Credit Decomposition and Real Exchange Rate Dynamics

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Abstract

The literature shows that expansions in total private sector credit are associated with real exchange rate appreciations in emerging economies. In this paper, we first provide evidence that the nature of this relationship depends on the composition of private credit: household credit expansions have a much stronger correlation with real exchange rate appreciations than business credit. Then, using a two-sector real business cycle model of a small open economy, we study the model dynamics generated by household and business credit expansions. We show that positive shocks to household credit and tradable sector credit both generate a real exchange rate appreciation, with household credit having a much stronger impact. Credit expansion in the nontradable sector, on the other hand, leads to a real depreciation. A Vector Autoregression analysis using Turkish data confirms that the real exchange rate appreciates strongly after an increase in household credit, whereas nontradable sector credit expansions result in a real exchange rate depreciation.

JEL classification: E32, E44, F34, F41

Key Words: Household Credit, Business Credit, Credit Constraints, Real Exchange Rate

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1 Introduction

The literature on credit cycles, including Mendoza and Terrones (2008, 2012) and Tornell and Westermann (2002, 2003), has established that credit expansions are associated with real exchange rate appreciations. In these papers, the measure of credit includes all types of credit to the private sector without differentiating between lending to households and lending to firms. These two types of credit may generate different real exchange dynamics given that household credit expansions are likely to lead to an increase in consumption whereas business credit has the potential to increase investment and labor demand, and thereby increase output. Furthermore, the allocation of business credit between tradable and nontradable sectors is another factor that may affect the credit-real exchange rate relationship.

Our objective in this paper is to differentiate between household and firm lending, as well as the sectoral allocation of firm lending, to investigate whether they have different effects on the real exchange rate and other key macroeconomic variables. Using a two-sector small open economy real business cycle model, we find that real exchange rate appreciations during credit expansions largely result from increases in household credit. An expansion in tradable sector credit leads to a weak real appreciation, whereas a credit expansion in the nontradable sector results in a depreciation.

The correlations between the credit aggregates and real exchange rate show that the credit type is important for the credit-real exchange rate relationship. Table 1 reports these correlations for a group of emerging economies that have a positive correlation between total private credit and real exchange rate.[1] When we decompose credit into household and business credit, we find a very strong correlation between household credit and the real exchange rate. The average correlation between the household credit-to-GDP ratio and the real exchange rate is 0.56. On the other hand, the business credit-to-GDP ratio exhibits a much weaker correlation with the real exchange rate, with an average correlation of 0.07. In all countries except for Singapore, the correlation between business credit and the real exchange rate is weaker than the correlation of household credit and in some countries it

[1] The data is obtained from the Bank for International Settlements (BIS). Since data on sectoral allocation of business credit is not available for most of these countries, we can only analyze aggregate business credit.

is negative. Household credit, on the other hand, is consistently positively correlated with the real exchange rate. The data on real exchange rate and the credit-to-GDP ratios used in this table are plotted in Figures 1 and 2. These figures also show that there is a strong comovement between the household credit-to-GDP ratio and the real exchange rate, which is not observed for business credit for most countries.

Table 1: Correlations between credit aggregates and real exchange rate

	Total Credit/GDP	Household Credit/GDP	Business Credit/GDP
Brazil	0.67	0.77	0.41
Chile	0.09	0.43	-0.02
Czech Republic	0.14	0.49	-0.14
Hong Kong	0.12	0.79	-0.24
Hungary	0.26	0.74	-0.01
Poland	0.47	0.42	0.44
Singapore	0.65	0.28	0.62
South Africa	0.19	0.50	-0.25
Turkey	0.03	0.63	-0.17
Average	0.29	0.56	0.07

Note: All statistics are based on annual HP-filtered data. Credit data are obtained from BIS.

To analyze the channels through which household and business borrowing affect real exchange rate dynamics, we construct a two-sector small open economy real business cycle model where households and both the tradable and nontradable sectors are credit constrained, and firms have a working capital requirement. We choose to model both sectors as credit constrained since this allows us to study the model dynamics for each type of credit expansion and analyze the effects in each sector separately.[2] The model allows us to disaggregate total credit into three subcomponents: (i) household credit, (ii) nontradable sector business credit, and (iii) tradable sector business credit.

[2] As a robustness check, we also set up the model such that the tradable sector is not constrained, and the impulse responses to expansions in household and nontradable sector credit are quite similar to the current model. The results are available upon request.

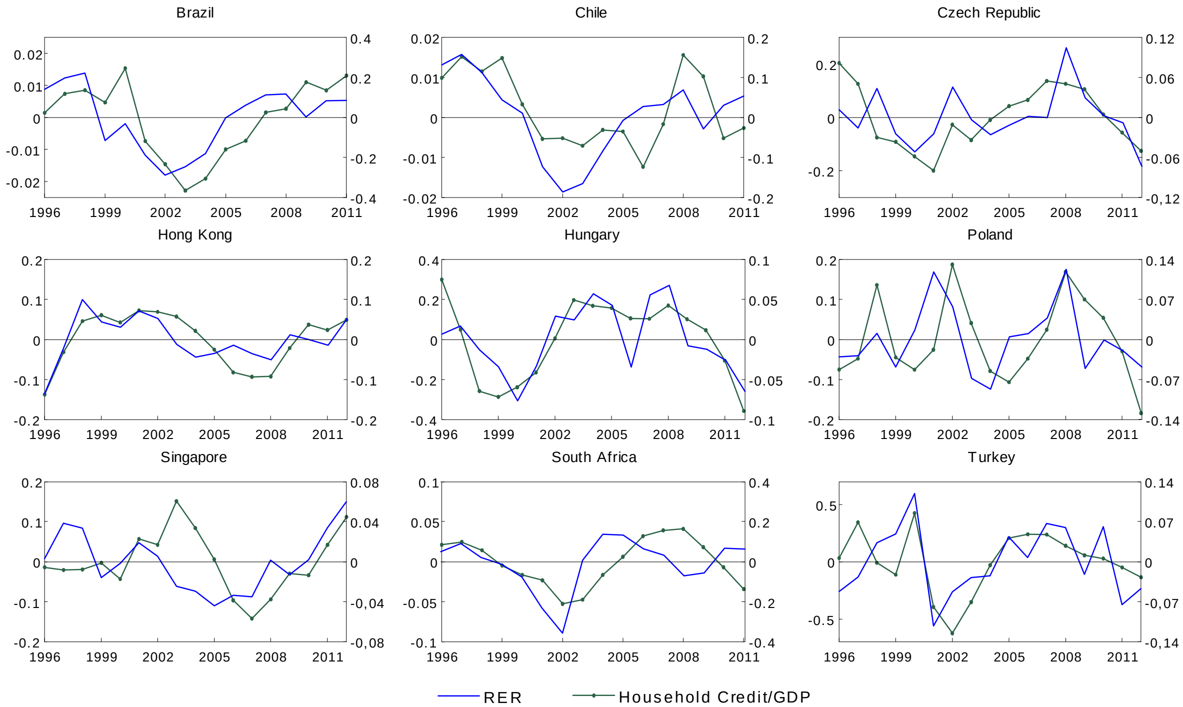

Figure 1. Real exchange rate and household credit-to-GDP ratio

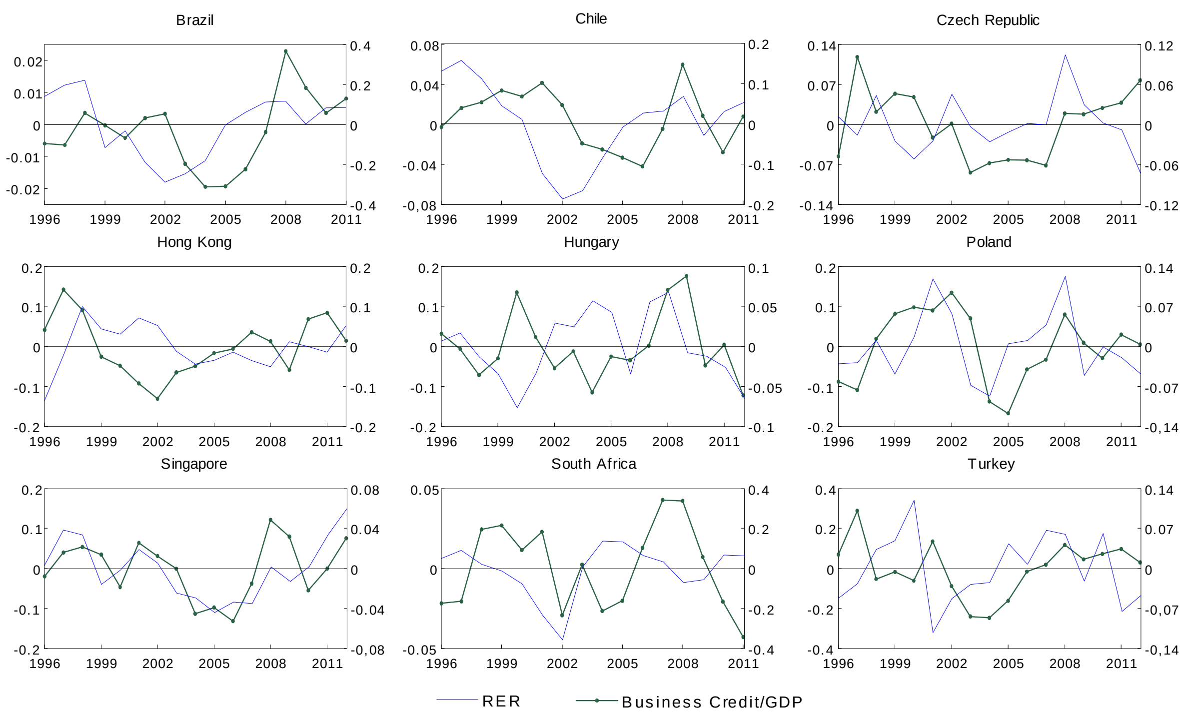

Figure 2. Real exchange rate and business credit-to-GDP ratio

Note: Left axis and right axis show the deviations of the credit-to-GDP ratios and log real exchange rate from their HP trends, respectively.

We study the model dynamics under productivity shocks in tradable and nontradable sectors and three types of credit shocks. The credit shocks are modeled as stochastic processes that affect the borrowing limits of the agents. The shocks to credit are similar to the financial sector shocks studied in Jermann and Quadrini (2009) and Kiyotaki and Moore (2008) who show that these shocks play an important role as a source of macroeconomic fluctuations in closed economy models. The contribution of the current paper is to analyze the effects of different types of credit shocks on the model dynamics in an open economy framework. Analyzing these shocks separately helps understand the mechanisms through which each type of credit affects the economy. Specifically, the effects of different types of credit expansions on the real exchange rate and sectoral composition of key macroeconomic variables that include output, consumption, investment, and labor are analyzed in the model.

We calibrate our model to Turkey for the period 1999Q1-2011Q4. 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, trade balance is countercyclical and business cycles are very volatile (see Table 3 for more details). With respect to the key relationship analyzed in this paper - the real exchange rate and credit - the correlations we observe for Turkey display the average pattern for other emerging economies in Table 1. Namely, household credit has a high positive correlation with the real exchange rate and business credit has a weaker correlation. The reason we choose to calibrate the model to Turkey is that we are able to obtain detailed sectoral data on credit variables at quarterly frequency for a relatively long time period. For our analysis, we not only need data on household and business credit separately, but also business credit data at the sectoral level. To the best of our knowledge, most of the emerging economies for which household credit and business credit data are separately available do not provide the sectoral credit classification.

The impulse response analysis shows that a positive shock to household credit generates a strong real exchange rate appreciation. An expansion in tradable sector credit also leads to an appreciation but to a much lower extent. On the other hand, when credit to the nontradable sector expands, real exchange rate depreciates as increases in labor and capital lead to an expansion in the nontradable sector production. The response of the real exchange rate depends on whether the credit expansion finances the demand for or the supply of nontradable goods. While changes in household and tradable sector credit mainly affect the demand for nontradable goods, credit to the nontradable sector increases production in this sector.

Sectoral output dynamics also depend on the type of the credit shock. All credit shocks lead to an increase in the production of the nontradable good, whereas tradable production only increases after an expansion in tradable sector credit. Higher business credit in each sector raises the production in the respective sector as firms can use more capital and labor through higher borrowing. The increase in the nontradable sector production following shocks to household credit and tradable sector credit, on the other hand, result from higher demand for the nontradable good, which also leads to a real appreciation.

To test the main predictions of our model with respect to the credit-real exchange rate relationship, we use a Vector Autoregression (VAR) analysis using Turkish data for the 1999Q1-2011Q4 period. Our VAR analysis provides results that are consistent with the dynamics of the model. Mainly, we find that a household credit expansion leads to a strong real exchange rate appreciation, whereas an expansion in nontradable sector credit results in a real depreciation. An increase in tradable sector credit also leads to a slight appreciation. However, this effect is not significant.

Our paper contributes to the literature that focuses on the distinction between household and business credit. Empirical studies by Büyükkarabacak and Krause (2009), Büyükkarabacak and Valev (2010), and Beck et al. (2012) on credit decomposition underline the importance of differentiating between the types of borrowers. The main conclusion of these papers is that the two types of credit serve different purposes and have distinct effects on the economy.[3] Bahadir and Gumus (2012) complement these studies by analyzing the channels through which household and business borrowing affect the economy in a one-sector RBC model.

[3] 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.

Our work is also related to the literature on the relationship between capital inflows and real exchange rates. The empirical evidence presented in this literature suggests that capital inflows are in general associated with real exchange rate appreciations (Edwards, 1998; Lartey, 2007; Combes et al., 2012). However, the degree of real exchange rate appreciation may vary across countries. Calvo et al. (1996) argue that the behavior of the real exchange rate during capital inflows presents a mixed picture. For the 1988-1994 period, they show that in most Latin American countries, capital inflows have been associated with a marked real exchange rate appreciation whereas in most of the Asian countries the real exchange rate remains stable through the inflow period. Athukorala and Rajapatirana (2003) show that, while both Asian and Latin American countries experienced real exchange rate appreciations after capital inflows, the degree of real exchange rate appreciation was much lower in Asian countries. In this paper, we show that one key factor that determines the level of real exchange rate appreciation during capital inflows, which correspond to credit expansions in our analysis, is the sectoral allocation of the funds received.

The stability of the real exchange rate is important for emerging market economies because of its effect on external imbalances and trade competitiveness. The fact that these countries mostly borrow in foreign currency makes the real exchange rate dynamics even more important for financial stability. In this paper, we study one of the factors that has been found to affect the real exchange rate dynamics, the private sector credit, in detail. Rapid growth in private credit, especially in household credit, has raised some concerns about financial instability in emerging market economies (see Chapter 2 of the IMF Global Financial Stability Report 2006 for a detailed discussion). The analysis in the current paper sheds light on one of the possible mechanisms through which household credit expansions may lead to financial instability by affecting the real exchange rate.

Our findings underline the importance of distinguishing between different credit types when studying real exchange rate movements in relation to credit cycles. 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 real exchange rate dynamics. The key difference between credit types depends on the purpose for which the credit is used and whether credit finances the consumption or the production of nontradable goods.[4] When considering policies that affect private sector credit, their possible effects on the real exchange rate through the allocation of credit should therefore be taken into account.

2 The Model

2.1 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

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

where b_t^h denotes the amount borrowed at time t, $R = (1+r)$ is the gross interest rate and r is the net real interest rate, which is taken as constant. 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

[4] Another paper that studies the link between real exchange rate and the type of spending is Galstyan and Lane (2009), which focuses on the composition of government spending. They find that an increase in government consumption appreciates the real exchange rate, while the effect of government investment is more ambiguous, leading to real depreciation for some country groups and having no effect in others.

many banks require income statements before they provide funds to the borrowers since income is associated with some observable measure of the borrower's financial health. The credit constraint of households is of the form

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

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

2.2 Entrepreneurs

2.2.1 Tradable sector

Entrepreneurs who produce tradable goods combine households' labor services with capital, $k_{t-1,T}$. Output is produced by a Cobb-Douglas technology:

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

where $A_{t,T}$ is an exogenous stochastic productivity shock.

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

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

where $i_{t,T}$ denotes investment in the tradable sector. 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 borrow $\theta w_{t,T} l_{t,T}$ at the beginning of period t and repay $R\theta w_{t,T} l_{t,T}$ 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 Christiano, Motto, and Rostagno (2010) and Mendoza (2010), we assume that the entrepreneur's total debt, which includes intertemporal debt 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

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

The loan-to-capital ratio, denoted by m_t^{eT}, is modeled as a stochastic process, and $q_{t+1,T}^k$ 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

$$q_{t,T}^k = 1 + \frac{\partial \Phi(k_{t-1,T}, i_{t,T})}{\partial i_{t,T}}, \tag{7}$$

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

The entrepreneur's problem is to maximize her expected utility

$$E_0 \sum_{t=0}^{\infty} (\beta^{eT})^t \frac{(c_t^{eT}(c_{t,N}^{eT}, c_{t,T}^{eT}))^{1-\sigma}}{1-\sigma} \tag{8}$$

subject to technology and borrowing constraints, and the following flow of funds constraint:

$$c_{t,T}^{eT} + p_{t,N} c_{t,N}^{eT} + w_{t,T} l_{t,T} + i_{t,T} + \Phi(k_{t-1,T}, i_{t,T}) + Rb_{t-1}^{eT} + (R-1)\theta w_{t,T} l_{t,T} = y_{t,T} + b_t^{eT}. \tag{9}$$

As in the case of households, consumption of the tradable sector entrepreneur, c_t^{eT}, is an aggregate of the consumption of nontradable and tradable goods, $c_{t,N}^{eT}$ and $c_{t,T}^{eT}$, respectively. Entrepreneur's borrowing at time t is denoted by b_t^{eT}.

We assume that $\beta^{eT} < 1/R$ so that the credit constraint is binding in and around the steady state, as in the case of households.

2.2.2 Nontradable sector

Entrepreneurs in the nontradable sector also produce output with a Cobb-Douglas technology:

$$y_{t,N} = e^{A_{t,N}} k_{t-1,N}^{\mu} l_{t,N}^{1-\mu}, \tag{10}$$

where $A_{t,N}$ is an exogenous stochastic productivity shock and $k_{t-1,N}$ denotes capital used in the production of the nontradable good. Capital is accumulated by the entrepreneur and the equation for capital accumulation is given by

$$i_{t,N} = k_{t,N} - (1-\delta)k_{t-1,N}, \tag{11}$$

where $i_{t,N}$ denotes investment in the nontradable sector.

Similar to the tradable sector, firms in the nontradable sector also have a working capital requirement and face a credit constraint. The entrepreneur's total value of debt including the interest payments cannot exceed a fraction of the expected value of the capital holdings:

$$Rb_t^{eN} + R\theta w_{t,N} l_{t,N} \leq m_t^{eN} E_t \left(q_{t+1,N}^k k_{t,N} \right). \tag{12}$$

The loan-to-capital ratio, denoted by m_t^{eN}, is modeled as a stochastic process. We use adjustment costs for capital accumulation in the nontradable sector as well, in order to reduce the volatility of investment. The price of capital in terms of tradable consumption, $q_{t,N}^k$, is given by

$$q_{t,N}^k = 1 + \frac{\partial \Phi(k_{t-1,N}, i_{t,N})}{\partial i_{t,N}}, \tag{13}$$

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

The entrepreneur in the nontradable sector maximizes her expected utility

$$E_0 \sum_{t=0}^{\infty} (\beta^{eN})^t \frac{\left(c_t^{eN} \left(c_{t,N}^{eN}, c_{t,T}^{eN}\right)\right)^{1-\sigma}}{1-\sigma} \tag{14}$$

subject to technology and borrowing constraints, as well as the following flow of funds constraint:

$$c_{t,T}^{eN} + p_{t,N} c_{t,N}^{eN} + p_{t,N} w_{t,N} l_{t,N} + i_{t,N} + \Phi(k_{t-1,N}, i_{t,N}) + Rb_{t-1}^{eN} + (R-1)\theta w_{t,N} l_{t,N} = p_{t,N} y_{t.N} + b_t^{eN}. \tag{15}$$

Consumption of the nontradable sector entrepreneur is also an aggregate of the consumption of nontradable and tradable goods, $c_{t,N}^{eN}$ and $c_{t,T}^{eN}$, respectively.

We also assume for the nontradable sector entrepreneur that $\beta^{eN} < 1/R$ to make sure that the credit constraint is binding in and around the steady state.

2.3 Equilibrium

Given initial conditions b_0^h, $b_0^{eT}, b_0^{eN}, k_{0,T}, k_{0,N}$, the constant interest rate r, the sequence of shocks to sectoral productivity levels, 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 households, and 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:

$$c_{t,T}^h + c_{t,T}^{eT} + c_{t,T}^{eN} + i_{t,T} + i_{t,N} + \Phi(k_{t-1,T}, i_{t,T}) + \Phi(k_{t-1,N}, i_{t,N}) + tb_t = y_{t,T} \quad (16)$$

$$c_{t,N}^h + c_{t,N}^{eT} + c_{t,N}^{eN} = y_{t,N} \quad (17)$$

where the trade balance is defined as

$$tb_t = R\left(b_{t-1}^h + b_{t-1}^{eT} + b_{t-1}^{eN}\right) + (R-1)\theta w_{t,T} l_{t,T} + (R-1)\theta w_{t,N} l_{t,N} - \left(b_t^h + b_t^{eT} + b_t^{eN}\right). \quad (18)$$

3 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 2.

We take the real interest rate as constant and set it equal to the average real interest rate in Turkey, which equals 0.015. We set the discount factors such that the credit constraints bind in and around the steady state. The value for β^h is set to 0.94, and the values for β^{eN} and β^{eT} are both set to 0.96, which are the highest possible values that guarantee binding credit constraints in the solution of the model.

Table 2. Parameter values of the benchmark model

Parameter	Value	Description
β^h	0.94	Discount factor of households
β^{eN}	0.96	Discount factor of nontradable sector entrepreneurs
β^{eT}	0.96	Discount factor of tradable sector entrepreneurs
σ	1	Relative risk aversion coefficient
η	1.7	Labor curvature
ψ	1.55	Labor weight in utility
γ	0.54	Nontradable weight in the consumption aggregator
α	0.35	Capital exponent in the tradable sector
μ	0.25	Capital exponent in the nontradable sector
δ	0.08	Annual depreciation rate
r	0.015	Real interest rate
φ_T	3.92	Capital adjustment cost coefficient in the tradable sector
φ_N	18.05	Capital adjustment cost coefficient in the nontradable sector
θ	0.25	Working capital coefficient
$\bar{m}^h$	0.424	Loan-to-income ratio
$\bar{m}^{eN}$	0.213	Loan-to-capital ratio in the nontradable sector
$\bar{m}^{eT}$	0.122	Loan-to-capital ratio in the tradable sector

Stochastic processes			
ρ^{A_T}	0.652	$\sigma(\varepsilon^{A_T})$	0.0290
ρ^{A_N}	0.770	$\sigma(\varepsilon^{A_N})$	0.0152
ρ^h	0.905	$\sigma(\varepsilon^h)$	0.0407
ρ^{eN}	0.811	$\sigma(\varepsilon^{eN})$	0.0280
ρ^{eT}	0.621	$\sigma(\varepsilon^{eT})$	0.0267

The value of η, which determines the intertemporal elasticity of substitution in labor supply, is set to 1.7 following 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 set θ equal to 0.25 following Bahadir and Gumus (2012) who calibrate this parameter for Turkey.

We cannot calibrate the capital share parameters in the tradable and nontradable sectors for Turkey due to unavailability of data. 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. Therefore, we set the capital's share of income equal to 0.35 in the tradable sector and 0.25 in the nontradable sector, which are close to the values used in the literature.

The value of ψ is set to 1.55 so that the steady state labor supply equals 0.17, which is the average value of time spent working as a percentage of total discretionary time in Turkey. 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 (LTC) 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 (LTI) 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%.

The consumption aggregator is assumed to be of the following form for all agents:

$$c_t^j\left(c_{t,N}^j, c_{t,T}^j\right) = (c_{t,N}^j)^{\gamma}(c_{t,T}^j)^{1-\gamma}, \quad 0 < \gamma < 1, \quad \text{for } j = h, eT, eN. \tag{19}$$

The form of the capital adjustment cost functions is given by

$$\Phi(k_{t-1,s}, i_{t,s}) = \frac{\varphi_s}{2} k_{t-1,s}\left(\frac{i_{t,s}}{k_{t-1,s}} - \delta\right)^2, \qquad \text{for } s = T, N.$$

The parameters that determine the size of the adjustment costs, φ_s, 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 and the LTI and LTC ratios. The processes for the productivity shocks are estimated using the Solow residuals for the tradable and nontradable sectors in Turkey as

$$A_{t,s} = \rho^{A_s} A_{t-1,s} + \varepsilon_t^{A_s},$$

where $s = T, N$ and $\varepsilon_t^{A_s}$ are normally distributed and serially uncorrelated innovations.

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

$$m_t^j = \bar{m}^j \exp(\tilde{m}_t^j),$$

for $j = h, eT, eN$. The stochastic process for the LTI and LTC ratios are as follows

$$\tilde{m}_t^j = \rho^j \tilde{m}_{t-1}^j + \varepsilon_t^j.$$

The innovations ε_t^j are normally distributed and serially uncorrelated for $j = h, eT, eN$.

4 Results

4.1 Impulse Response Analysis

4.1.1 Household Credit Shock

Figure 3 shows the response of the economy to a positive one standard deviation shock to household credit, i.e. an increase in m_t^h. With higher credit availability, households increase their demand for both tradable and nontradable goods. Higher demand raises the relative price of the nontradable good and the real exchange rate appreciates.

The responses of output in the two sectors depend on the labor supply response. With the appreciation of the real exchange rate, the return to labor in the nontradable sector increases relative to the tradable sector and labor moves from the tradable sector to the nontradable sector. While total labor supply does not change on impact, it decreases in the second period. This decline is due to the effect of the borrowing constraint on the supply of labor. With the borrowing limit of the household tied to next period's labor income, labor supply has the additional benefit of enabling a higher level of borrowing. Therefore, labor supply response is not only determined by the wage rate, but also by changes in credit availability. The increase in m_t^h raises the direct return to working, while at the same time the credit constraint becomes less binding, which reduces the benefit of working. The decline in the Lagrange multiplier of the credit constraint offsets the positive effect of an increase in m_t^h, and as a result total labor supply decreases in the second period leading to a decline in labor in both sectors. Sectoral production levels follow the same paths as sectoral labor.

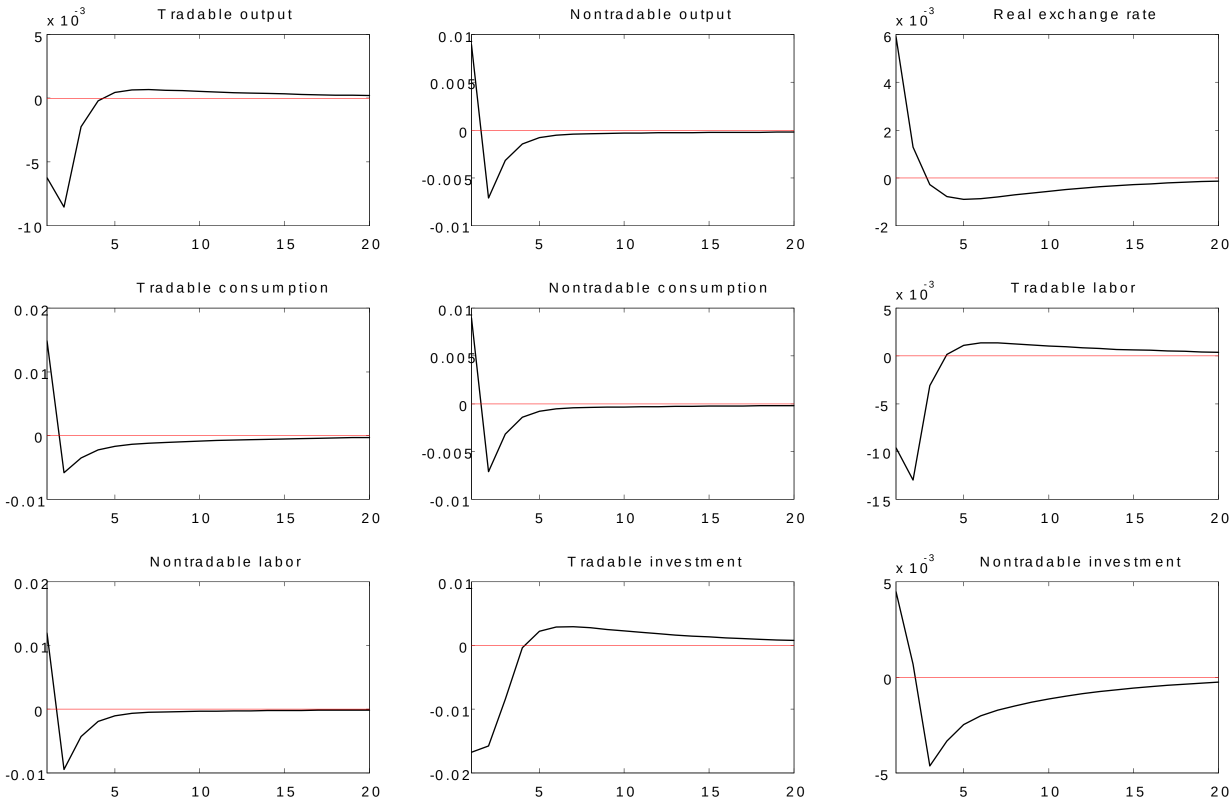

Figure 3. Positive household credit shock: Percent deviation of variables from their steady-state values

After the household credit shock, aggregate consumption of both tradable and nontradable goods increase. This response is reversed in the second period as the credit constraint becomes more binding and the initial period's debt has to be repaid as well.

Investment decreases in the tradable sector after the household credit shock. The real appreciation raises the cost of consumption and falling tradable production reduces the income of entrepreneurs in the tradable sector. Therefore, they reduce their consumption and marginal utility of consumption increases, which leads to a decline in investment. In the nontradable sector, investment at first increases as the real appreciation raises the relative return to investment and then falls as the income level also falls.

4.1.2 Tradable Sector Credit Shock

Figure 4 reports the impulse response functions for a positive one standard deviation shock to business credit in the tradable sector. With an increase in m_t^{eT}, the tradable sector entrepreneurs borrow more and increase their investment. Since borrowing is needed for labor payments, higher credit availability raises the demand for labor in this sector as well. Therefore, production of the tradable good increases with higher labor and capital.

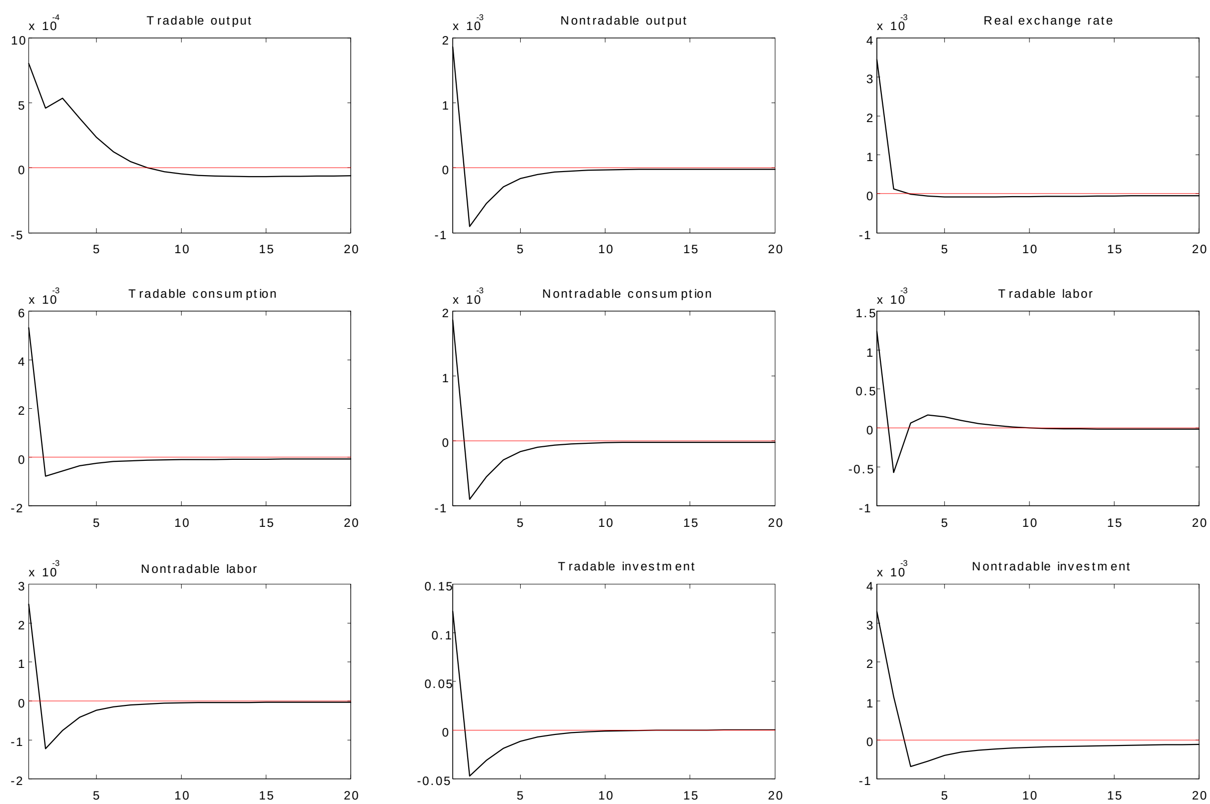

Figure 4. Positive tradable sector credit shock: Percent deviation of variables from their steady-state values

Higher tradable sector income raises the demand for the nontradable good, which leads to an increase in the real exchange. The appreciation the real exchange rate raises the returns to labor and capital in the nontradable sector, leading to higher labor and investment in this sector as well. Therefore, a positive shock to tradable sector credit and the ensuing appreciation of the real exchange rate leads to an expansion in the nontradable sector, resulting in a comovement of output in the two sectors.

The consumption of the tradable good increases on impact with the increased credit limit of the tradable sector entrepreneur and higher income of all agents.

4.1.3 Nontradable Sector Credit Shock

Figure 5 reports the impulse response functions for a positive one standard deviation shock to business credit in the nontradable sector. Similar to the tradable sector, with an increase in m_t^{eN}, nontradable sector investment and consumption of both goods increase. Higher borrowing increases the labor demand in the nontradable sector as firms have more funds available for wage payments. With increasing labor, the production of the nontradable good increases, which results in a real exchange rate depreciation.

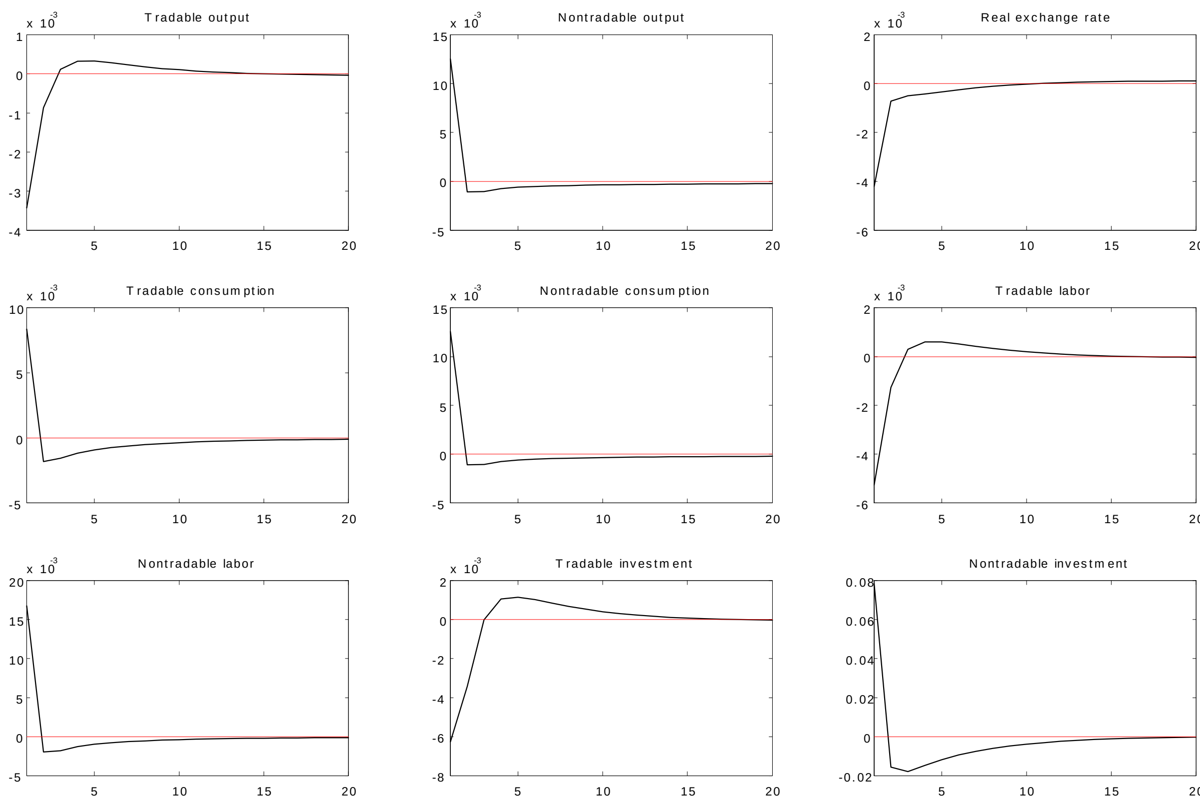

Figure 5. Positive nontradable sector credit shock: Percent deviation of variables from their steady-state values

Since the higher availability of credit in the nontradable sector reduces the cost of labor to the entrepreneurs in this sector, their labor demand increases. As a result, labor moves from the tradable sector to the nontradable sector, which in turn lowers tradable output. With lower income, tradable entrepreneurs reduce their investment.

4.1.4 Productivity Shocks

Figure 6 shows the response of the economy to a positive one standard deviation shock to productivity in the tradable sector.

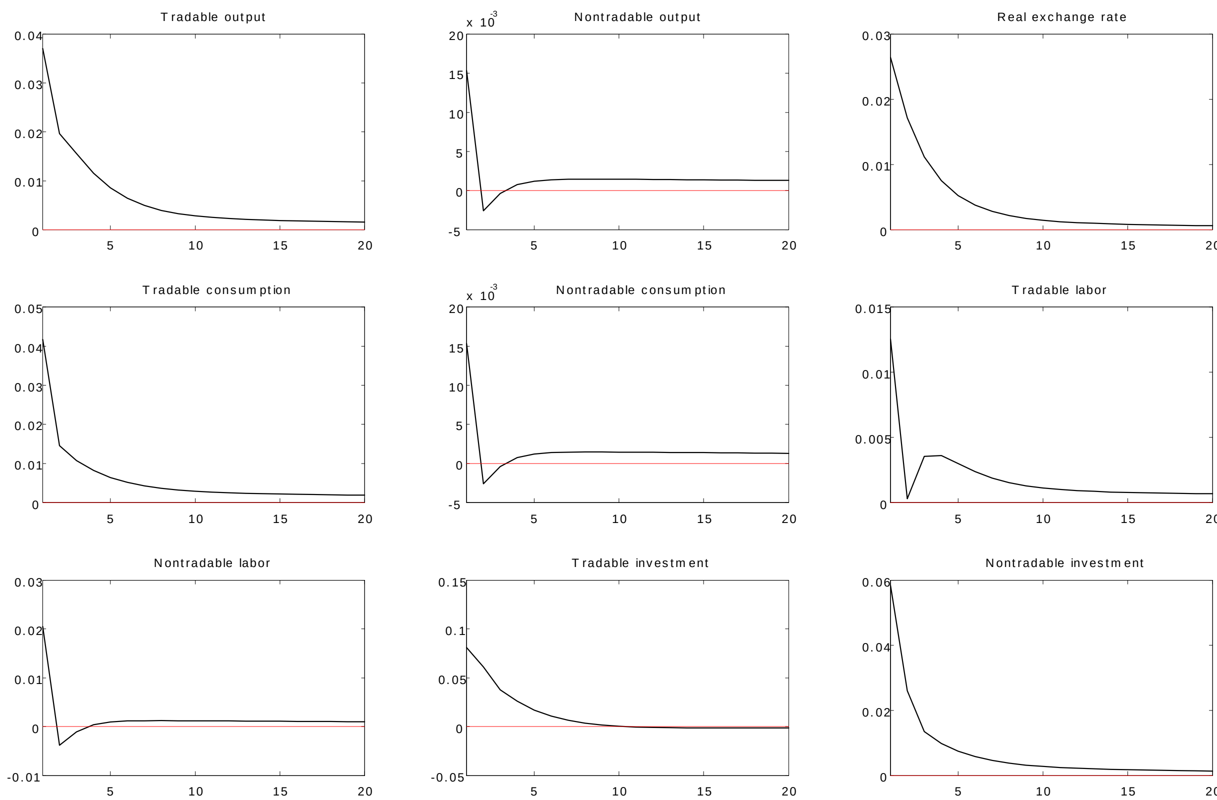

Figure 6. Positive tradable sector productivity shock: Percent deviation of variables from their steady-state values

The productivity shock has the standard positive effects on output, labor and investment in the tradable sector. Higher income and borrowing of households and entrepreneurs result in an increase in the demand for the nontradable good, which leads to a real exchange rate appreciation. As the real appreciation raises the return to labor in the nontradable sector, labor increases in this sector, resulting in an increase in output. The increase in the relative price of the nontradable good leads to an increase in the nontradable sector investment as well. Increasing investment levels in both sectors lead to higher labor demand since an increase in next period's capital relaxes the borrowing constraints of firms. This has an additional positive effect on the labor used in the two sectors.

Figure 7 reports the impulse response functions following a one standard deviation shock to productivity in the nontradable sector. In this case, a positive productivity shock leads to a real exchange rate depreciation due to increasing supply of the nontradable good. Nontradable sector labor and investment also increase with increasing productivity in this sector. With higher labor input in the tradable sector, the production of the tradable good increases, and increasing tradable sector income leads to higher investment in this sector as well.

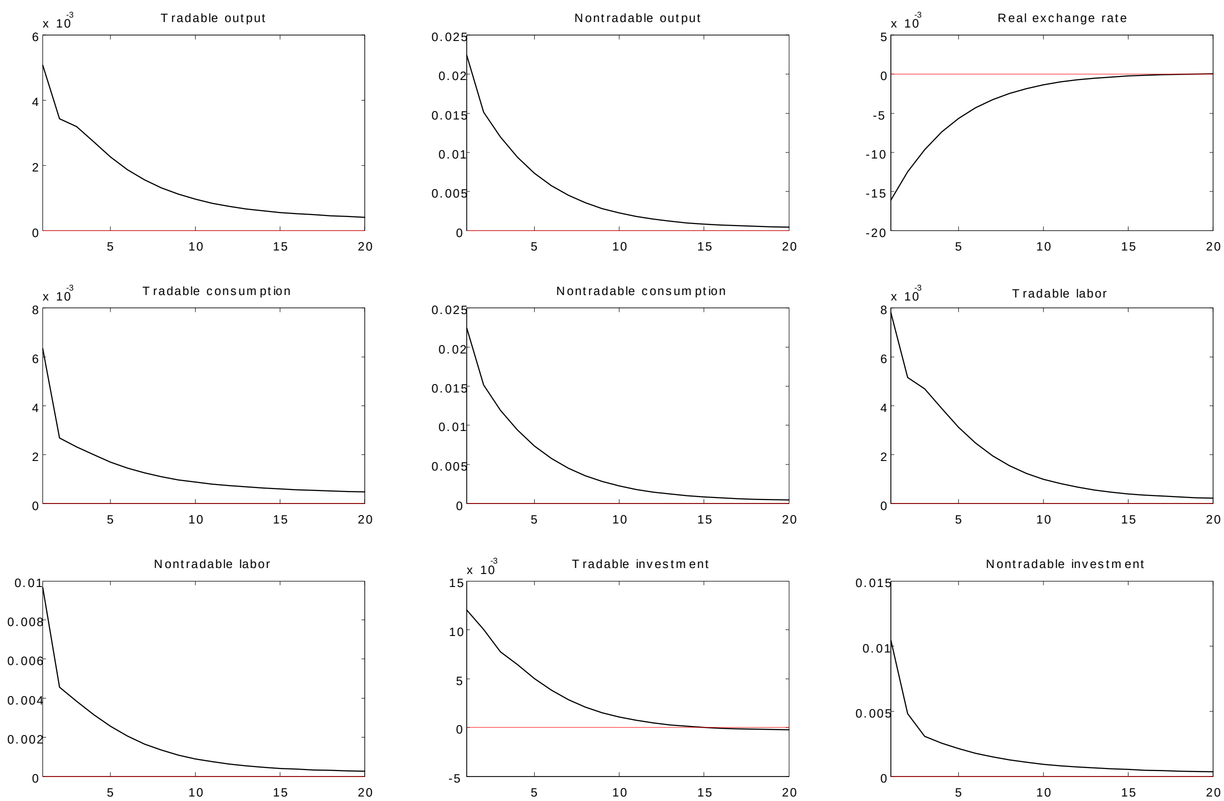

Figure 7. Positive nontradable sector productivity shock: Percent deviation of variables from their steady-state values

5 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 3 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 and credit shocks.

The model performs well in matching most of the volatilities observed in the data. Total and sectoral output volatilities and the volatility of labor relative to output are pretty close to the data. The volatility of the trade balance-to-GDP ratio is reasonably close to the data as well. The model cannot generate the empirical regularity of consumption volatility being higher than output for aggregate consumption. The nontradable consumption makes it harder to match this moment since the credit constraints mainly affect the consumption of tradables. The pattern observed in the data for the volatility of aggregate consumption holds only for tradable consumption in the model, where the volatility of tradable consumption relative to output is 1.11. The volatility of nontradable consumption equals that of nontradable output, which is mainly determined by the productivity shock in that sector and the low volatility of nontradable output leads to consumption volatility being less than output at the aggregate level.

The model generates a countercyclical trade balance, which is a key business cycle regularity of emerging economies. The model successfully matches this feature, which is difficult to match using standard small open economy models that assume perfect capital mobility. The correlations between output and the three types of credit are also in line with the data, where the household credit has the highest correlation with output. The correlation between the real exchange rate and the change in household credit as a ratio of output is also strongest in the model as in the data, and the correlations between the real exchange rate and the two types of business credit are weakly positive, as observed in the data.

Table 3. Business cycle properties

	Standard Deviations			Correlations	
	Data	Model		Data	Model
$\sigma(Y)$	3.61	4.04	$\rho(C, Y)$	0.73	0.83
$\sigma(YT)$	4.49	4.03	$\rho(L, Y)$	0.40	0.74
$\sigma(YN)$	3.66	3.40	$\rho(\frac{TB}{Y}, Y)$	-0.69	-0.39
$\sigma(L)/\sigma(Y)$	0.60	0.56	$\rho(\frac{\Delta HC}{Y}, Y)$	0.56	0.43
$\sigma(C)/\sigma(Y)$	1.10	0.87	$\rho(\frac{\Delta BCN}{Y}, Y)$	0.48	0.34
$\sigma(IT)/\sigma(YT)$	4.18	4.18	$\rho(\frac{\Delta BCT}{Y}, Y)$	0.50	0.22
$\sigma(IN)/\sigma(YN)$	3.04	3.04	$\rho(RER, Y)$	0.40	0.70
$\sigma(RER)/\sigma(Y)$	1.97	0.88	$\rho(\frac{\Delta HC}{Y}, RER)$	0.58	0.35
$\sigma(\frac{TB}{Y})$	2.19	1.70	$\rho(\frac{\Delta BCN}{Y}, RER)$	0.14	0.06
			$\rho(\frac{\Delta BCT}{Y}, RER)$	0.11	0.18

Note: Trade balance (TB) is exports minus imports. 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. Output (Y), tradable output (YT), nontradable output (YN), consumption (C), labor (L), sectoral investment (IT and IN) and real exchange rate (RER) are in logarithms. All series are HP filtered. The standard deviations are reported in percentage terms.

6 VAR Analysis

We conduct a reduced form VAR analysis for Turkey to test whether the predictions of the model with respect to the relationship between different credit types and real exchange rate are consistent with the facts observed in Turkey. The analysis is conducted using seasonally adjusted quarterly data from 1999Q1 to 2011Q4. The VAR includes detrended real GDP, change in credit relative to GDP for the three types of credit, detrended real exchange rate, a time trend, and a constant. Two lags of each variable are included according to the Hannah-Quinn criterion. In the Cholesky decomposition, the shocks are orthogonalized in the following order: change in household credit; change in tradable sector credit, change in nontradable credit, real exchange rate, and real GDP.

Figure 8 presents the impulse responses with 99% confidence intervals. The results confirm the main predictions of the model regarding the relationship between different credit types and real exchange rate. In particular, we observe a significant increase in the real exchange rate, i.e. a real appreciation, after a household credit shock. In response to an unanticipated one standard deviation shock to the change in household credit-to-GDP ratio (0.40 percentage points increase on a quarterly basis), real exchange rate appreciates by 10 percent and stays high for four quarters after the shock. After an expansion in nontradable sector credit, on the other hand, real exchange rate declines significantly. In this case, a one standard deviation increase in nontradable sector credit (0.67 percentage points increase) leads to a 5 percent depreciation in the real exchange rate. Tradable sector credit also leads to an appreciation as predicted by the model. However, the effect of tradable sector credit on real exchange rate is not significant.

The observations from the VAR analysis with respect to the relationship between output and credit types suggest that household and nontradable sector credit lead to an increase in output, whereas tradable credit has a negative effect. However, these effects are not significant. The results also suggest that when there is an expansion in household credit, both types of business credit increase whereas we do not observe such a positive response in household credit after increases in the two types of business credit. Another observation from the VAR results is that a real exchange rate appreciation leads to an increase in both types of business credit whereas it does not affect the household credit.

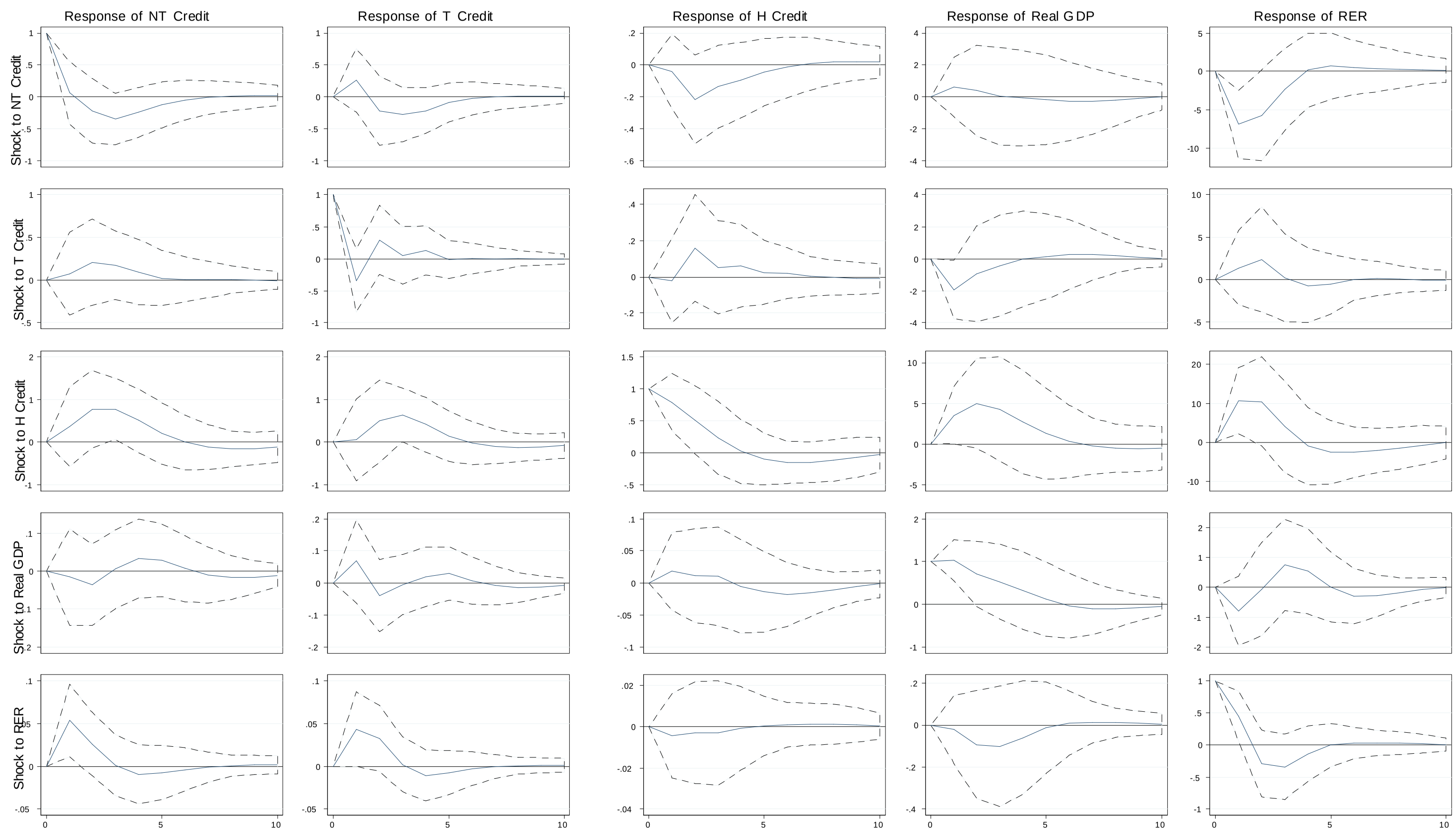

Figure 8. VAR evidence for Turkey

7 Concluding Remarks

We develop a two-sector real business cycle model of a small open economy to examine the effects of different types of private sector credit on model dynamics with a focus on the real exchange rate. Our results show that expansions in both household credit and tradable sector credit generate a real exchange rate appreciation since both types of credit increase the demand for nontradable goods. Household credit expansions generate a strong real appreciation, while credit to the tradable sector has a much lower impact. On the other hand, when credit to the nontradable sector expands, real exchange rate depreciates with an expansion in the nontradable sector production. The results also show that the sectoral output dynamics depend on the type of the credit shock. Production of the nontradable good increases with a positive shock to all types of credit, whereas tradable production only increases after an expansion in tradable sector credit.

Our VAR results confirm the predictions of our theoretical model. Using data for the Turkish economy, we find that a household credit expansion leads to a strong real exchange rate appreciation, whereas an increase in nontradable sector credit results in a depreciation of the real exchange rate.

Our paper contributes to the literature on the effects of private credit on the real economy and our results suggest that when studying private credit, it is important to understand the mechanisms through which different types of credit affect the economy. 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 real exchange rate dynamics.

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Appendix

Construction of the series used in the paper

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 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. Average hours per worker data can only be computed for the manufacturing sector and we use this series for both sectors (Bergoeing et al. (2002) and Meza and Quintin (2007) also use average hours in manufacturing to find 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 average for Turkey of total hours per capita 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 is 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 data. 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

$$A_{t,i} = \log\left(y_{t,i}\right) - \alpha \log\left(k_{t-1,i}\right) - (1-\alpha)\log\left(l_{t,i}\right)$$

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

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 GDP divided by real GDP in 1998 prices. Since the credit constraints on firms take the form

$$Rb_t^{ei} + R\theta w_{t,i} l_{t,i} \leq m_t^{ei} E_t\left(q_{t+1,i}^k k_{t,i}\right), \tag{20}$$

for $i = T, N$, we calculate the series for m_t^{ei} as the real value of sectoral business credit multiplied by the gross interest rate used in the calibration 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: The credit constraint on households takes the form

$$Rb_t^h \leq m_t^h E_t \left(w_{t+1,T} l_{t+1,T} + p_{t+1,N} w_{t+1,N} l_{t+1,N} \right).$$

We calculate m_t^h as the nominal value of household credit multiplied by the gross interest rate used in the calibration 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.

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 U.S. 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 U.S. Treasury securities in basis points for dollar denominated sovereign debt. The U.S. real interest rate is computed by subtracting expected inflation rate from the interest rate on 90-day U.S. Treasury bills. Expected inflation in period t is computed as the average of U.S. GDP deflator inflation in the current period and in the three preceding periods.

Data sources and definitions:

- 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.

- Trade balance: 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: Central Bank of Turkey

- Sectoral shares of investment: Total gross fixed investment by sectors, Ministry of Development of Turkey.

- U.S. Treasury bill rate and GDP deflator inflation : International Financial Statistics, IMF.

- Sovereign spread: Emerging Markets Bond Index Global (EMBIG), J.P. Morgan.