Credit Decomposition and Business Cycles

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Abstract

Recent empirical evidence suggests that household and business credit evolve differently and have distinct effects on the economy. However, small open economy models have not incorporated the distinction between household and business borrowing yet. We construct a dynamic stochastic general equilibrium model to study the effects of household and business credit on business cycles in a small open economy. Distinguishing between the two types of credit allows us to disentangle the independent role each credit type plays in the transmission mechanism of credit expansions. We show that household credit expansions decrease labor supply and output volatility whereas they lead to a higher consumption-to-output volatility. Business credit expansions, on the other hand, mainly affect investment dynamics. For baseline parameters, our model calibrated to Turkish data successfully matches the standard business cycle moments as well as the moments of credit variables.

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1 Introduction

In recent years, the level of credit to the private sector has increased substantially in many emerging countries. An important part of this rise is due to the rapid expansion of household credit rather than business credit. Since household credit and business credit serve different purposes, an expansion in each type of borrowing is likely to affect the economy through different channels. However, small open economy models have yet to recognize the growing share of household credit and incorporate the distinction between household and business borrowing. In this paper, we construct a dynamic stochastic general equilibrium (DSGE) model that allows us to distinguish between these two types of credit, and study the dynamics of the model for different levels of household and business borrowing.

Recent developments in credit markets show the importance of distinguishing between household and business credit. Table 1 reports the household and business credit to GDP ratios for six emerging countries: Brazil, Bulgaria, Chile, Czech Republic, Turkey, and Romania. The two types of credit exhibit different trends. In the Czech Republic, while the household credit to GDP ratio grew nearly five times in size from 2000 (5.47%) to 2010 (27.1%), the business credit to GDP ratio decreased from 34.4% to 21.3%. In Turkey, the household credit to GDP ratio was only 2.05% in 2000, and by 2010 it has reached 12.5%. Bulgaria and Romania also experienced a remarkable increase in the household credit to GDP ratio during a five year period. The business credit to GDP ratio, on the other hand, has also grown except for in the Czech Republic, but at much slower rates than the household credit.

Table 1: Household and Business Credit as % of GDP

	Household Credit (HC)			Business Credit (BC)		
	2000	2005	2010	2000	2005	2010
Brazil	9.01	8.83	17.3	15.3	15.8	23.2
Bulgaria	-	15.2	26.9	-	24.5	45
Chile	17.1	22.2	28.2	38.2	39.1	43.9
Czech Republic	5.47	11.2	27.1	34.4	16.6	21.3
Turkey	2.05	4.86	12.5	9.76	8.94	15.7
Romania	-	11.7	19.2	-	14.2	18.9

Empirical studies by Büyükkarabacak and Krause (2009), Büyükkarabacak and Valev (2010), and Beck et al. (2010) on credit decomposition underline the importance of differentiating between the types of borrowers. 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. (2011) show that bank lending to firms is positively associated with growth, while the relationship between household credit and growth is insignificant. The main conclusion of this literature is that the two types of credit serve different purposes and have distinct effects on the economy.

Despite the empirical evidence on the differential effects of household and business credit, existing models in the small open economy literature abstract from the distinction between household and business credit. For example, Mendoza (1994, 2002) considers an economy-wide borrowing constraint faced by the representative agent but does not distinguish between borrowing for consumption and investment. Aghion, Bacchetta, and Banerjee (2001, 2004), Caballero and Krishnamurthy (2001), and Schneider and Tornell (2004) model the credit constraints faced by firms and focus on the production sector. While these models yield important insights on the role of financial constraints in macroeconomic instability, their setup does not have a transmission mechanism through which credit constraints on households affect the model dynamics. We extend this literature by modeling firms' and households' credit constraints separately. Such a framework allows us to analyze the independent roles of household and business credit in the transmission mechanism of credit expansions.

To analyze the effects of household and business borrowing on the dynamics of an economy, we construct a dynamic stochastic general equilibrium (DSGE) model with two types of agents: households and entrepreneurs. Both agents borrow from international markets and face constraints on their borrowing. Entrepreneurs produce a tradable home good using capital that they hold and labor that they hire from households. New capital is formed through a composite of the home good and a foreign good. The foreign good is used for investment by entrepreneurs and for consumption by households. We study the model dynamics after a productivity shock and a terms of trade shock for different levels

of loan-to-income (LTI) and loan-to-capital (LTC) ratios for households and entrepreneurs, respectively. We then analyze the standard business cycle moments as well as the moments of the credit variables in Turkey.

We show that the two types of credit affect the business cycles through different channels. Household credit expansions, modeled as an increase in the LTI ratio, lower the responses of labor supply and output for both shocks. As a result, labor supply and output volatilities decrease. While output becomes less volatile, the consumption-to-output volatility increases. This result is consistent with the empirical evidence that an increase in financial integration, which is measured by increased access to foreign borrowing, has differential effects on output and consumption volatility.[1] The difference in the dynamics of the model for different levels of household borrowing is mainly due to the interaction between the labor supply and the credit constraint. Since the borrowing capacity of the household is tied to labor income, the borrowing constraint introduces a new channel, and changes in credit access affect the labor supply decision. Business credit expansions, on the other hand, mainly increase investment. Both types of credit affect the trade balance dynamics and credit expansions deteriorate the trade balance.

Our model is successful at generating the business cycle properties of the data for Turkey. In particular, it generates a strongly countercyclical trade balance, which is a feature of emerging market economies that is hard to match in real business cycle (RBC) models. The model also matches the positive correlations of household and business credit expansions with output, and their negative correlations with the trade balance. In the data, household credit expansions are more positively correlated with output and more negatively correlated with the trade balance compared to business credit expansions. The model successfully matches this order as well. The consumption volatility generated by the model is also closer to the data and higher than the version of the model without any credit constraints.

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[1]See Kose et al. (2003) for the effects of financial integration on output and consumption volatility.

2 The Model

We use a small open economy model inhabited by two types of agents: households and entrepreneurs. Both types of agents have access to international financial markets, but face constraints on their borrowing. Entrepreneurs produce a tradable home good using capital and labor. Labor services are provided by households, while capital is held by entrepreneurs. Building new capital requires an investment good, which is a composite of the home good and a foreign good. The foreign good is imported from abroad to be used in investment by entrepreneurs, and it is also used as a consumption good by households.

2.1 Households

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

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

where $\beta^h \in (0,1)$ is the discount factor, c_t^h is consumption, 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 home and foreign goods:

$$c_t^h = (c_{t,H}^h)^{\nu} (c_{t,F}^h)^{1-\nu}, \quad 0 < v < 1 \tag{2}$$

where $c_{t,H}^h$ is the consumption of the home good and $c_{t,F}^h$ is the consumption of the foreign good at time t.

The budget constraint of households is given by

$$c_{t,H}^h + p_t c_{t,F}^h + R_{t-1} b_{t-1}^h = b_t^h + w_t l_t, \tag{3}$$

where b_t^h denotes the amount borrowed at time t, $R_t = (1+r_t)$ is the gross interest rate and r_t is the net real interest rate, p_t is the price of foreign goods relative to home goods, i.e. the terms of trade, and w_t is the wage rate. The relative price of foreign goods is modeled as an exogenous stochastic process.

Households face a credit constraint in every period and they can only borrow up to a fraction of their current income. As in Ludvigson (1997), 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 some observable measure of the borrower's financial health. The credit constraint of households is of the form

$$b_t^h \le m^h w_t l_t. \tag{4}$$

In the calibration of the model, β^h is chosen such that $\beta^h < 1/(1 + \bar{r})$, where $\bar{r}$ is the steady-state real interest rate. This condition guarantees that the credit constraint is binding in and around the steady state.[2]

Maximizing the objective function subject to the budget and credit constraints yields the following first order conditions:

$$\left(c_t^h - \psi l_t^\eta\right)^{-\sigma} \left(\frac{\partial c_t^h}{\partial c_{t,H}^h}\right) = \beta^h E_t \left[R_t \left(c_{t+1}^h - \psi l_{t+1}^\eta\right)^{-\sigma} \left(\frac{\partial c_{t+1}^h}{\partial c_{t+1,H}^h}\right) \right] + \lambda_t^h, \tag{5}$$

$$\left(c_t^h - \psi l_t^\eta\right)^{-\sigma} \psi \eta l_t^{\eta-1} = w_t \left[\left(c_t^h - \psi l_t^\eta\right)^{-\sigma} \left(\frac{\partial c_t^h}{\partial c_{t,H}^h}\right) + \lambda_t^h m^h \right], \tag{6}$$

$$p_t = \left(\frac{1-v}{v}\right) \left(\frac{c_{t,H}^h}{c_{t,F}^h}\right), \tag{7}$$

where

$$\frac{\partial c_t^h}{\partial c_{t,H}^h} = v \left(\frac{c_{t,F}^h}{c_{t,H}^h}\right)^{1-\nu}. \tag{8}$$

These equations differ from the first order conditions of the household's problem in a standard small open economy RBC model because of the presence of the borrowing constraint: In equation (5) the Lagrange multiplier, λ_t^h, represents the increase in lifetime utility that would arise from relaxing the borrowing constraint at time t, in equation (6)

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[2] Iacoviello (2005) argues that, with a concave objective function, the precautionary saving motive of households and entrepreneurs might outweigh impatience. In that case, agents might not hit the borrowing limit after a sufficiently long run of positive shocks. Here, we take as given that credit constraints on agents are so tight that it takes very high risk aversion coupled with very high volatility to have precautionary behavior. See Iacoviello (2005) Appendix C for a detailed discussion on binding credit constraints.

the credit constraint increases the return to labor by $w_t \lambda_t^h m^h$, since credit availability is tied to the income of the household.

2.2   Entrepreneurs

Entrepreneurs produce a tradable home good, combining households' labor services with capital. Output is produced by a Cobb-Douglas technology:

$$y_t = e^{A_t} k_{t-1}^{\mu} l_t^{1-\mu}, \tag{9}$$

where A_t is an exogenous stochastic productivity shock. As households, entrepreneurs are also restricted in their borrowing due to enforceability problems. Following Kiyotaki and Moore (1997), we assume that the entrepreneur's borrowing can not exceed a fraction of the collateral assets, which is the capital holdings in our model:

$$b_t^e \leq m^e p_t^I k_t. \tag{10}$$

Since borrowing is done in units of the home good, the value of capital is converted to home-good units by multiplying with p_t^I, the price of capital in terms of home goods, which is explained below.

The capital accumulation decision is made by the entrepreneurs and building new capital requires an investment good, which is a composite of the home good and the foreign good. Investment goods are formed through a Cobb-Douglas aggregator given by

$$G(i_{t,H}, i_{t,F}) = i_{t,H}^{\omega} i_{t,F}^{1-\omega}, \tag{11}$$

where $i_{t,H}$ is the amount of home good used for investment, $i_{t,F}$ is the amount of imported foreign good used for investment, and ω is the share of the home good. In formulating the investment good as a composite of home and foreign goods, we follow De Bock (2010). Analyzing the composition of imports in 17 emerging market economies over the period 1980-2000, he shows that the share of capital goods in total imports is roughly one third, and also capital good imports constitute a sizable fraction of GDP (median share is about 7%).

Based on these observations, we follow his modeling strategy of formulating investment in new capital as a combination of home and foreign goods.

The capital accumulation equation is given by

$$i_t = k_t - (1 - \delta)k_{t-1}, \tag{12}$$

where $i_t = G(i_{t,H}, i_{t,F})$.

Since capital is a composite of home and foreign goods, its value in terms of the home good is measured by the investment price index p_t^I. The investment price index is defined as the minimum expenditure in terms of the home good required for one unit of investment, and it is given by

$$p_t^I = \left(\frac{1 - \omega}{\omega}\right)^\omega \frac{p_t^{1-\omega}}{1 - \omega}. \tag{13}$$

Formally, the entrepreneur's problem is to maximize her expected utility

$$E_0 \sum_{t=0}^{\infty} (\beta^e)^t \frac{(c_t^e)^{1-\sigma}}{1 - \sigma}$$

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

$$y_t + b_t^e = c_t^e + w_t l_t + R_{t-1} b_{t-1}^e + i_{t,H} + p_t i_{t,F}, \tag{14}$$

where b_t^e is entrepreneur's borrowing, and c_t^e is entrepreneur's consumption of the home good.

We assume that $\beta^e < 1/(1+\bar{r})$, where $\bar{r}$ is the steady-state real interest rate. In the presence of credit constraints, entrepreneurs can choose to postpone consumption and quickly accumulate enough capital so that the credit constraint becomes nonbinding. Essentially, one needs to make sure that entrepreneurial consumption occurs to such an extent that self-financing does not arise. For that matter, we assume that entrepreneurs discount the future heavily so that the credit constraint is binding in and around the steady state, as in the case of households.

The first-order conditions are:

$$(c_t^e)^{-\sigma} = \beta^e E_t \left[R_t \left(c_{t+1}^e \right)^{-\sigma} \right] + \lambda_t^e, \tag{15}$$

$$(c_t^e)^{-\sigma} \left(\frac{1}{\partial G / \partial i_{t,H}} \right) = \beta^e E_t \left[(c_{t+1}^e)^{-\sigma} \left(\mu \frac{y_{t+1}}{k_t} + \frac{(1-\delta)}{\partial G / \partial i_{t+1,H}} \right) \right] + \lambda_t^e m^e p_t^I, \tag{16}$$

$$w_t = (1-\mu) \left(\frac{y_t}{l_t} \right), \tag{17}$$

$$p_t = \left(\frac{1-\omega}{\omega} \right) \left(\frac{i_{t,H}}{i_{t,F}} \right), \tag{18}$$

where

$$\frac{\partial G}{\partial i_{t,H}} = \omega \left(\frac{i_{t,F}}{i_{t,H}} \right)^{1-\omega}. \tag{19}$$

Both the Euler and the capital demand equations differ from the usual formulations because of the presence of λ_t^e, the Lagrange multiplier on the credit constraint. Investing in new capital relaxes the borrowing constraint of the entrepreneur. Therefore, investment has an additional benefit $\lambda_t^e m^e p_t^I$ besides its usual benefit in terms of increased future production, as shown in equation (16). The Euler equation of the entrepreneur also has the term λ_t^e which is the increase in lifetime utility from relaxing the credit constraint, as seen in equation (15).

2.3   Equilibrium

Given initial conditions b_0^h, b_0^e and k_0, and the sequence of shocks to productivity and terms of trade, the competitive equilibrium is defined as a set of allocations and prices $\left\{ y_t, l_t, k_t, i_{t,H}, i_{t,F}, c_{t,H}^h, c_{t,F}^h, c_t^h, c_t^e, b_t^h, b_t^e, \lambda_t^e, \lambda_t^h, p_t^I, r_t, w_t \right\}$ such that (i) the allocations solve the problems of households and entrepreneurs at the equilibrium prices, (ii) factor markets clear, and (iii) the resource constraint holds:

$$c_{t,H}^h + c_t^e + p_t c_{t,F}^h + i_{t,H} + p_t i_{t,F} + tb_t = y_t \tag{20}$$

where the trade balance is defined as

$$tb_t = R_{t-1} \left(b_{t-1}^h + b_{t-1}^e \right) - \left(b_t^h + b_t^e \right). \tag{21}$$

3 Calibration

The model is solved using quarterly Turkish data for the period 1995-2009. 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 first set the discount factors of households and entrepreneurs. We follow Iacoviello (2005) and fix β^h at 0.95 and β^e at 0.98.[3] These values guarantee an impatience motive for households and entrepreneurs large enough that they are close to the borrowing limit, so that the credit constraints bind in and around the steady state.

The value of η, which determines the intertemporal elasticity of substitution in labor supply, is set to 1.6 following Neumeyer and Perri (2005) and Aguiar and Gopinath (2007). The coefficient of relative risk aversion is set to 2 and the labor's share of income is set to 0.7, both of which are standard values in business cycle studies. The share of home goods in the investment aggregator is set to 0.5 following De Bock (2010). Likewise the share of home goods in the consumption aggregator is set to 0.5. The annual depreciation rate is set to 0.08 following Meza and Quintin (2007). Using this value for the depreciation rate results in an average capital-output ratio of 2.01.

The value of ψ is set to 2.22 so that the steady state labor supply equals 0.18, which is the average value in Turkey of time spent working as a percentage of total discretionary time. The real interest rate is taken as constant and set equal to the average real interest rate in Turkey. The LTC ratio, m^e, is set to match the average value of the ratio of business credit to capital stock in Turkey for the sample period. Likewise, in equation (4), the LTI ratio, m^h, is set to match the average value of the ratio of household credit to labor income in the data.[4]

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[3] Iacoviello (2005) calibrates his model using the U.S. data. The discount rates for a small open economy can be different from these values. Unfortunately, the small open economy literature does not provide an estimate for the discount rates of credit constrained households. We test the sensitivity of our results for different values. The dynamics of the model remain the same.

[4] Throughout the text we use LTI ratio (LTC ratio) and m^h (m^e) interchangeably.

The stochastic processes used in the model are for total factor productivity and terms of trade. As mentioned before, construction of these series is explained in the Appendix. The process for the productivity shock is estimated using the Solow residual for Turkey as

$$A_t = \rho^A A_{t-1} + \varepsilon_t^A,$$

where ε_t^A is a normally distributed and serially uncorrelated innovation.

The terms of trade is defined as the ratio of import to export unit values as exports are selected as numeraire. It is characterized by the following law of motion

$$p_t = p \exp(\tilde{p}_t),$$

where p is normalized to one and the shocks are modeled as an AR(1) process

$$\tilde{p}_t = \rho^p \tilde{p}_{t-1} + \varepsilon_t^p,$$

where innovations ε_t^p are normally distributed and serially uncorrelated.

The parameter values of the shock processes and the other model parameters are summarized in Table 2.

In the next section we compare the impulse responses and the business cycle statistics of our benchmark model with those of an unconstrained version of the model. In the unconstrained model, households and firms do not face any constraints on their borrowing. There are also some minor differences between the two models. In the unconstrained model, capital adjustment costs are used to reduce the excessive volatility of investment, as in a standard small open economy RBC model. The adjustment cost parameter is set to match the volatility of investment relative to the volatility of output. Also, the model is solved under the assumption that households and entrepreneurs face portfolio adjustment costs, as in Schmitt-Grohe and Uribe (2003), in order to induce stationarity. Another difference between the two models is that the discount factors have to be set equal to the inverse of the steady state interest rate, i.e. $\beta^h = \beta^e = 1/(1 + \bar{r})$, in the unconstrained model, which is the only value consistent with zero long-run consumption growth. The unconstrained

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model is described in the Appendix. Other than these differences, the two models are solved using the same parameters.

Table 2. Parameter values of the benchmark model

Parameter	Value	Description
β^h	0.95	Discount factor of households
β^e	0.98	Discount factor of entrepreneurs
σ	2	Relative risk aversion coefficient
η	1.6	Labor curvature
ψ	2.22	Labor weight in utility
μ	0.30	Capital's share of income
δ	0.08	Annual depreciation rate
υ	0.5	Share of home goods in consumption
ω	0.5	Share of home goods in investment
$\bar{r}$	0.015	Real interest rate
m^h	0.26	Loan to income ratio
m^e	0.056	Loan to capital ratio
Stochastic processes		
ρ^A	0.88	$\sigma(\varepsilon^A)$ 0.0215
ρ^p	0.76	$\sigma(\varepsilon^p)$ 0.0175

4 Results

4.1 The Mechanism

4.1.1 Productivity Shock

Figure 1 shows the response of the economy to a productivity shock for three different levels of the LTI ratio: $m^h = 0, 0.26, 0.4$. One observation that stands out is that as m^h increases, the response of the labor supply declines. When there is no borrowing ($m^h = 0$), labor supply increases by 2.5 percent. As we increase m^h to 0.26, labor supply increases by 0.9 percent and more surprisingly when m^h is 0.4, the contemporaneous response of the labor supply is almost zero.

In the existence of a credit constraint, equation (6) differs from the usual formulations because of the additional term $w_t \lambda_t^h m^h$, which represents the additional benefit of labor supply. Since an increase in labor supply relaxes the credit constraint and allows the constrained households to borrow and consume more, labor supply has an additional benefit in this context. As productivity increases, an increase in w_t raises the marginal benefit of labor through this channel as well. However, changes in the Lagrange multiplier, λ_t^h, also affect this term and the labor supply decision. For different levels of credit access, the Lagrange multiplier responds differently to a productivity shock which leads to the differential response of the labor supply. The effect of the Lagrange multiplier on labor supply can be more clearly understood from the log-linearized version of equation (6):

$$\kappa_1 \hat{l}_t = \hat{w}_t + \kappa_2 \left(\hat{c}_{t,H}^h - \hat{c}_{t,F}^h \right) + \kappa_3 \hat{\lambda}_t^h + \kappa_4 \hat{c}_t^h, \tag{22}$$

where $\kappa_1, \kappa_2 > 0, \kappa_3, \kappa_4 \geq 0$, and hatted variables denote percentage deviations from their steady-state values. The exact forms of these parameters are given in the Appendix.

The Lagrange multiplier, which is the increase in lifetime utility that would stem from borrowing, declines after a positive productivity shock due to diminishing marginal utility, i.e. $\hat{\lambda}_t^h < 0$. As households have higher access to credit, the decline in λ_t^h gets bigger. For $m^h = 0$, this term does not affect the labor supply decision as $\kappa_3 = 0$. For positive values of m^h, on the other hand, the decline in λ_t^h reduces the labor supply and leads to a lower response of labor supply for higher levels of m^h. While contemporaneously labor supply movement is muted when $m^h = 0.4$, the following period it increases since the effect of the positive productivity shock fades away, the credit constraint gets tighter, and the Lagrange multiplier goes back up.[5]

The response of the labor supply also determines the behavior of output. As m^h increases, output increases less as a result of lower labor supply. The difference in the response of output is however more subtle, as output increases not only due to higher labor supply but also directly through higher productivity. Consumption increases with increasing income after the productivity shock. While the path of consumption is exactly the same as

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[5]The response of labor supply to an increase in the LTI ratio is consistent with the findings of Campbell and Hercowitz (2005). In a closed economy framework, they show that the relaxation of collateral constraints reduces the labor supply reaction to wage movements.

the path of output in the no-borrowing case, when borrowing is positive it increases more in the initial period compared to the hump-shaped response of output. Since the productivity shock raises the credit availability, consumption increases more right after the shock due to higher borrowing, and then slowly declines. Investment mimics the response of output as the marginal product of capital determines the entrepreneur's investment decision. Trade balance is another variable whose response to a productivity shock displays large variation depending on different levels of the LTI ratio. When there is no borrowing by households, despite the increase in consumption and investment, trade balance declines only marginally. This is due to the large increase in output which is almost as large as the total increase in consumption and investment. With increasing m^h, trade deficit deteriorates as output increases less relative to the consumption.
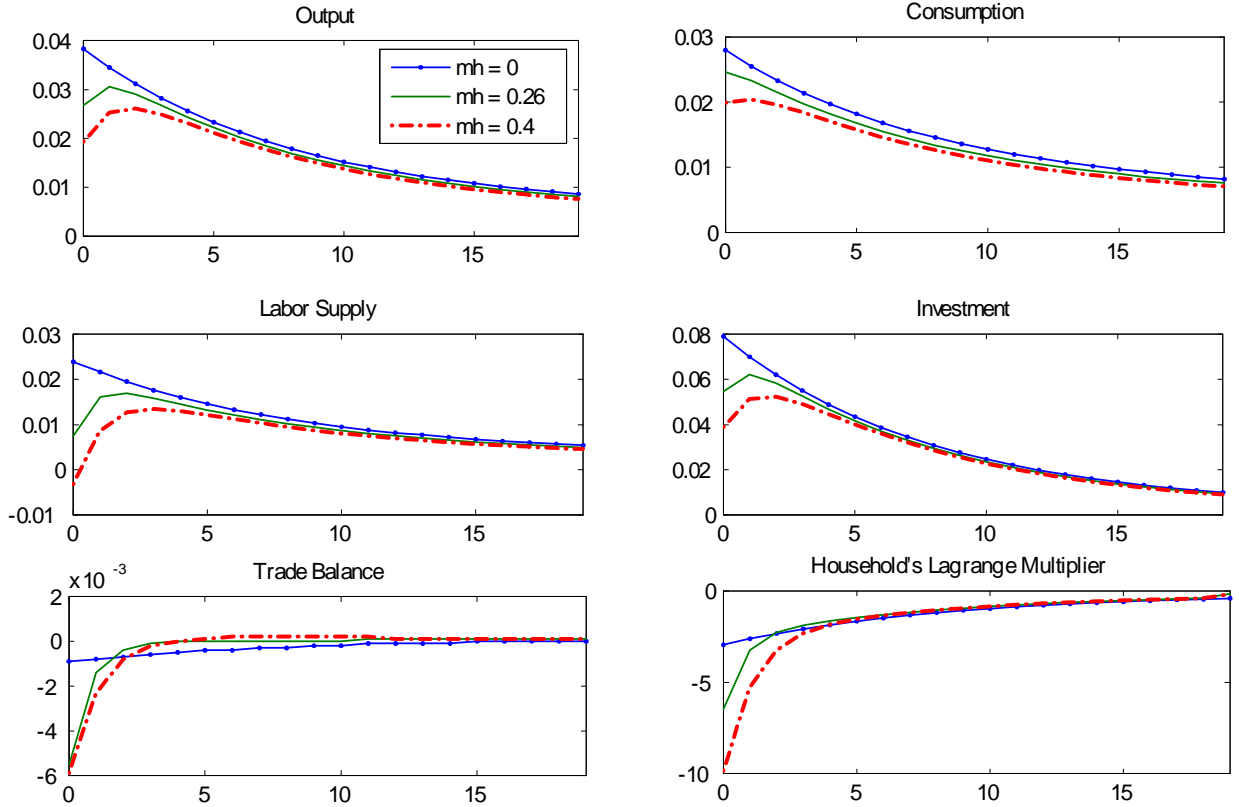

Figure 1. The response of the economy to a one standard deviation increase in productivity for different levels of LTI ratio

Figure 2 shows the impulse response functions to a positive productivity shock for different values of m^e. Compared to m^h, changes in m^e have minor effects on the variables.

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The two variables where the value of m^e matters are investment and trade balance. As expected, an increase in m^e relaxes entrepreneur's credit constraint which allows them to invest more. Entrepreneurs choose to invest the additional borrowing since a positive productivity shock increases the return to capital. Following the response of investment, the trade balance deteriorates more for higher values of m^e. The responses of the other variables remain the same for different values of m^e.
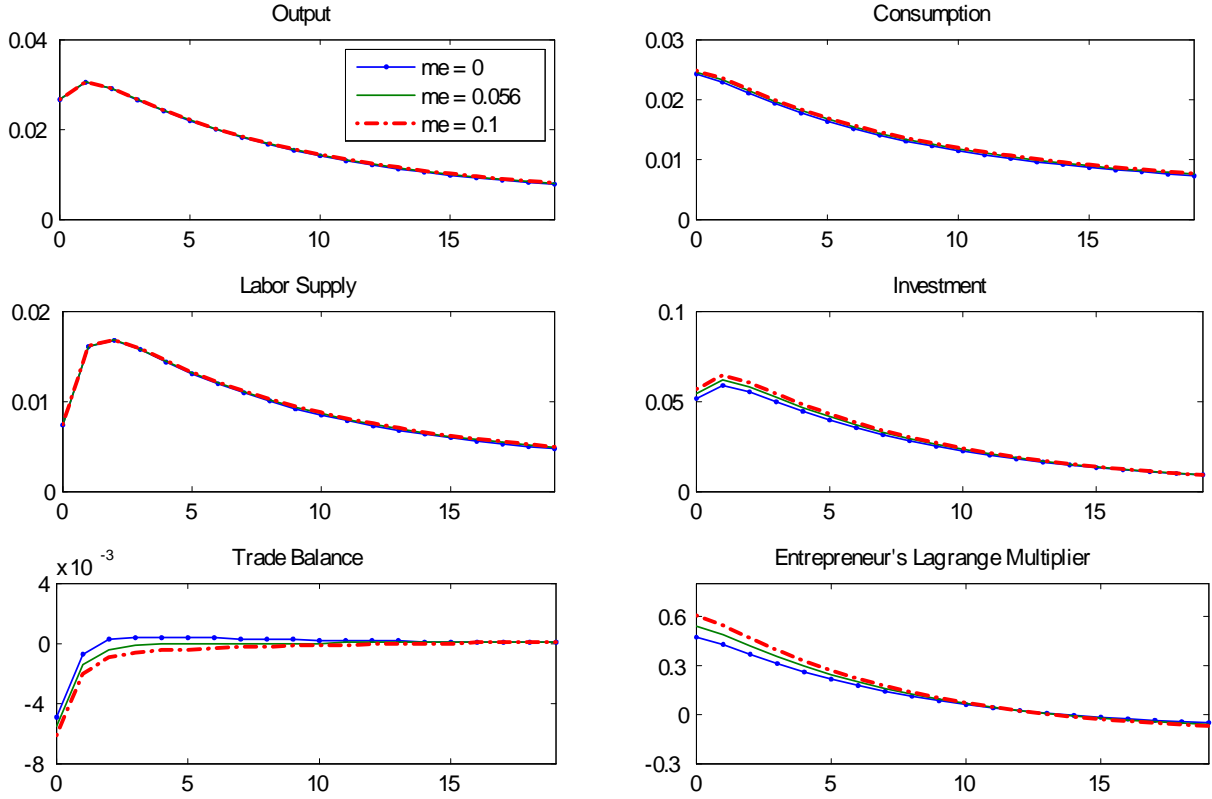

Figure 2. The response of the economy to a one standard deviation increase in productivity for different levels of LTC ratio

We find it instructive to compare the responses of the benchmark model to those of an unconstrained model where households and businesses do not face any credit constraints.[6] The labor supply increases more in the unconstrained model since there is no negative effect that the credit constraint causes. The response of output again mimics the response of labor supply. In the unconstrained model, consumption increases less compared to the benchmark model. After a positive productivity shock, households in this model increase

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[6]See the Appendix for the details of the unconstrained model.

their consumption at a rate lower than the constrained households as consumption of constrained households is determined by their income and borrowing limit. Unconstrained households, on the other hand, are able to optimize their consumption at all times. Investment increases more contemporaneously in the unconstrained model. However, investment level in the constrained case stays higher due to the positive multiplier on the borrowing constraint. The trade balance improves after a productivity shock in the unconstrained model whereas it deteriorates in the benchmark model. As output increases more and consumption increases less in the unconstrained model, trade balance increases after a positive productivity shock.
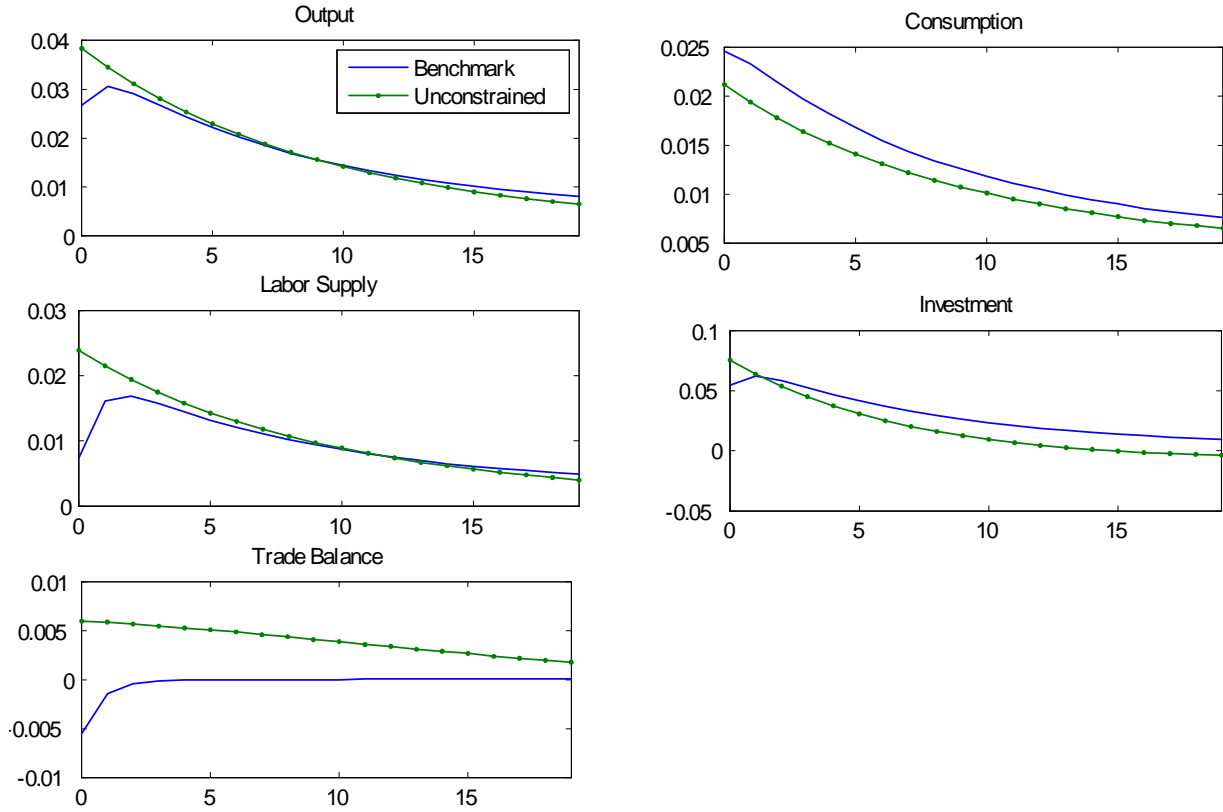

Figure 3. The response of the unconstrained economy to a one standard deviation increase in productivity

4.1.2 Terms of Trade Shock

In this section we repeat the last section's analysis for a terms of trade shock. As in the case of a productivity shock, the dynamics of the model change as we change the LTI ratio. As Figure 4 shows, an increase in the terms of trade, p_t, makes the foreign good more

expensive relative to the home good. This reduces the purchasing power of the real wage, since the real wage is in terms of the home good. Therefore, households reduce their labor supply, which leads to a decline in output. For higher levels of m^h labor supply and output decline less after the shock, which is due to the response of the Lagrange multiplier. For higher values of the LTI ratio, the Lagrange multiplier increases more after a terms of trade shock. For a given decrease in labor supply after the shock, credit availability declines more for higher values of m^h. Therefore, the constraint becomes more binding compared to its initial level and its cost increases more for higher m^h.
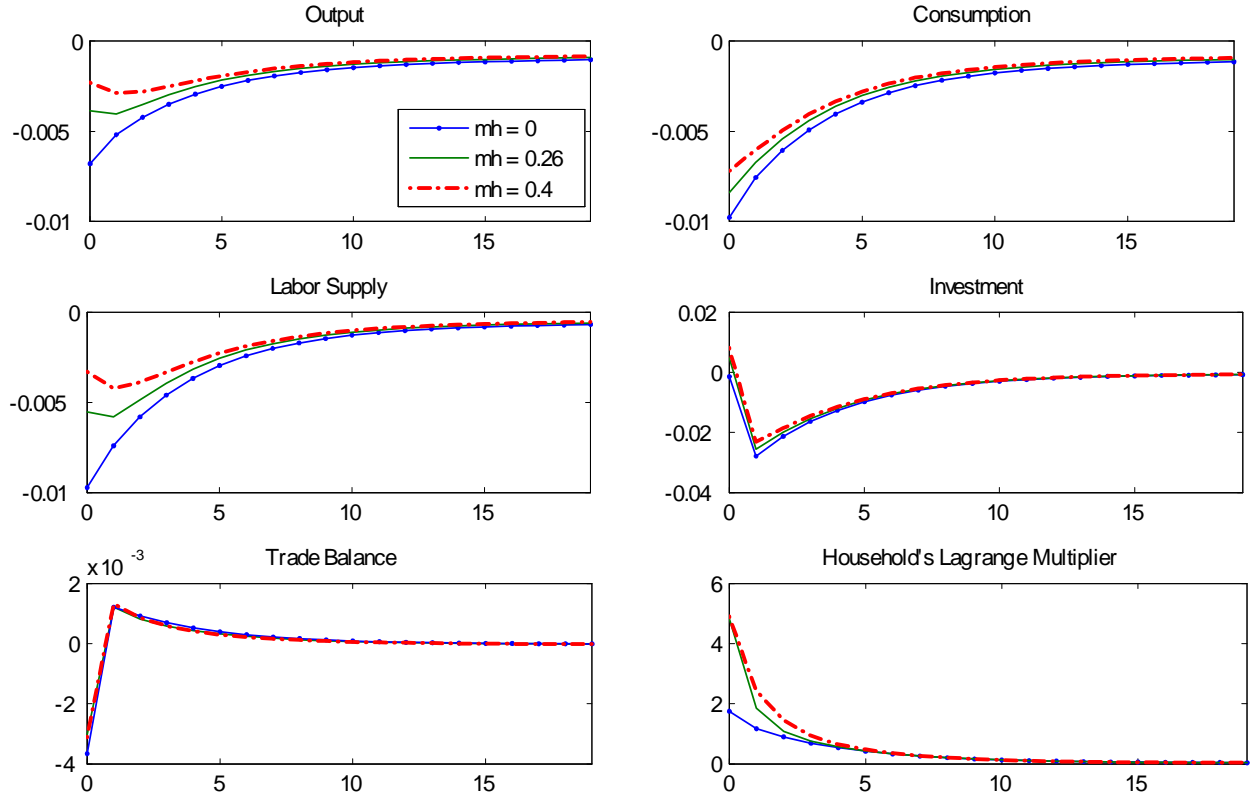

Figure 4. The response of the economy to a one standard deviation increase in the price of the foreign good relative to the home good for different levels of LTI ratio

Consumption also decreases with a terms of trade shock as both income declines and relative cost of consumption increases. The decline in consumption is again larger for lower values of m^h. Since investment is also a composite good, its cost increases as well, which has a negative effect on investment. However, the value of the firm's capital stock in terms of the home good increases with an increase in p_t, which relaxes the borrowing constraint

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of the entrepreneur and increases investment. These two effects and the decline in labor supply, which affects the productivity of capital, determine the response of investment. Since labor supply responds differently for different values of m^h, investment response slightly changes depending on m^h as well. The response of investment is higher for higher values of m^h, as labor supply and consequently productivity of capital decline less. Trade balance deteriorates contemporaneously and increases one period after the shock. The response of the trade balance depends on the difference between output and spending as well as the price of the foreign good. The dynamics of these variables turn out to be such that the response of the trade balance is the same for all levels of m^h.
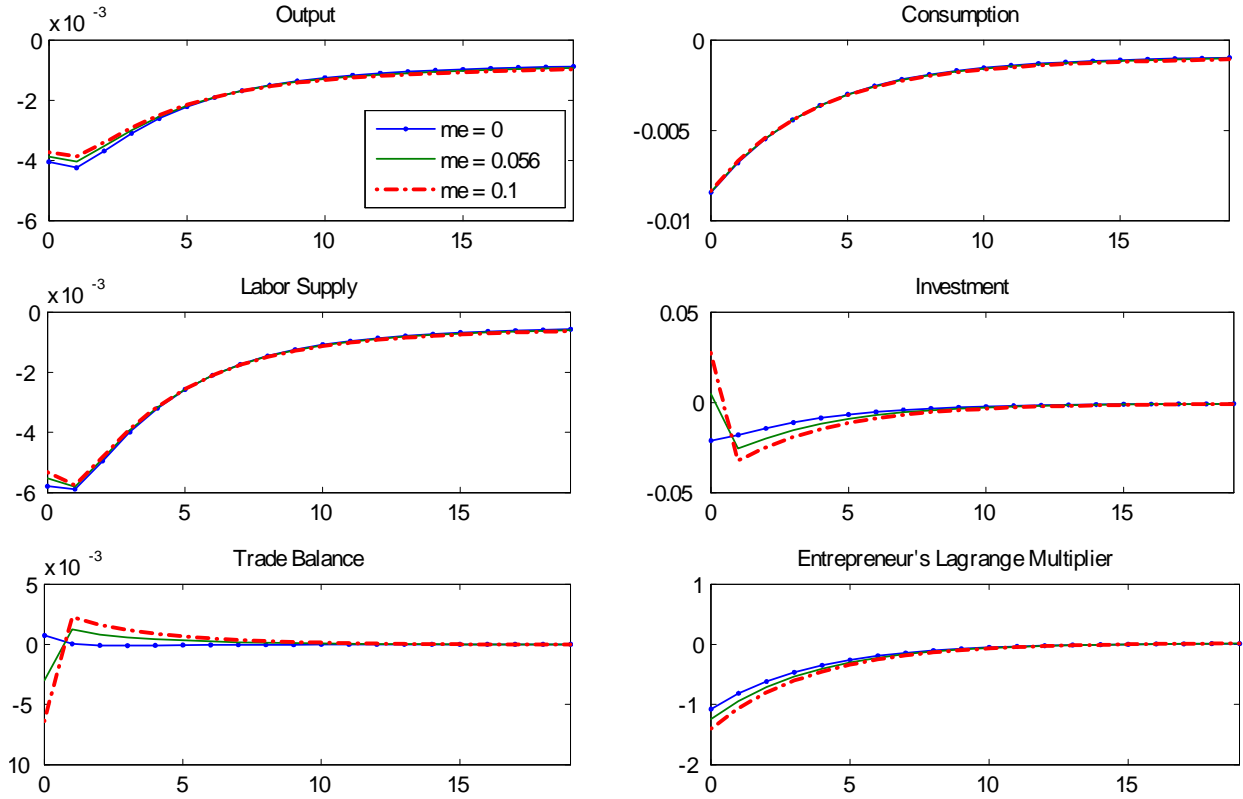

Figure 5. The response of the economy to a one standard deviation increase in the price of the foreign good relative to the home good for different levels of LTC ratio

For the entrepreneurs, as in the case of a productivity shock, changing the level of the LTC ratio affects investment, and therefore the trade balance. In Figure 5, when m^e is zero, investment declines contemporaneously as the cost of investment increases and the productivity of capital declines due to decreasing labor supply. However, when there is

borrowing, the value of the capital stock goes up as the terms of trade increases, and firms can borrow and invest more. Therefore, the response at the time of the shock is either zero ($m^e = 0.056$) or positive, increasing with the value of m^e. However, next period investment drops for positive values of m^e as the reduction of labor supply reduces the productivity of capital and this effect dominates the loosening of the credit constraint. Since the other variables do not change much for different values of m^e, the response of investment determines the response of the trade balance.
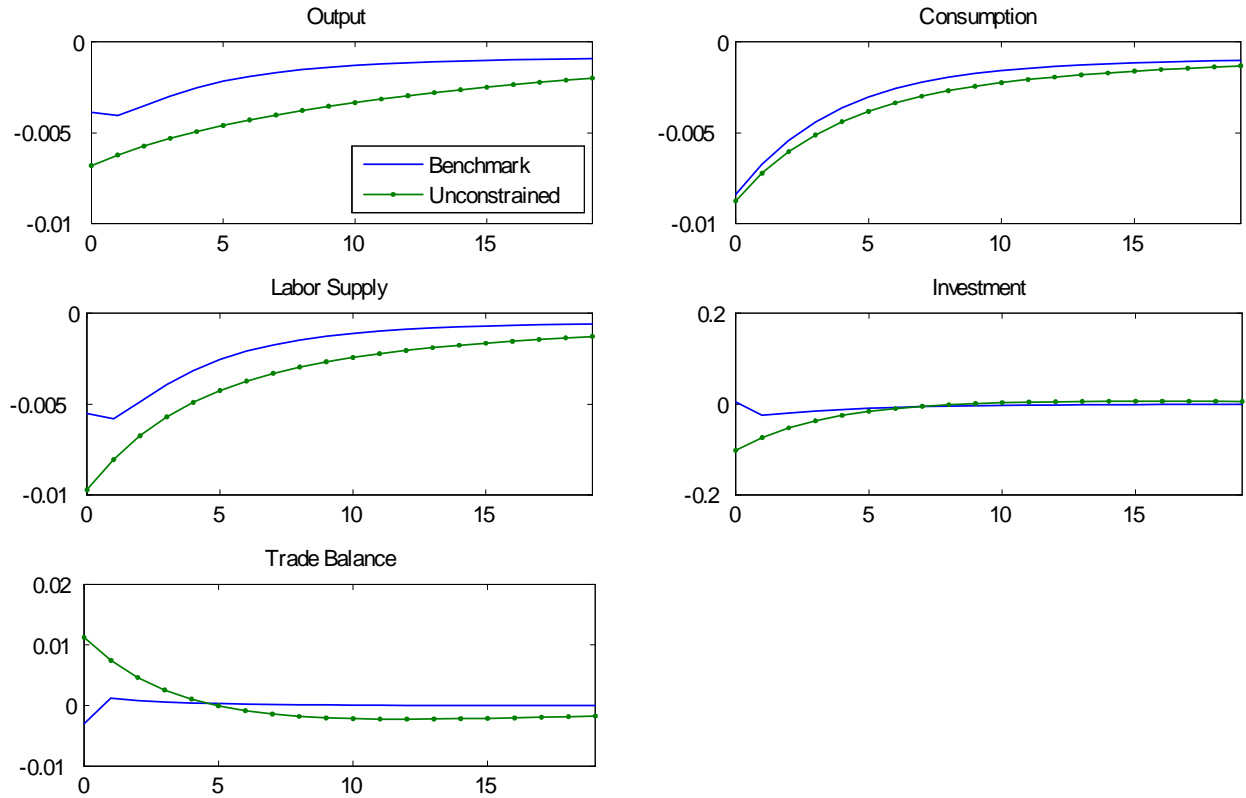
Figure 6. The response of the unconstrained economy to a one standard deviation increase in the price of the foreign good relative to the home good

As in the case of a productivity shock, the unconstrained version of the model shows different dynamics than the benchmark model after a terms of trade shock. More specifically, labor supply declines more since the households in this model do not face any credit constraints and therefore, labor income does not provide the additional benefit of relaxing the credit constraint. Consequently, output and consumption decline more. Because the credit constraint of the firm is tied to capital, an increase in the terms of trade relaxes the

constraint, which leads the firm to borrow more. Since the unconstrained model does not have that channel and also the decline in labor is larger, the terms of trade shock leads to a bigger decline in investment. As the decline in investment and consumption outweighs the decline in output, trade balance improves in the unconstrained model.

4.2   Business Cycle Properties

4.2.1   The Benchmark Model

We examine the ability of the model to match the main characteristics of business cycles observed in Turkey in the period 1995-2009. 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. To understand the role of credit constraints in the quantitative predictions of the model, the statistics from the unconstrained model are also reported.

Business cycle properties of Turkey conform with the properties observed in other emerging market economies as documented by Neumeyer and Perri (2005) and Aguiar and Gopinath (2007), among others. In particular, the volatility of consumption is higher than output, investment is about three times more volatile than output, and the ratio of trade balance to output is strongly countercyclical. The volatility of labor supply is quite low compared to output, and its correlation with output is also lower than the correlations of consumption and investment.

In the data, the changes in the household credit and the business credit relative to output are both procyclical, and the correlation of household credit with output is higher. This shows that credit expansions for both types of credit occur in periods of high output, and household credit responds more strongly to cyclical fluctuations. The correlations of changes in household credit and business credit with the trade balance are negative. Credit expansion, whether it is household credit or business credit, leads to an increase in imports as imported goods are used both by consumers and as inputs by firms. Also, household credit has a much higher correlation than business credit.

The model replicates most of the features of the data quite successfully. The volatility of output and the correlations generated by the model are quite close to the data. In

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particular, the model generates a strongly countercyclical trade balance, which is hard to generate in standard small open economy RBC models. The model also generates procyclical consumption, investment and labor supply, even though the correlation of labor supply is higher than the data. The correlations of the changes in credit with output are positive for both types of credit, and household credit is more strongly procyclical as in the data. However, the correlations generated by the model are somewhat lower than the data. The model matches the negative correlation of the household and business credit changes with the trade balance, and the ordering of the correlations are again in the same direction as the data.

Table 3. Business cycle properties

	Standard Deviations				Correlations		
	Data	Model	Unconstrained model		Data	Model	Unconstrained model
$\sigma(Y)$	3.78	4.13	4.95	$\rho(C,Y)$	0.81	0.97	0.98
$\sigma(C)/\sigma(Y)$	1.13	0.81	0.58	$\rho(I,Y)$	0.91	0.96	0.72
$\sigma(I)/\sigma(Y)$	3.13	2.19	3.13	$\rho(L,Y)$	0.58	0.92	0.98
$\sigma(L)/\sigma(Y)$	0.53	0.56	0.66	$\rho(\frac{TB}{Y},Y)$	-0.69	-0.39	0.37
$\sigma(\frac{TB}{Y})$	1.78	0.64	1.61	$\rho(\frac{\Delta HC}{Y},Y)$	0.58	0.33	-0.99
$\sigma(\frac{\Delta HC}{Y})$	1.17	0.49	1.14	$\rho(\frac{\Delta BC}{Y},Y)$	0.37	0.15	0.30
$\sigma(\frac{\Delta BC}{Y})$	2.96	0.41	1.68	$\rho(\frac{\Delta HC}{Y},\frac{TB}{Y})$	-0.67	-0.75	-0.28
				$\rho(\frac{\Delta BC}{Y},\frac{TB}{Y})$	-0.34	-0.60	-0.77

Note: Trade balance (TB) is exports minus imports. Change in household credit (ΔHC) is $HC_t - HC_{t-1}$, change in business credit (ΔBC) is $BC_t - BC_{t-1}$. GDP (Y), consumption (C), investment (I), and labor (L) are in logarithms. All series are HP filtered.

The volatilities generated by the model are somewhat lower than the data, except for the volatility of output. As widely documented in the literature, consumption is more volatile than output in emerging market economies. Standard RBC models cannot generate this property, and the simulation results of our model are in line with the other studies. The model generates an investment volatility lower than the data as well. Since capital

accumulation is restricted in our model by the credit constraint of entrepreneurs, investment volatility turns out to be lower than the data. The volatilities of the changes in the two types of credit and the trade balance are also lower in the model than in the data. Since borrowing in the model is restricted by credit constraints for both households and firms, the only sources of volatility for borrowing are changes in output for households and changes in the capital stock for firms. In reality, changing conditions in international financial markets as well as variations in domestic macroeconomic conditions affect credit availability and cause fluctuations in access to borrowing, which are not captured by this model. Another reason for the discrepancy with the data is that all agents in the model are restricted in their borrowing, whereas part of the volatility in the data is due to different types of agents having different levels of access to credit. Since we are representing the economy by two types of agents, we can match only a fraction of the actual volatility.

To understand the effects of credit constraints on the business cycle predictions of the model, we compare the business cycle statistics from the benchmark model with the unconstrained version of the same model. The model without borrowing constraints behaves quite differently than our benchmark model. In the unconstrained model, the volatilities of the variables, other than consumption, are higher than the constrained model as expected. Output volatility increases while consumption is much smoother than the benchmark model and the data. Since agents are not constrained in their borrowing, they are able to smooth consumption better. Investment volatility matches the data since we set the capital adjustment cost parameter to match this statistic. The volatilities of the trade balance and the changes in credit are higher than the benchmark model and closer to the data. The agents in this model do not face any constraints on their borrowing and the consumption smoothing motive leads to a higher variation in household credit compared to the constrained model, while it leads to smoother consumption. Matching the investment volatility raises the volatility of business credit as well, since firms use business credit for investing in new capital. Higher volatility in both business and household credit is also reflected in higher volatility of the trade balance.

In terms of the correlations, the unconstrained model is again quite different from the benchmark model, and some of the correlations are at odds with the data. The trade balance-output correlation is strongly positive and the correlation of household credit

change with output is strongly negative, while the trade balance is countercyclical and the household credit change is procyclical in the data. When households are unconstrained in their borrowing, they borrow more in low output episodes to smooth consumption, and this leads to a procyclical trade balance and a countercyclical credit expansion. The unconstrained model also generates a more negative correlation between business credit and trade balance compared to the correlation of household credit and trade balance, which is in contrast with the data. Overall, these results show that introducing credit constraints to the model improves the match between the data and the model on several fronts, and especially helps to generate correlations that are consistent with the data.

4.2.2 Credit Expansions

Table 4 presents the business cycle statistics for different levels of m^h and m^e.[7] Higher levels of m^h decreases the volatility of labor supply as higher credit access of households weakens the response of labor supply to wage changes. Lower labor supply volatility leads to a decline in output volatility. On the other hand, consumption volatility increases as households have higher access to credit. Since households have binding credit constraints, they cannot borrow and increase consumption as much as they want with an increase in income. As credit availability increases, their consumption fluctuates more since they can increase consumption more with an increase in income. These results are consistent with the empirical findings of Kose et al. (2003) regarding the effects of increased financial integration on macroeconomic volatility. They show that in developing countries the volatility of output growth decreased in the 1990s while financial integration increased substantially. They also show that financial integration is associated with an increase in the ratio of consumption volatility to income volatility. Our model provides a transmission mechanism to explain these empirical findings by focusing on the interaction between household credit and labor supply dynamics. Changing the credit access level of firms, on the other hand, does not affect the volatilities of output, consumption and labor. One volatility that is affected by changes in m^e is the volatility of investment. As firms can borrow more with higher levels of m^e, their investment levels change more depending on the shocks hitting the economy.

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[7] We only present the statictics that are responsive to changes in the LTI and LTC ratios.

The volatility of the trade balance increases as both m^h and m^e increase. Likewise the volatility of the change in household credit relative to output increases with m^h, and the volatility of the change in business credit relative to output increases with m^e. Since the credit access of the agents increase with these two parameters, their borrowing levels fluctuate more with the cycle, which leads to higher volatilities of these variables.

Table 4. Business cycle properties for different levels of m^h and m^e

	$m^h=0$	$m^h=0.26$	$m^h=0.4$	$m^e=0$	$m^e=0.056$	$m^e=0.1$
		(Benchmark)			(Benchmark)	
$\sigma(Y)$	4.90	4.13	3.54	4.14	4.13	4.13
$\sigma(C)/\sigma(Y)$	0.76	0.81	0.83	0.80	0.81	0.82
$\sigma(I)/\sigma(Y)$	2.15	2.19	2.22	2.04	2.19	2.47
$\sigma(L)/\sigma(Y)$	0.66	0.56	0.56	0.56	0.56	0.56
$\sigma(\frac{TB}{Y})$	0.42	0.64	0.70	0.50	0.64	0.92
$\sigma(\frac{\Delta HC}{Y})$	-	0.49	0.56	0.49	0.49	0.49
$\sigma(\frac{\Delta BC}{Y})$	0.41	0.41	0.41	-	0.41	0.78
$\rho(\frac{TB}{Y},Y)$	-0.21	-0.39	-0.35	-0.33	-0.39	-0.35
$\rho(\frac{\Delta HC}{Y},\frac{TB}{Y})$		-0.75	-0.80	-1.00	-0.75	-0.50
$\rho(\frac{\Delta BC}{Y},\frac{TB}{Y})$	-1.00	-0.60	-0.56	-	-0.60	-0.83

Note: Trade balance (TB) is exports minus imports. Change in household credit (ΔHC) is $HC_t - HC_{t-1}$, change in business credit (ΔBC) is $BC_t - BC_{t-1}$. GDP (Y), consumption (C), investment (I), and labor (L) are in logarithms. All series are HP filtered.

As the LTI ratio increases, the negative correlation of the trade balance with the change in household credit increases. The increase in m^h, holding m^e constant, raises the share of household borrowing in total borrowing, and its correlation with the trade balance becomes stronger while the correlation of business credit gets weaker. The same pattern holds for business credit as well. As m^e increases, the change in business credit becomes more negatively correlated with trade balance. For $m^e = 0.1$, the order of household credit and business credit in terms of their correlations with the trade balance is actually reversed, since borrowing by firms dominates borrowing by households.

5   Sensitivity Analysis

We study the sensitivity of our results for two different specifications. First, we change the labor supply elasticity by setting $\eta = 2.2$, which is another value used in the literature for labor curvature. Second, we study the business cycle properties and impulse responses of our model using a Cobb-Douglas utility function rather than a GHH utility function.[8]

The main business cycle statistics for the sensitivity analysis are reported in Table 5. For $\eta = 2.2$ the results remain the same except for the volatilities of output and labor supply. A lower labor supply elasticity leads to a lower volatility of labor supply, which reduces the volatility of output as well.

Table 5. Sensitivity Analysis

	GHH, $\eta = 1.6$ (Benchmark)	GHH, $\eta = 2.2$	Cobb-Douglas
$\sigma(Y)$	4.13	3.73	2.55
$\sigma(C)/\sigma(Y)$	0.81	0.82	0.81
$\sigma(I)/\sigma(Y)$	2.19	2.20	2.32
$\sigma(L)/\sigma(Y)$	0.56	0.42	0.19
$\sigma(\frac{TB}{Y})$	0.64	0.65	0.55
$\sigma(\frac{\Delta HC}{Y})$	0.49	0.49	0.33
$\sigma(\frac{\Delta BC}{Y})$	0.41	0.41	0.41
$\rho(L,Y)$	0.96	0.94	-0.48
$\rho(\frac{TB}{Y},Y)$	-0.39	-0.40	-0.32
$\rho(\frac{\Delta HC}{Y},\frac{TB}{Y})$	-0.75	-0.76	-0.65
$\rho(\frac{\Delta BC}{Y},\frac{TB}{Y})$	-0.60	-0.61	-0.79

When we use a Cobb-Douglas utility function, the volatility of labor supply drops significantly, which also leads to a decline in output volatility. The only other statistic significantly affected by this specification is the correlation of labor supply with output. This correlation becomes negative as the response of labor supply to a productivity shock

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[8]In the Cobb-Douglas utility function $\frac{\left((c_t^h)^\alpha l_t^{1-\alpha}\right)^{1-\sigma}}{1-\sigma}$, the exponent of consumption, α, is set to match the steady state labor supply. Other parameters of the model remain the same.

is negative for this utility function, as illustrated in Figure 7 and explained below. Other properties remain mostly unchanged.

We also study the impulse responses after a productivity shock for the Cobb-Douglas utility function.[9] Figure 7 shows that, for a productivity shock, the model exhibits similar patterns as the version of the model with a GHH utility function. More specifically, output and investment increase less and trade balance decreases more for higher values of m^h. These differences are again driven by labor supply dynamics. Labor supply decreases in response to a productivity shock for positive values of the LTI ratio since the income effect and the effect of the decline in the Lagrange multiplier dominate the substitution effect. As m^h increases, labor supply decreases more as the decline in the Lagrange multiplier gets larger, and consequently output increases less as well.
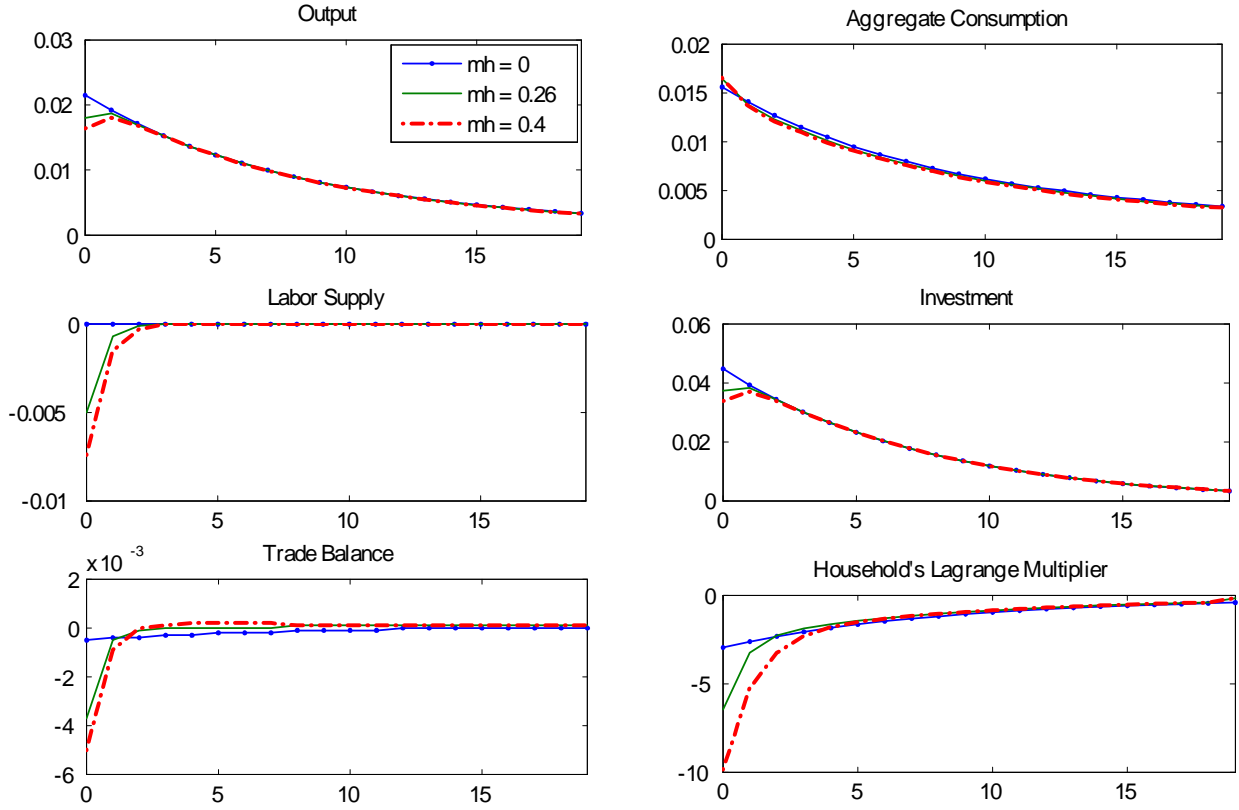

Figure 7. The response of the variables to a one standard deviation increase in productivity for a Cobb-Douglas utility function

[9]We only discuss the productivity shock for different levels of the LTI ratio because changes in the LTI ratio have negligible effects on the dynamics of the model for the terms of trade shock. The same is true for different levels of LTC for both types of shocks.

6 Concluding Remarks

This paper extends the small open economy literature on borrowing constraints by studying the differential effects of household and business credit constraints on business cycles. Household credit expansions affect the cycle through labor supply - higher credit access of households weakens the response of labor supply to changes in the wage rate. This in turn leads to a decline in output volatility. An increase in business borrowing, on the other hand, only affects investment and trade balance dynamics.

The paper uses an RBC model where there is one type of household and both households and entrepreneurs are borrowers. Abstracting from a heterogenous household setup with domestic savers has the advantage of using a production function with a single type of labor, which allows us to focus on the effects of credit expansions on the macroeconomy without creating a complex interplay between labor supply decisions of agents with different time preferences.

While our contribution has been to provide evidence in support of differentiating between household and business credit in studying the effects of credit expansions on business cycles, we plan to extend our research to incorporate the role of financial institutions where banks face exchange rate risks while intermediating the funds to credit constrained households and entrepreneurs. We believe that the interaction between credit constraints, real exchange rate dynamics and collateral type merits investigation.

References

Aghion, P., P. Bacchetta, and A. Banerjee, (2001). Currency Crises and Monetary Policy in an Economy with Credit Constraints. European Economic Review, 45, 1121-50.

Aghion, P., P. Bacchetta and A. Banerjee, (2004). Financial Development and the Instability of Open Economies. Journal of Monetary Economics, 51, 1077-1106.

Aguiar, M., and G. Gopinath, (2007). Emerging Market Business Cycles: The Cycle Is the Trend. Journal of Political Economy, 115 (1), 69-102.

Beck, T., B. Büyükkarabacak, F. Rioja, and N. Valev, (2008). Who Gets the Credit? Household vs. Firm Lending Across Countries. Policy Research Working Paper 4661, World Bank.

Bergoeing, R., P. J. Kehoe, T. J. Kehoe, and R. Soto, (2002). A Decade Lost and Found: Mexico and Chile in the 1980s. Review of Economic Dynamics, 5, 1, 166-205.

Büyükkarabacak, B., S. Krause, (2009). Studying the Effects of Household and Firm Credit on the Trade Balance: The Composition of Funds Matters. Economic Inquiry 47 (4), 653–666.

Büyükkarabacak, B., N. Valev, (2010). The Role of Household and Business Credit in Banking Crises. Journal of Banking and Finance 34, 1247-1256.

Caballero, R., and A. Krishnamurthy, (2001). International and Domestic Collateral Constraints in a Model of Emerging Market Crises. Journal of Monetary Economics 48, 513-548.

Campbell, J., and Z. Hercowitz., (2005). The Role of Collateralized Household Debt in Macroeconomic Stabilization. NBER Working Paper Series 11330.

Correia, I., J. C. Neves, and S. Rebelo, (1995). Business cycles in a small open economy. European Economic Review, 39, 6, 1089-1113.

De Bock, R., (2010). The Composition and Cyclical Behavior of Trade Flows in Emerging Economies. IMF Working Paper, No 1046.

Iacoviello, M., (2005). House Prices, Borrowing Constraints and Monetary Policy in the Business Cycle. The American Economic Review, 95, 739-764.

Kiyotaki, N. and J. Moore, (1997). Credit Cycles. Journal of Political Economy, 105(2), 211-48.

Kose, A., E. Prasad, and M. Terrones, (2003). Financial Integration and Macroeconomic Volatility, IMF Staff Papers, Vol. 50, Special Issue.

Mendoza, E., (1994). The Robustness of Macroeconomic Indicators of Capital Mobility, in Capital Mobility: The Impact on Consumption, Investment, and Growth, ed. by Leonardo Leiderman and Assaf Razin (Cambridge: Cambridge University Press), 83–111.

Mendoza, E., (2002). Credit, Prices, and Crashes: Business Cycles with a Sudden Stop, Chapter 7 of Preventing Currency Crises in Emerging Markets, in S. Edwards and J. Frankel, eds., University of Chicago Press, 335-389.

Meza, F. and Quintin, E., (2007). Factor Utilization and the Real Impact of Financial Crises. The B.E. Journal of Macroeconomics: Vol. 7: Iss. 1 (Advances), Article 33.

Neumeyer, P. and F. Perri, (2005). Business Cycles in Emerging Economies: The Role of Interest Rates. Journal of Monetary Economics, 61, 163-185.

Schneider, M. and A. Tornell, (2004). Balance Sheet Effects, Bailout Guarantees and Financial Crises. Review of Economic Studies, 1-31.

Schmitt-Grohé, S. and M. Uribe, (2003). Closing Small Open Economy Models. Journal of International Economics, 61, 163-185.

Uribe, M. and V. Z. Yue, (2006). Country Spreads and Emerging Countries: Who Drives Whom?. Journal of International Economics, 69, 6-36.

Young, A. (1995), The Tyranny of Numbers: Confronting the Statistical Realities of the East Asian Growth Experience, Quarterly Journal of Economics, 110, 3, 641-680.

Appendix

Log-linearized version of equation (6):

Log-linearizing equation (6) around the steady state gives the following equation where $\bar{x}$ denotes the steady-state value of the variable x_t and $\hat{x}_t$ denotes the log-deviation from its steady-state value:

$$\kappa_1 \hat{l}_t = \hat{w}_t + \kappa_2 \left(\hat{c}^h_{t,H} - \hat{c}^h_{t,F} \right) + \kappa_3 \hat{\lambda}^h_t + \kappa_4 \hat{c}^h_t,$$

where

$$
\begin{aligned}
\kappa_1 &= (\eta - 1) + \bar{w}\bar{\lambda}^h m^h \sigma \left(\bar{c}^h - \psi \bar{l}^\eta \right)^{\sigma - 1} \bar{l}, \\
\kappa_2 &= \frac{\bar{w}v(1-v)(\bar{c}^h_F/\bar{c}^h_H)^{(1-v)}}{\psi \eta \bar{l}^{\eta - 1}}, \\
\kappa_3 &= \frac{\bar{w}\bar{\lambda}^h m^h \left(\bar{c}^h - \psi \bar{l}^\eta \right)^\sigma}{\psi \eta \bar{l}^{\eta - 1}}, \\
\kappa_4 &= \frac{\bar{w}\bar{\lambda}^h m^h \sigma \left(\bar{c}^h - \psi \bar{l}^\eta \right)^{\sigma - 1} \bar{c}^h}{\psi \eta \bar{l}^{\eta - 1}}.
\end{aligned}
$$

The unconstrained model:

In the unconstrained model, households and entrepreneurs do not face any borrowing constraints. The budget constraint of the household changes as follows

$$c^h_{t,H} + p_t c^h_{t,F} + R_{t-1} b^h_{t-1} = b^h_t + w_t l_t - \frac{\phi_1}{2} (b^h_t - \bar{b}^h)^2. \tag{23}$$

Since the model is nonstationary, it is assumed that both households and entrepreneurs face portfolio adjustment costs in order to induce stationarity, as in Schmitt-Grohe and Uribe (2003). The parameter that determines the size of these costs, ϕ_1, is assumed to be the same for both agents. This parameter is set to the minimum value that guarantees that the equilibrium solution is stationary, as in Neumeyer and Perri (2005). In the portfolio adjustment cost functions $\bar{b}^h$ and $\bar{b}^e$ are the steady-state levels of household and firm credit, which are set to the same values as in the constrained model.

In this model, the first order conditions (5) and (6) from the household's problem change as follows

$$\left(c_t^h - \psi l_t^\eta\right)^{-\sigma} \left(\frac{\partial c_t^h}{\partial c_{t,H}^h}\right) \left[1 - \phi_1\left(b_t^h - \bar{b}^h\right)\right] = \beta^h E_t \left[R_t \left(c_{t+1}^h - \psi l_{t+1}^\eta\right)^{-\sigma} \left(\frac{\partial c_{t+1}^h}{\partial c_{t+1,H}^h}\right)\right] \quad (24)$$

$$\left(c_t^h - \psi l_t^\eta\right)^{-\sigma} \psi \eta l_t^{\eta-1} = w_t \left(c_t^h - \psi l_t^\eta\right)^{-\sigma} \left(\frac{\partial c_t^h}{\partial c_{t,H}^h}\right). \quad (25)$$

The entrepreneur faces the following budget constraint

$$y_t + b_t^e = c_t^e + w_t l_t + R_{t-1} b_{t-1}^e + i_{t,H} + p_t i_{t,F} + \frac{\phi_1}{2}(b_t^e - \bar{b}^e)^2 + \frac{\phi_2}{2}(k_t - k_{t-1})^2 \quad (26)$$

where the last term is the capital adjustment cost. Capital adjustment costs are necessary in small open economy models to prevent investment from being counterfactually volatile. The parameter ϕ_2 is set to 5.11 to match the relative volatility of investment.

In the unconstrained model, the first order conditions (15) and (16) of the entrepreneur change as follows

$$\left(c_t^e\right)^{-\sigma} \left[1 - \phi_1\left(b_t^e - \bar{b}^e\right)\right] = \beta^e E_t \left[R_t \left(c_{t+1}^e\right)^{-\sigma}\right] \quad (27)$$

$$\left(c_t^e\right)^{-\sigma} \left(\frac{1}{\partial G/\partial i_{t,H}} + \phi_2(k_t - k_{t-1})\right) = \beta^e E_t \left[\left(c_{t+1}^e\right)^{-\sigma} \left(\mu\frac{y_{t+1}}{k_t} + \frac{(1-\delta)}{\partial G/\partial i_{t+1,H}} + \phi_2(k_{t+1} - k_t)\right)\right] \quad (28)$$

Construction of the series used in the paper:

The nominal GDP, investment and consumption series are converted into real units by dividing the nominal series with the GDP deflator for constant 2005 prices.

Capital Stock: The capital stock is generated using a perpetual inventory method. The nominal investment series has been converted into 2005 prices and seasonally adjusted for constructing the 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 rate of investment in the first five years of the series is representative of the growth rate of investment in previous years.

Labor Input:

We calculate total hours worked by multiplying the average hours per worker with total employment. We use average hours per worker in the manufacturing sector, since there is no data that covers all sectors (Bergoeing et al. (2002) and Meza and Quintin (2007) also use manufacturing sector data). 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). We use this series as representative of average hours per worker in the economy as a whole, and multiply it by total employment to get total hours worked. We seasonally adjust this data and use it as the measure of total hours worked to calculate total factor productivity as explained below.

To calibrate the parameter that measures the disutility from working, ψ, we need a measure of total hours per capita. We divide the total hours worked data by the total working age population, which is 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 0.18.

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 where quarterly data is missing.

Total Factor Productivity: The data on TFP have been constructed as

$$A_t = \log(y_t) - \mu \log(k_t) - (1 - \mu) \log(l_t)$$

where y_t is GDP in 2005 prices, k_t is capital stock in 2005 prices and l_t is total hours worked. The TFP series is then linearly detrended and the residuals are used to estimate the AR(1) process for the productivity shock.

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), which is available starting in 1998. 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.

Terms of trade: The terms of trade is computed as the ratio of import unit values to export unit values.

Business Credit: We construct the real value of business credit in 2005 prices by dividing the business credit series with the GDP deflator. Since the credit constraint on firms takes the form

$$b_t^e \le m^e p_t^I k_t,$$

we calculate m^e as the average value of the real value of business credit divided by the capital stock, where both series are in units of 2005 prices.

Household Credit: The credit constraint on households takes the form

$$b_t^h \leq m^h \left(w_t l_t \right).$$

Therefore, we calculate m^h as the average value of the household credit divided by the labor share of total output, which is equal to $0.7 y_t$, for the value of μ used in the calibration of the model.

Data sources:

- GDP, GDP deflator, investment, consumption, trade balance, import and export unit values, U.S. Treasury bill rate: IFS

- Indexes of total hours worked and total employment in manufacturing: OECD

- Total employment and total working age population: Turkish Statistical Institute

- Household credit (consumer credit, individual credit cards, and loans to personnel) and business credit (credit to non-financial companies and individual corporations): Central Bank of Turkey.