section, we examine the ability of the model to match the main characteristics of business cycles observed in Turkey in the period 1999Q1–2011Q4. Table 5 documents the key business cycle moments obtained from the data and the model. The model is log-linearized around the steady state and the moments are calculated using HP-filtered series. The model dynamics are generated by productivity, interest rate and credit shocks.

The correlations of different types of credit with output, real exchange rate and the net exports-to-GDP ratio are in general consistent with the patterns observed in the data. The model generates a stronger correlation between household credit and output compared to the two types of business credit, which is in line with the empirical regularity observed in emerging economies.[5] In the model as well as in the data, the comovement between different credit types and output is determined by a two-way interaction between credit and output: not only output responds to credit shocks, but credit movements are also affected by output dynamics. Hence the correlations between credit types and output are generated by two channels: the credit-to-output and the output-to-credit channels. The credit-to-output channel captures the positive response of output to credit shocks, whereas the output-to-credit channel captures the fluctuations in credit as a result of a change in output.

The impulse responses from the model show that all types of credit shocks increase total output by a similar magnitude, which partly explains the positive correlation of output with all types of credit. However, output affects household and business credit differently and the output-to-credit channel is stronger for household credit. Two factors determine the strength of this channel in the model. First, as the borrowing capacity of households is tied to their income, any factor that leads to an income expansion also generates a rise in household credit, increasing the household credit-output correlation. Business credit, on the other hand, is tied to the capital stock of the firm and increases with investment. Productivity and

[4] The impulse responses of new borrowing and borrowing net of interest payments are available upon request.

[5] In the statistics reported in Table 3, the differences between household credit and the two types of business credit in terms of correlations with output in Turkey are higher than those in Table 5. The reason for this difference is that output is measured in tradable units in Table 5 to make the data comparable with the model, while the output measure used in Table 3 is real GDP.

Table 5
Business cycle properties.

	Data	Model		Data	Model
Standard deviations					
$\sigma(Y)$	3.61	4.26	$\sigma(L)/\sigma(Y)$	0.60	0.58
$\sigma(YT)$	4.49	3.50	$\sigma(RER)/\sigma(Y)$	1.97	0.91
$\sigma(YN)$	3.66	4.03	$\sigma\left(\frac{NX}{Y}\right)$	2.19	2.10
$\sigma(C)/\sigma(Y)$	1.10	1.02	$\sigma\left(\frac{\Delta HC}{Y}\right)$	1.29	1.38
$\sigma(IT)/\sigma(YT)$	4.18	4.18	$\sigma\left(\frac{\Delta BCN}{Y}\right)$	2.35	1.34
$\sigma(IN)/\sigma(YN)$	3.04	3.04	$\sigma\left(\frac{\Delta BCT}{Y}\right)$	2.38	1.23
Correlations					
$\rho(C,Y)$	0.73	0.88	$\rho\left(\frac{NX}{Y},RER\right)$	−0.56	−0.44
$\rho(L,Y)$	0.40	0.71	$\rho\left(\frac{\Delta HC}{Y},RER\right)$	0.58	0.62
$\rho(I,Y)$	0.78	0.74	$\rho\left(\frac{\Delta BCN}{Y},RER\right)$	0.14	−0.04
$\rho\left(\frac{NX}{Y},Y\right)$	−0.69	−0.68	$\rho\left(\frac{\Delta BCT}{Y},RER\right)$	0.11	0.30
$\rho\left(\frac{\Delta HC}{Y},Y\right)$	0.56	0.76	$\rho\left(\frac{\Delta HC}{Y},\frac{NX}{Y}\right)$	−0.79	−0.70
$\rho\left(\frac{\Delta BCN}{Y},Y\right)$	0.48	0.38	$\rho\left(\frac{\Delta BCN}{Y},\frac{NX}{Y}\right)$	−0.24	−0.62
$\rho\left(\frac{\Delta BCT}{Y},Y\right)$	0.50	0.35	$\rho\left(\frac{\Delta BCT}{Y},\frac{NX}{Y}\right)$	−0.26	−0.67
$\rho(RER,Y)$	0.40	0.72			

Notes: Changes in household credit (ΔHC), nontradable sector credit (ΔBCN) and tradable sector credit (ΔBCT) are $HC_t - HC_{t-1}$; $BCN_t - BCN_{t-1}$ and $BCT_t - BCT_{t-1}$, respectively. Net exports (NX) are exports minus imports. Output (Y), tradable output (YT), nontradable output (YN), consumption (C), labor (L), sectoral investment (IT and IN) and real exchange rate (RER) are in logs. Data series have been seasonally adjusted and all series have been HP filtered. Standard deviations are reported as percentages. See the appendix for data sources.

business credit shocks to each sector lead to higher investment in the sector receiving the shock, resulting in a borrowing increase. However, these responses are limited to sector-specific shocks, which reduce the correlation of business credit with the cycle, whereas household credit moves in response to any factor that leads to a change in income such as shocks to productivity in both sectors and credit shocks for all agents.

The second factor that determines the strength of the output-to-credit channel is the relative importance of productivity shocks in access to credit for different agents, which is captured by the stochastic processes of credit shocks. It is a well-documented fact that emerging market economies borrow more when their output level is high and have limited access to international financial markets in low-output episodes, which holds for Turkey as well. In the estimation of the credit shock processes, we find that productivity shocks increase credit access for all types of agents with a stronger effect on household credit. These two factors that are behind the output-to-credit channel, as well as the positive response of output to household credit shocks, generate the strong correlation between household credit and output in the model.

The credit–real exchange rate correlations from the model are in line with the data as well. The correlation between the real exchange rate and the change in household credit as a ratio of output is strongly positive and very close to the data. This is consistent with the appreciation of the real exchange rate following a household credit shock in the impulse responses analysis. In the case of business credit, the correlations get weaker as observed in the data.

The net exports-to-GDP ratio has a much stronger negative correlation with household credit than with the other two types of credit in the data for Turkey. The model matches this feature, albeit less strongly than the data. The effect of changes in a certain type of credit on net exports is closely tied to the LTI and LTC ratios of the agents. Since household credit is lower than the other two types of credit in the data, the credit limit of the household is lower in the model as well, which reduces the impact of household credit changes on net exports. When the credit-to-GDP ratios are equalized for all agents, the negative correlation of household credit with net exports increases relative to the other credit types, as illustrated in Table 7.

The model also generates a strongly countercyclical net exports-to-GDP ratio, with a value very close to the data, and a consumption volatility higher than output volatility. Both of these are common features of emerging market economies and hard to match using standard real business cycle models.

5.2.1. Assessing the effects of different shocks

In this section, we eliminate each type of shock one by one to understand their relative importance in generating the model dynamics. First we eliminate the credit shocks, then the shocks to the world interest rate and the risk premium, and the productivity shocks in both sectors as the last exercise. The results are presented in Table 6. The performance of the model deteriorates significantly in several dimensions when the credit shocks are eliminated. The model cannot match the relative volatility of consumption, generating a consumption volatility much lower than the data. The volatility of the net exports-to-GDP ratio is very low as well. The credit constraints on agents limit the amounts that they can borrow. Even though the fluctuations in output and capital lead to changes in the amount of debt through the value of the collateral, these changes are not enough to generate the volatility observed in net exports. The credit constraints also limit the response of consumption to shocks and the lack of volatility in borrowing leads to a lower consumption volatility as well. The credit shocks are also important in matching the volatilities of the changes in credit relative to output. Overall, these results show that the volatilities generated by productivity and interest rate shocks are not sufficient to match the volatilities observed in the data.

The correlations of the credit variables generated by the model also deteriorate considerably when the credit shocks are excluded. The model with credit shocks always has the correct ordering in terms of the correlations of different types of credit, with the household credit having a stronger correlation with output, real exchange rate and net exports. In the simulation results without the credit shocks, the ordering of the correlations are inconsistent with the data and the magnitudes of the correlations are quite far from the data as well. These results show that the credit shocks are important in matching certain features of the data, especially the moments related to different credit types.

Eliminating the interest rate shocks has almost no effect on the moments, which shows that interest rate shocks play a minor role in this model. Since all agents face borrowing constraints, their response to interest rate shocks remains limited. The credit constraints are the main determinant of the borrowing levels and have an important effect on business cycle dynamics whereas interest rate shocks have a minor effect. In the case without the productivity shocks, output volatilities decrease significantly, as expected, while consumption volatility is much higher than the data. The fit of the model worsens in terms of correlations as well. Comparing this case and the case with no credit shocks shows that productivity shocks are important in generating sufficient volatility in output, whereas credit shocks are important in generating sufficient volatility in consumption and net exports.

5.2.2. Different levels of credit and working capital

To understand the importance of the credit levels and the working capital requirement for the model dynamics, here we present the business cycle statistics for different values of the LTI and LTC ratios and the working capital parameter θ.

In the benchmark model, the LTI and LTC ratios are set to match the credit-to-GDP ratios in the data for each credit type, which are 7.2%, 9.6% and 11.2% for household credit, tradable sector credit and nontradable sector credit, respectively. To evaluate whether the difference in the credit ratios is important for the model statistics, we set the LTI and LTC ratios in a way to equalize the credit-to-GDP ratios for all agents and analyze how the moments change when

Table 6
The effects of different shocks.

	Data	Baseline	No credit shocks	No interest rate shocks	No productivity shocks
Standard deviations					
$\sigma(Y)$	3.61	4.26	3.86	4.25	0.88
$\sigma(YT)$	4.49	3.50	3.75	3.46	0.97
$\sigma(YN)$	3.66	4.03	2.87	3.97	1.78
$\sigma(C)/\sigma(Y)$	1.10	1.02	0.78	1.01	2.02
$\sigma(IT)/\sigma(YT)$	4.18	4.18	2.06	4.18	11.91
$\sigma(IN)/\sigma(YN)$	3.04	3.04	2.08	3.09	4.95
$\sigma(L)/\sigma(Y)$	0.60	0.58	0.47	0.58	1.42
$\sigma(RER)/\sigma(Y)$	1.97	0.91	0.87	0.93	1.18
$\sigma\left(\frac{NX}{Y}\right)$	2.19	2.10	0.56	2.11	1.55
$\sigma(\frac{\Delta HC}{Y})$	1.29	1.38	0.55	1.39	0.84
$\sigma(\frac{\Delta BCN}{Y})$	2.35	1.34	0.51	1.34	1.10
$\sigma(\frac{\Delta BCT}{Y})$	2.38	1.23	0.24	1.22	1.14
Correlations					
$\rho\left(\frac{NX}{Y}, Y\right)$	−0.69	−0.68	−0.83	−0.69	−0.59
$\rho\left(\frac{\Delta HC}{Y}, Y\right)$	0.56	0.76	0.70	0.77	0.46
$\rho\left(\frac{\Delta BCN}{Y}, Y\right)$	0.48	0.38	0.65	0.38	0.39
$\rho\left(\frac{\Delta BCT}{Y}, Y\right)$	0.50	0.35	0.78	0.36	0.30
$\rho\left(\frac{\Delta HC}{Y}, RER\right)$	0.58	0.62	0.42	0.63	0.69
$\rho\left(\frac{\Delta BCN}{Y}, RER\right)$	0.14	−0.04	0.37	−0.03	−0.47
$\rho\left(\frac{\Delta BCT}{Y}, RER\right)$	0.11	0.30	0.50	0.30	0.42
$\rho\left(\frac{\Delta HC}{Y}, \frac{NX}{Y}\right)$	−0.79	−0.70	−0.95	−0.70	−0.43
$\rho\left(\frac{\Delta BCN}{Y}, \frac{NX}{Y}\right)$	−0.24	−0.62	−0.89	−0.63	−0.57
$\rho\left(\frac{\Delta BCT}{Y}, \frac{NX}{Y}\right)$	−0.26	−0.67	−0.96	−0.67	−0.65

Notes: See the notes in Table 5 for the definition of the variables and the description of how the statistics are computed.

each agent borrows the same amount on average. For this analysis, the borrowing limits are changed such that the credit-to-GDP ratio for each sector is equal to 11.2% and the results are reported in Table 7. With borrowing levels of the household and the tradable sector increasing, both the relative volatility of consumption and the volatility of the net exports-to-GDP ratio increase. When agents face higher credit limits, they increase their borrowing more in response to positive shocks, which leads to larger fluctuations in consumption and net exports. While most of the correlations are not affected, the correlations of different types of credit with net exports change. The effect of an agent's borrowing on net exports increases with the borrowing limit, which leads to a higher correlation. In the baseline analysis, the credit type that is most negatively correlated with net exports is the household credit, even though the credit limit of the household is the lowest as implied by the household credit-to-GDP ratio. When the credit limits are adjusted such that all agents on average borrow equal amounts, the negative correlation between household credit and net exports-to-GDP ratio gets stronger while the correlations of business credit get weaker.

Table 7
Different levels of credit and working capital.

	Data	Baseline	Equal credit/GDP	No working capital
Standard deviations				
$\sigma(Y)$	3.61	4.26	4.51	4.33
$\sigma(YT)$	4.49	3.50	3.33	3.24
$\sigma(YN)$	3.66	4.03	4.53	3.72
$\sigma(C) / \sigma(Y)$	1.10	1.02	1.10	1.03
$\sigma(IT) / \sigma(YT)$	4.18	4.18	4.18	4.18
$\sigma(IN) / \sigma(YN)$	3.04	3.04	3.04	3.04
$\sigma(L) / \sigma(Y)$	0.60	0.58	0.76	0.49
$\sigma(RER) / \sigma(Y)$	1.97	0.91	0.94	0.96
$\sigma\left(\frac{NX}{Y}\right)$	2.19	2.10	2.44	2.48
$\sigma(\frac{\Delta HC}{Y})$	1.29	1.38	1.84	1.36
$\sigma(\frac{\Delta BCN}{Y})$	2.35	1.34	1.35	1.01
$\sigma(\frac{\Delta BCT}{Y})$	2.38	1.23	1.36	1.12
Correlations				
$\rho\left(\frac{NX}{Y}, Y\right)$	−0.69	−0.68	−0.75	−0.74
$\rho\left(\frac{\Delta HC}{Y}, Y\right)$	0.56	0.76	0.81	0.76
$\rho\left(\frac{\Delta BCN}{Y}, Y\right)$	0.48	0.38	0.39	0.32
$\rho\left(\frac{\Delta BCT}{Y}, Y\right)$	0.50	0.35	0.38	0.37
$\rho\left(\frac{\Delta HC}{Y}, RER\right)$	0.58	0.62	0.67	0.69
$\rho\left(\frac{\Delta BCN}{Y}, RER\right)$	0.14	−0.04	−0.05	0.14
$\rho\left(\frac{\Delta BCT}{Y}, RER\right)$	0.11	0.30	0.32	0.34
$\rho\left(\frac{\Delta HC}{Y}, \frac{NX}{Y}\right)$	−0.79	−0.70	−0.76	−0.78
$\rho\left(\frac{\Delta BCN}{Y}, \frac{NX}{Y}\right)$	−0.24	−0.62	−0.55	−0.58
$\rho\left(\frac{\Delta BCT}{Y}, \frac{NX}{Y}\right)$	−0.26	−0.67	−0.62	−0.70

Notes: See the notes in Table 5 for the definition of the variables and the description of how the statistics are computed.

The last column in Table 7 shows the moments from the model when the working capital parameter θ is set to zero. The value of the working capital parameter mostly affects the volatilities. In the absence of working capital, the volatilities of labor, sectoral output and business credit decline. However, the main results of the analysis do not change. We still observe a stronger comovement between household credit and the key macroeconomic variables compared to the two types of business credit. The effect of working capital on the volatilities is mainly due to the change in the response of labor demand to credit shocks. Without a working capital requirement, credit shocks affect labor demand to a lesser extent and labor volatility decreases, which leads to a decline in the volatilities of the other variables.[6]

[6] Although sectoral output volatilities go down, there is a slight increase in total output volatility, which is due to the increase in real exchange rate fluctuations. When θ is different from zero, a positive nontradable sector credit shock generates a larger increase in output in that sector, which leads to a larger depreciation of the real exchange rate. With the household and tradable sector credit shocks leading to an appreciation, the depreciation due to the nontradable credit shock counteracts the effects of the other two credit shocks and real exchange rate fluctuates less. Without the working capital requirement, this counteracting effect is absent, leading to higher volatility in the real exchange rate. The same dynamics lead to a positive correlation between the real exchange rate and nontradable credit when θ equals zero.

6. Conclusions

In this paper, we analyze different types of private sector credit in relation to business cycles in emerging market economies. First, we compute the correlations between private sector credit and key macroeconomic variables for a group of emerging markets, using data for household and business credit separately. We show that the patterns documented in the literature with respect to credit and business cycles are stronger for household credit: household credit exhibits a strong positive comovement with output, consumption, investment and real exchange rate appreciation, and a negative correlation with net exports. Business credit, on the other hand, has weaker correlations with all of these variables.

We then use a small open economy real business cycle model to analyze the dynamics generated by different types of credit, distinguishing between household and business credit, as well as the sectoral allocation of business credit. The impulse response analysis of the model shows that the three types of credit generate different macroeconomic dynamics. The most distinct difference is in the response of the real exchange rate, which responds positively to an expansion in household and tradable sector credit, and negatively to an expansion in nontradable sector credit. These responses explain the large differences observed in the data for the correlation of the real exchange rate with different credit types. The model also generates a strong positive correlation of output with household credit, whereas for the two types of business credit the correlations are weaker. The strength of the comovement of output and different types of credit depends on a two-way interaction: while output responds to credit shocks, output fluctuations also affect credit dynamics. The analysis of the model shows that all credit shocks have a positive effect on output of similar magnitudes whereas output fluctuations are more important for household credit than tradable and nontradable sector credit. Output dynamics have a stronger effect on household credit due to the structure of the credit constraints and the relative importance of productivity shocks in determining the stochastic processes for the credit limits.

Our paper contributes to the literature on the relationship between private sector credit and the real economy by differentiating the types of credit. Our results suggest that it is important to understand the mechanisms through which different types of credit affect the economy as well as the response of credit to output dynamics. A key policy implication of our analysis is that policy makers should pay attention to the dynamics of sectoral credit separately, rather than aggregate private credit, in order to understand the effects of credit cycles on the economy.

Appendix

A1. Cross-sectional data

The data on household and business credit used in Fig. 1 and Tables 1 and 2 come from Bank for International Settlements (BIS) "Long series on credit to the private non-financial sector" database except for Chile and South Africa, for which we obtained the credit series from their respective central banks. The data sources and the time period for each series are reported in Table A.1.

For Turkey, the credit data we use in Fig. 1 and Table 1 also come from the BIS database as the other countries. For the statistics in Table 3 and the model solution, we need data on business credit for tradable and nontradable sectors separately. The credit data for different sectors are available at the Central Bank of Turkey, which we use in Table 3 and the rest of the paper. For consistency between the statistics reported in Tables 2 and 3, we use the credit data from the Central Bank of Turkey in Table 2 instead of the data from the BIS database. The statistics calculated with the BIS data give similar results.

Table A.1
Data sources for the credit series.

Countries	Time period	Source
Argentina	1994Q1–2014Q2	BIS
Brazil	1995Q1–2014Q3	BIS
Chile	1999Q1–2014Q4	Central Bank of Chile
Korea	1994Q1–2014Q4	BIS
Mexico	1994Q4–2014Q4	BIS
South Africa	1994Q1–2014Q2	South African Reserve Bank
Thailand	1993Q1–2014Q3	BIS
Turkey[1]	1994Q1–2014Q3	BIS
Turkey[2]	1999Q1–2011Q4	Central Bank of Turkey

Notes: For Turkey, 1 refers to data used in Fig. 1 and Table 1 and 2 refers to data used in Tables 2 and 3 and the model solution.

The data for the national accounts and the real exchange rate are obtained from IMF's International Financial Statistics database. Consumption is household consumption expenditures, investment is gross fixed capital formation and net exports are exports minus imports. Consumption and investment are deflated using the GDP deflator. Real exchange rate for country i is calculated as $CPI_i/(XR_i \times CPI_{US})$, where XR_i is the nominal exchange rate defined as the domestic currency per US dollar and CPI denotes the consumer price index. All series are seasonally adjusted and HP filtered.

A2. Data for Turkey

The construction of the series used in the model solution is explained below.

Sectoral output: The sectors for which the average of (Exports + Imports) / Output is less than 10% in the sample period are classified as nontradable. The sectors classified as tradable are Agriculture, hunting and forestry; Fishing; Mining and quarrying; and Manufacturing. The rest of the sectors are classified as nontradable (the highest tradability ratio for the sectors classified as nontradable is 6%).

Labor input: We calculate total hours worked in tradable and nontradable sectors by multiplying total employment in each sector with the average hours per worker. Data needed to compute average hours per worker are only available for the manufacturing sector. Therefore, we use the average hours per worker in the manufacturing sector for both the tradable and the nontradable sectors (Bergoeing et al. (2002) and Meza and Quintin (2007) also use average hours in manufacturing to calculate total hours worked in the whole economy).

In order to find average hours per worker in the manufacturing sector, we multiply an index of total hours worked in manufacturing by the actual hours worked in 2005, which is the base year. We then divide this by the number of workers in manufacturing, which is also calculated as the index of workers times the actual number of workers in 2005. We scale the resulting series by 1274, an approximation of total discretionary time available in a quarter (corresponds to 98 weekly hours used by Correia et al. (1995)).

To calibrate the parameter that measures the disutility from working, ψ, we need a measure of total hours per capita. We multiply the average hours per worker with total employment for the whole economy and divide by the total working age population, which corresponds to the population of age 15 and higher. We then set ψ so that the steady state labor supply equals the sample period average of total hours per capita in Turkey as a fraction of total discretionary time, which is 0.17.

The total employment and total working age population figures are reported twice a year by the Turkish Statistical Institute in the period 1995–1999, and quarterly figures are available starting in 2000. The quarterly values are obtained from the biannual figures through linear interpolation in the period for which quarterly data are missing.

Capital stock: The capital stock data for the two sectors are generated using a perpetual inventory method. The sectoral investment series are obtained by multiplying the capital formation series at 1998 constant prices for the whole economy with the sectoral shares of investment. The seasonally adjusted sectoral investment data are then used to construct the sectoral capital stock series. For the perpetual inventory method, we use a yearly depreciation rate of 0.08 as Meza and Quintin (2007). To set the initial capital stock, we follow Young (1995) and Meza and Quintin (2007) and assume that the growth rates of sectoral investment in the first five years of the series are representative of the growth rates of investment in previous years. Note that the sectoral investment share data are available annually and we assume that these shares are the same for all quarters within a year when constructing the sectoral investment series.

Total factor productivity: The data on TFP have been constructed as

$$A_{t,j} = \log(y_{t,j}) - \alpha_j \log(k_{t-1,j}) - (1-\alpha_j)\log(l_{t,j})$$

for $j = T, N$, where $y_{t,j}$ is sectoral GDP in 1998 prices, $k_{t,j}$ is sectoral capital stock in 1998 prices and $l_{t,j}$ is sectoral hours worked. The TFP series are then HP filtered and used to estimate the AR(1) processes for the productivity shocks.

Real interest rate: The series for the real interest rate is computed using the procedure followed by Neumeyer and Perri (2005). The real interest rate for Turkey is computed as the US real interest rate plus the sovereign spread for Turkey. The sovereign spread is measured by J.P. Morgan's Emerging Markets Bond Index Global (EMBIG). The EMBIG spreads measure the premium above US Treasury securities in basis points for dollar denominated sovereign debt. The US real interest rate is computed by subtracting expected inflation rate from the interest rate on 90-day US Treasury bills. Expected inflation in period t is computed as the average of US GDP deflator inflation in the current period and in the three preceding periods.

Real exchange rate: The real exchange rate is calculated as CPI_{TR} / $(XR_{TR} \times CPI_{US})$, where XR_{TR} is the nominal exchange rate defined as the Turkish Liras per US dollar and *CPI* denotes the consumer price index.

Business credit: We construct the series for sectoral business credit in 1998 prices by dividing the sectoral business credit series with the sectoral GDP deflators. GDP deflators for each sector are calculated as nominal sectoral output divided by real sectoral output in 1998 prices. Given the credit constraints in Eqs. (6) and (7), we calculate the series for the business credit shocks m_t^{ej}, for $j = T, N$, as the real value of sectoral business credit multiplied by the gross interest rate and divided by the value of sectoral capital stock, where both the credit and the capital stock series are in units of 1998 prices.

Household credit: Given the form of the household credit constraint in Eq. (3), we calculate the series for the credit shock m_t^h as the nominal value of household credit multiplied by the gross interest rate and divided by next period's total labor income, which is the sum of labor income from the two sectors. We calculate the sectoral labor income as the sectoral labor share of income used in the calibration times the nominal sectoral output.

Sources and definitions of the data used in calibration:

– Nominal GDP: GDP at current prices, Turkish Statistical Institute (TUIK).
– Real GDP: GDP at 1998 prices, TUIK.
– Investment: Gross fixed capital formation at 1998 prices, TUIK.
– Consumption: Final consumption expenditure of resident households at 1998 prices, TUIK.
– Net exports: Exports minus imports of goods and services, TUIK.
– Sectoral employment and total working age population: TUIK
– Indexes of total hours worked and total employment in manufacturing: OECD
– Household credit: The sum of housing credit, consumer credit, individual credit cards, and loans to personnel, Central Bank of Turkey.
– Business credit: Credit to nonfinancial firms, Central Bank of Turkey.
– Sectoral shares of investment: Total gross fixed investment by sectors, Ministry of Development of Turkey.
– Nominal exchange rate and CPI for Turkey, US Treasury bill rate, CPI and GDP deflator inflation for the US: International Financial Statistics, IMF.
– Sovereign spread: Emerging Markets Bond Index Global (EMBIG), J.P. Morgan.

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