IDB WORKING PAPER SERIES No. IDB-WP-548

Macroeconomic Effects of Credit Deepening in Latin America

Carlos Carvalho
Nilda Pasca
Laura Souza
Eduardo Zilberman

January 2015

Inter-American Development Bank
Department of Research and Chief Economist

Macroeconomic Effects of Credit Deepening in Latin America

Carlos Carvalho
Nilda Pasca
Laura Souza
Eduardo Zilberman

Pontifícia Universidade Católica do Rio de Janeiro (PUC-Rio)

Inter-American Development Bank
2015

Cataloging-in-Publication data provided by the
Inter-American Development Bank
Felipe Herrera Library

Macroeconomic effects of credit deepening in Latin America / Carlos Carvalho, Nilda Pasca, Laura Souza, Eduardo Zilberman.
p. cm. — (IDB Working Paper Series ; 548)
Includes bibliographic references.
1. Credit—Brazil. 2. Credit—Latin America. 3. Credit control—Brazil. 4. Credit control—Latin America. I. Carvalho, Carlos Viana de. II. Pasca, Nilda Mercedes Cabrera. III. Souza, Laura Candido de. IV. Zilberman, Eduardo. V. Inter-American Development Bank. Department of Research and Chief Economist. VI. Series.
IDB-WP-548

http://www.iadb.org

Abstract[*]

This paper augments a relatively standard dynamic general equilibrium model with financial frictions in order to quantify the macroeconomic effects of the credit deepening process observed in many Latin American (LA) countries in the last decade, most notably in Brazil. In the model, a stylized banking sector intermediates credit from patient households to impatient households and firms. The key novelty of the paper, motivated by the Brazilian experience, is to model the credit constraint faced by (impatient) households as a function of future labor income. In the calibrated model, credit deepening generates only modest above-trend growth in consumption, investment, and GDP. Since Brazil has experienced one of the most intense credit deepening processes in Latin America, it is argued that the quantitative effects for other LA economies are unlikely to be sizeable.

JEL classifications: E20, E44, E51
Keywords: Credit deepening, Financial frictions, *Consignado* credit, Payroll lending

[*] This is a summary of the paper that was commissioned by the IDB for the project "Macroeconomic and Financial Challenges Facing Latin America and the Caribbean after the Crisis." Emails: cvianac@econ.puc-rio.br, nildis87@gmail.com, laurac.souza@gmail.com, zilberman@econ.puc-rio.br.

1 Introduction

In the last 10 years, many countries in Latin America (LA) experienced a process often referred to as "credit deepening," during which measures of credit usage in the economy increase markedly.[2] Figure 1 plots the ratio of domestic credit to GDP for Brazil, Colombia, Ecuador, Mexico, Paraguay and Peru. It shows that, during the 2000s, these Latin American countries experienced large expansions of domestic credit – most notably Brazil.

While credit deepening is often cited as a factor that contributed to above-trend growth in LA in the last decade and to the resilience of its economies in the aftermath of the global financial crisis, we are not aware of any attempt to quantify the macroeconomic effects of that process. In this paper, we use a relatively standard new Keynesian dynamic general equilibrium model, augmented with financial frictions, to address this question.

In the model, a stylized banking sector intermediates credit from patient households to impatient households and firms. While we borrow from several contributions available in the literature, one feature of our model is, to our knowledge, novel. Specifically, we model the credit constraint faced by (impatient) households as a function of future labor income.[3] We do so motivated by the Brazilian experience, which featured a sizeable increase in household credit that was *not* associated with purchases of real estate or other collaterilizable assets (e.g., durable goods). In Brazil, an important factor behind the credit expansion was the emergence of so-called *consignado* credit ("payroll lending,") whereby creditors are paid straight out of debtors' paychecks. Such lending is thus not collateralized by an asset, but by some valuation of future labor income.

Although our modeling of *consignado* credit is very stylized, we believe this is an important feature of the Brazilian credit deepening process that we should try to capture in our analysis for two reasons. First, Brazil is the largest economy in LA, and the one that arguably featured one of the most intense credit deepening processes in the region (see Figure 1). Second, we believe our modeling of *consignado* credit might be a useful reduced-form way to account for credit frictions in other economies in which "non-collateralized" credit was an important part of the credit expansion process.[4]

Another important institutional change that spurred the credit deepening process in Brazil was a change in lending practices backed by a new law that allowed autos to be kept as property of

[2] Another possible label for such a process would be simply "credit expansion." The key difference is that credit deepening processes are associated with institutional changes that tend to generate permanent increases in the level of credit in the economy. Below we argue that this happened in at least one of the leading cases in LA – that of Brazil.

[3] Mendoza (2002) develops a model in which a fraction of consumption has to be financed with current income. While his assumption leads to a debt limit that depends on current labor income, this is fundamentally different from a limit based on future labor income, which arises because creditors are repaid out of debtors' future paychecks. The paper that comes closest to ours in terms of motivation for the credit limit based on future labor income is Carvalho et al. (2013). They propose a model of risky lending to households, in which, upon default, creditors can seize a fraction of the debtor's labor income. In contrast, we rely on the fact that payroll lending in Brazil involves one of the lowest risks of non-performance to abstract from default in these operations. Our papers were developed in parallel, and independently from one another.

[4] Anecdotal evidence suggests that payroll lending has also been growing rapidly in other countries, such as in Mexico: http://online.wsj.com/news/articles/SB10001424127887323689604578222130866020660.

creditors until the associated loans had been repaid in full. Before this law, a car could be used as collateral for the loan obtained to finance its purchase, but upon default judges often ruled against creditors seizing the collateral. As a result, that market was relatively underdeveloped, and credit was expensive. Besides household credit, lending to firms also increased significantly in the last decade in Brazil (Figure 2).[5]

We calibrate the model to replicate the credit deepening process witnessed in Brazil since 2004. In particular, we require our model to match the credit expansion for both firms and households – including both non-collateralized and collateralized credit in the latter case (Figure 3).[6] While our model has features that allow for an endogenous response of credit to economic developments (such as "valuation effects" in the credit constraints that we impose on borrowers), we essentially match the path of the various credit measures over GDP by calibrating three time-varying parameters that dictate the tightness of the credit constraints in the model. This is consistent with the idea that a large fraction of the credit expansion was due to reforms and "innovations" (such as the spreading of *consignado* credit) that fueled the credit deepening process. We believe that all these characteristics of the Brazilian economy make it a nice laboratory to understand a credit deepening process that might be informative of what happened in other countries in LA and other developing countries.

According to our calibrated model, the aggregate effects of the credit deepening process witnessed in Brazil were relatively small in absolute terms. Credit deepening increased GDP by only 1.8 percent between 2004 and 2012 (that is, an annual growth rate of 0.2 percent). Still according to the model, during the same period consumption and investment increased by 1 and 3 percent, respectively. These results come about despite the fact that our calibration is biased towards generating meaningful aggregate effects in response to such a credit deepening process. Given that Brazil has experienced one of the most intense credit deepening processes in LA, we argue that analogous exercises for other countries are unlikely to produce sizable macroeconomic effects, at least in absolute terms.

However, because our model does not feature trend growth, in order to assess the importance of credit deepening for the Brazilian macroeconomic performance between 2004 and 2012 we need to compare the results generated by the model with above-trend growth during that period. If one assumes trend growth of 2.5 percent per year, the effects of credit deepening quantified by the model account for 13.4, 4.8, and 9.7 percent of above-trend growth in GDP, consumption, and investment, respectively. These results reflect the fact that Brazilian economic performance during the 2000s was relatively weak compared to other developing countries. Hence, the modest (in absolute terms) macroeconomic effects of the credit deepening process might still have played a relatively important role in the Brazilian context.

Finally, we use our calibrated model to study whether credit deepening changes the way in which monetary policy or technology shocks affect the economy. We find that the impulse response

[5] As the data in Figure 2 include only non-earmarked credit, the ratio of total credit to GDP differs from Figure 1.

[6] *Consignado* credit accounts for roughly 60 percent of the increase in non-collateralized credit.

functions to both technology and monetary policy shocks are almost identical in economies with low and high credit-to-GDP ratios. That is, the financial frictions we introduce into the standard new Keynesian DSGE model do not change the propagation mechanisms of these key shocks in any meaningful way. Hence, business cycle moments would barely change across low- and high-credit economies. This paper is organized as follows. Section 2 presents a brief review of the literature. Section 3 outlines the theoretical framework. Section 4 describes the quantitative analysis, encompassing the calibration procedure, results and sensitivity analysis. Finally, Section 5 concludes.

2 Brief Review of the Literature

This paper fits a fast-growing literature that integrates financial frictions into the new Keynesian workhorse model. Bernanke and Gertler (1989) and Bernanke et al. (1999) are the leading early references in that literature. See Gertler and Kiyotaki (2010) for a recent survey.

We consider three types of financial frictions. First, we follow Kiyotaki and Moore (1997), who tied the amount an agent can borrow to the value of his collateral asset in a general equilibrium model, and Iacoviello (2005), who introduces this financial friction into a new Keynesian framework. We also follow these authors by introducing entrepreneurs who can use capital as collateral in order to borrow. By relaxing this financial friction over time, we can emulate the credit expansion we observe for firms. Second, as in Iacoviello and Neri (2010) and Gerali et al. (2010), we also distinguish patient from impatient households. We tie an impatient household?s capacity to borrow to some collateral as well. This financial friction allows us to emulate the consumer credit expansion we observe in practice. However, instead of using only durable goods (such as housing) as collateral, we also consider future labor income, which is arguably in line with the Brazilian experience, where housing-related credit is a small fraction of household credit and *consignado* credit plays a prominent role.

Finally, intermediaries are in line with Curdia and Woodford (2010). In particular, we assume that it is costly for banks to raise funds, which generates an endogenous spread between borrowing and lending rates. This friction is added for the sake of realism.

We study the credit deepening process in Brazil by changing the ability of firms and households to borrow. In that sense, our work is similar in spirit to Justiniano et al. (2014), who study the macroeconomic consequences of leveraging and deleveraging in the United States.

Recent papers use new Keynesian DSGE models with financial frictions to address questions related to Brazil – e.g., De Castro et al. (2011), Da Silva et al. (2012) and Kanczuk (2013). However, we are not aware of other studies of the credit deepening process in Brazil or other Latin American countries using such a model. To the best of our knowledge, our modeling of *consignado* credit in a DSGE model is also novel – having been developed in parallel with, and independently of, Carvalho et al. (2013) (see footnote 3).

3 The Analytical Framework

Time is discrete. We consider a closed economy populated by three types of infinitely-lived agents: entrepreneurs (e), patient households (p) and impatient households (i), with masses μ^e, μ^p and μ^i, respectively.[7] Both entrepreneurs and impatient households have lower discount factors than patient households (i.e., $\beta^e, \beta^i < \beta^p$). Consequently, in equilibrium, both entrepreneurs and impatient households have incentives to borrow from patient households. We assume that agents face credit constraints that tie borrowing to some collateral. The tightness of these borrowing constraints governs the amount of credit in the economy. In order to study the interactions between credit and monetary policy, which follows a simple Taylor rule, we assume price stickiness in retailers that operate under monopolistic competition. Finally, to focus on the effects of a prolonged credit deepening process during the transition to a high-credit economy, we abstract from aggregate uncertainty (and thus omit expectations operators to lighten notation). In Section 4.4 we turn to a stochastic version of the model to study the way in which the level of credit in the economy might affect the amplification and propagation of monetary and productivity shocks.

3.1 Households

Representative patient and impatient households derive utility from leisure, a nondurable consumption good C_t^j, and a durable consumption good S_t^j, where $j \in \{i, p\}$ indexes the type of the household. We assume preferences for each household are given by:

$$\sum_{t=0}^{\infty}(\beta^j)^t \left\{ \log\left(\left[\xi (C_t^j)^{\sigma} + (1-\xi)(S_t^j)^{\sigma} \right]^{\frac{1}{\sigma}} \right) - \frac{(L_t^j)^{1+\varphi}}{1+\varphi} \right\}, \text{ where } \beta^j \in (0,1) \text{ and } \varphi > 0, \quad (1)$$

where L_t^j, $j \in \{i, p\}$ denotes labor supply. Nondurable and durable consumption are combined with a CES aggregator.

3.1.1 Patient Households

Given that $\beta^p > \max\{\beta^i, \beta^e\}$, patient households are more prone to save. We focus on transitions between a low-credit and a high-credit steady state during which patient households are always lenders. Thus, we do not need to explicitly account for a borrowing constraint in their problems. In particular, given the real wage rate (W_t^p), the relative price of the durable good in terms of the final good (q_t^S), and the interest rate accrued on deposits (r_t^h), they choose a stream of nondurable consumption (C_t^p), durable consumption (S_t^p), labor services (L_t^p), and bank deposits (D_t^p) in order to maximize (1) subject to the budget constraint

$$C_t^p + q_t^S S_t^p + D_t^p \leq W_t^p L_t^p + q_t^S (1-\delta_S) S_{t-1}^p + \frac{(1+r_{t-1}^h)}{\pi_t} D_{t-1}^p + T_t,$$

[7] Although many Latin American countries are considered small open economies, we focus on Brazil, which is a relatively closed economy.

where $\pi_t = P_t/P_{t-1}$ is the gross inflation rate, and δ_S is the rate of depreciation of the durable good. We assume that patient agents own all banks and firms in the economy and, thus, receive their profits, which are aggregated in T_t.

3.1.2 Impatient Households

In contrast with patient households, the impatient ones are borrowers. Hence, we need to account for a borrowing constraint in their problems. In particular, given W_t^i, q_t^S and r_t^h, they choose a stream of nondurable consumption C_t^i, durable consumption S_t^i, labor services L_t^i and debt B_t^i in order to maximize (1) subject to the budget constraint

$$C_t^i + q_t^S S_t^i + \frac{1 + r_{t-1}^h}{\pi_t} B_{t-1}^i \leq W_t^i L_t^i + q_t^S (1 - \delta_S) S_{t-1}^i + B_t^i,$$

and the following borrowing constraint:

$$(1 + r_t^h) B_t^i \leq \tau_t^{WL} \pi_{t+1} W_{t+1}^i L_{t+1}^i + \tau_t^S q_{t+1}^S \pi_{t+1} (1 - \delta_S) S_t^i.$$

This borrowing constraint states that impatient households can borrow up to a fraction τ_t^{WL} of the value of next period's labor income plus a fraction τ_t^S of the value of next period's stock of durable goods. We assume that the deposit rate and the rates that apply to household credit are the same. This simplification is motivated by the fact that *consignado* and consumer collateralized credits carry a relatively low interest rate in Brazil. We thus set this spread to zero and allow for a positive spread only when credit is extended to entrepreneurs.

Similar constraints, which tie debt to the value of some collateral, have been adopted in the literature (e.g., Kiyotaki and Moore, 1997; Iacoviello, 2005; Gerali et al., 2010). However, to our knowledge, our modeling of a credit constraint that depends on future labor income is novel.[8] By calibrating τ_t^{WL} to replicate the expansion of non-collateralized credit (which includes *consignado*), we can study the macroeconomic effects of such expansion. Similarly, we will calibrate τ_t^S to study the expansion of collateralized credit to individuals.

3.2 Entrepreneurs

Entrepreneurs have preferences given by

$$\sum_{t=0}^{\infty} (\beta^e)^t \log(C_t^e), \quad \text{where } \beta^e \in (0, 1), \tag{2}$$

where, again, $\beta^e < \beta^p$. Moreover, they have access to a production technology, in which labor inputs (L_t^p, L_t^i) and capital K_t are employed to produce a wholesale good Y_t^e, according to

$$Y_t^e = A_t K_{t-1}^{\alpha} [(\mu^p L_t^p)^{\theta} (\mu^i L_t^i)^{1-\theta}]^{1-\alpha}, \tag{3}$$

[8] See, however, footnote 3.

where A_t is the level of technology,[9] common to all entrepreneurs, and $\alpha \in (0,1)$ is the capital share. Notice that, as in Iacoviello and Neri (2010), we assume complementarity across labor types, which is governed by the parameter $\theta \in (0,1)$.

In the economies that we analyze, entrepreneurs act as borrowers. Hence, we need to account for a borrowing constraint in their problems. Unlike households, entrepreneurs use capital as collateral.

Given prices, entrepreneurs choose a stream of nondurable consumption C_t^e, capital K_t, debt B_t^e, and labor inputs (L_t^p, L_t^i) to maximize (2) subject to (3), the budget contraint

$$C_t^e + W_t^p L_t^p + W_t^i L_t^i + \frac{(1+r_{t-1}^e)B_{t-1}^e}{\pi_t} + q_t^K K_t \leq q_t^W Y_t^e + B_t^e + q_t^K(1-\delta_K)K_{t-1},$$

and the borrowing constraint

$$(1+r_t^e)B_t^e \leq \tau_t^K q_{t+1}^K \pi_{t+1}(1-\delta_K)K_t,$$

where δ_K is the depreciation rate of capital, q_t^K is the price of capital in terms of the final good, and $q_t^W \equiv P_t^W/P_t$ is the relative price of the wholesale good Y_t^e. Notice that r_t^e is the nominal interest rate faced by entrepreneurs. Later, we explain how the credit spread, $\omega_t = (1+r_t^e)/(1+r_t^h) - 1$, is determined endogenously. Finally, by imposing an exogenous path to τ_t^K, aiming to replicate the expansion of corporate credit in Brazil, we can study the macroeconomic effects of such expansion.

3.3 Firms

There are four types of firms: Competitive capital producers, competitive producers of durable goods, retailers who operate in a monopolistic competitive market, and competitive final goods producers. All firms are owned by patient households.

3.3.1 Capital Producers

At the beginning of each period, capital producers buy an amount of the final good I_t^K from retail firms and the stock of undepreciated capital $(1-\delta_K)K_{t-1}$ at price q_t^K from entrepreneurs. The stock of undepreciated capital is transformed one-to-one into new capital, while the transformation of final goods into new capital is subject to a quadratic adjustment cost. The new capital K_t is sold to entrepreneurs at relative price q_t^K to be used in production in the subsequent period.

Hence, new capital is chosen to maximize

$$\sum_{t=0}^{\infty} \Delta_t [q_t^K (K_t - (1-\delta_K)K_{t-1}) - I_t^K],$$

[9] In our analysis of the transition effects of credit deepening we abstract from technology shocks. We then analyze their aggregate effects around low- and high-credit steady states.

subject to the law of motion

$$K_t = (1-\delta_K)K_{t-1} + \left[1 - \frac{\kappa_K}{2}\left(\frac{I_t^K}{I_{t-1}^K} - 1\right)^2\right] I_t^K,$$

where the parameter κ_K determines how costly it is to adjust capital, and Δ_t is the stochastic discount factor of patient households.

3.3.2 Producers of Durable Goods

At the beginning of each period, producers of durable goods buy an amount of the final good I_t^S from final goods firms and the stock of undepreciated durable goods $(1-\delta_S)S_{t-1}$ at relative price q_t^S from both patient and impatient households. The stock of undepreciated durable goods is transformed one-to-one into new durable goods, while the transformation of final goods into new durable goods is subject to a quadratic adjustment cost. New durable goods S_t are sold at relative price q_t^S to both patient and impatient households.

Hence, durable goods producers choose the level of production to maximize

$$\sum_{t=0}^{\infty} \Delta_t [q_t^S (S_t - (1-\delta_S)S_{t-1}) - I_t^S],$$

subject to the law of motion

$$S_t = (1-\delta_S)S_{t-1} + \left[1 - \frac{\kappa_S}{2}\left(\frac{I_t^S}{I_{t-1}^S} - 1\right)^2\right] I_t^S,$$

where the parameter κ_S determines how costly it is to adjust durable goods. Any profits originating in this sector are transferred to patient households.

3.3.3 Retail Firms and Final Goods Producers

We assume monopolistic competition among retail firms. Each retail firm m buys wholesale good Y_t^e from entrepreneurs at price P_t^W and differentiates it at no cost. Firms set prices $P_t(m)$ in order to maximize profits subject to the demand originating from final goods producers and also subject to quadratic price adjustment costs that arise whenever a firm changes its price by more than a weighted average of past and steady-state inflation (with relative weights equal to ι and $(1-\iota)$, respectively).

Let $Y_t(m)$ denote production of variety m. We assume that final good producers are competitive, and they simply aggregate, through a CES composite, the continuum of differentiated varieties produced by retailers. In particular,

$$Y_t = \left[\int_0^1 Y_t(m)^{\frac{\varepsilon-1}{\varepsilon}} dm\right]^{\frac{\varepsilon}{\varepsilon-1}},$$

where ε is the elasticity of substitution between varieties. Let P_t be the associated Dixit-Stiglitz price index.

This final good is purchased by patient households, impatient households and entrepreneurs for consumption, and by capital and durable goods producers for production.

Finally, it remains to formalize retail firm m's problem. $P_t(m)$ is chosen to maximize

$$\sum_{t=0}^{\infty} \Delta_t \left[P_t(m) Y_t(m) - P_t^W Y_t(m) - \frac{\kappa_P}{2} \left(\frac{P_t(m)}{P_t(m-1)} - \pi_{t-1}^{\iota} \bar{\pi}^{1-\iota} \right)^2 P_t Y_t \right],$$

subject to the following demand schedule obtained from the cost-minimization problem of final goods producers:

$$Y_t(m) = \left(\frac{P_t(m)}{P_t} \right)^{-\varepsilon} Y_t.$$

The parameter κ_P controls the price adjustment cost and dictates the degree of price stickiness in the economy and $\bar{\pi}$ denotes steady-state inflation. Any profits originating in this sector are transferred to patient households.

3.4 Banks

Banks behave competitively, taking both r_t^h and r_t^e as given. Recall that r_t^h is the interest rate on both the debt of impatient households and the savings of patient ones. At the beginning of each period, banks collect deposits from patient households D_t, which are lent to both impatient households and entrepreneurs. Originating loans to entrepreneurs entails an extra cost which is borne out in terms of the final good. As in Curdia and Woodford (2010), we assume that cost is given by $\eta(B_t^e)^\gamma$, with $\eta > 0$ and $\gamma > 1$. Intuitively, this is a shortcut to capture both agency and operational costs that are not modeled explicitly. As explained earlier, we assume that such costs are not present when banks lend to impatient households.

The excess funds of the banks are given by

$$D_t - B_t^e - B_t^i - \eta(B_t^e)^\gamma, \tag{4}$$

which are transferred to patient households. Let the credit spread ω_t be defined implicitly by $(1 + r_t^e) = (1 + \omega_t)(1 + r_t^h)$. Given that assets must equal liabilities at the end of the period, the following equation must hold

$$D_t = (1 + \omega_t) B_t^e + B_t^i. \tag{5}$$

By plugging (5) into (4), we obtain

$$\omega_t B_t^e - \eta(B_t^e)^\gamma,$$

which is maximized at $B_t^e = (\eta\gamma/\omega_t)^{1/(1-\gamma)}$. Since $\gamma > 1$, the model induces a positive correlation between the credit spread ω_t and the amount borrowed by entrepreneurs B_t^e.

3.5 Monetary Policy

Monetary policy is conducted through a Taylor rule with interest rate smoothing. In particular,

$$(1+r_t^h) = (1+r)^{1-\rho}(1+r_{t-1}^h)^{\rho}\left(\frac{\pi_t}{\pi}\right)^{\phi_\pi(1-\rho)}\left(\frac{y_t}{y_{t-1}}\right)^{\phi_y(1-\rho)} e^{u_t^r},$$

where ϕ_π and ϕ_y are the weights assigned to inflation and output stabilization, respectively, π and r are the steady-state levels of inflation and the policy rate, respectively, and u_t^r is a monetary policy shock.[10]

3.6 Market Clearing

The definition of the equilibrium is standard. We assume that capital, wholesale good, durable good, and both types of labor markets are competitive. In particular, notice that the market clearing condition for the wholesale good reads:

$$\int_0^1 Y_t(m)dm = \mu^e Y_t^e.$$

In contrast, we assume monopolistic competition at the retail level, where the nondurable good is composed. Finally, given that $C_t = \mu^p C_t^p + \mu^i C_t^i + \mu^e C_t^e$, the market clearing condition in the final goods market is

$$Y_t = C_t + I_t^S + I_t^K + \eta(B_t^e)^\gamma + \text{ all adjustment costs.}$$

4 Quantitative Analysis

After calibrating the model outlined above, we use it to perform two exercises. First, in order to assess the macroeconomic effects of the credit expansion observed in Brazil, we solve for the time-varying paths of τ_t^{WL}, τ_t^S, and τ_t^K that generate paths for non-collateralized credit, collateralized credit to households, and credit to non-financial corporations that resemble their counterparts in the data (see Figures 2 and 3).

Second, in a stochastic version of the model, we evaluate the propagation mechanism of both technology and monetary policy shocks (which we add to the model for this exercise only). In particular, we compare impulse response functions to these shocks in the neighborhood of steady states with low and high levels of credit.

4.1 Calibration

We consider several sources of information to calibrate the parameters of the model, in which the time period is set to one quarter. Whenever we set a parameter to match a given statistic for the

[10] In our analysis of the transition effects of credit deepening we abstract from monetary policy shocks. We then analyze their aggregate effects around low- and high-credit steady states.

Brazilian economy, we consider its average between 2004 and 2012. Details of the data used in the calibration can be found in the Appendix.

Steady state inflation is set to 5.5 percent per year (5.35 percent on a logarithmic basis). Regarding the discount factors, we set $\beta^p = 0.9834$ to generate a nominal interest rate that accrues on savings deposit of 12.5 percent per year, in steady state (11.8 percent on a logarithmic basis). We set $\beta^i = \beta^e = 0.91$, which is associated with an annual "subjective time-discount rate" of 52 percent. We pick this arguably extreme value for two reasons. First, as we show below, low values for β^i and β^e increase the ability of the model to produce meaningful aggregate effects in response to credit deepening. Second, with high values for β^i and β^e, the borrowing constraints for impatient households and entrepreneurs may not be binding at times during the transition.[11]

The Frisch elasticity $1/\varphi$ is set to one, which is within the range commonly used in the literature. We follow Fernndez-Villaverde and Krueger (2004) to calibrate the parameters associated with preferences for durable and nondurable goods. In the absence of definitive estimates for σ, we set it to zero, so that the composite becomes a Cobb-Douglas, $(C_t^j)^{\xi}(S_t^j)^{1-\xi}$, $j = i, p$, with ξ set to 0.8.

The depreciation rate of capital δ_K is set to 0.025, so that the investment to GDP ratio is approximately 18 percent. The adjustment cost parameter κ_K is 2.53, which is in line with the value estimated in De Castro et al. (2011). In the absence of similar information regarding the production of durable goods, we set $\delta_S = \delta_K$ and $\kappa_S = \kappa_K$.

Regarding the Cobb-Douglas technology used by entrepreneurs, since information on patient and impatient labor income shares in Brazil is not available, we set $\theta = 0.7$ to generate a ratio of average household debt to annual income of 22 percent. The capital share α is set to 0.44, in line with the evidence for Brazil reported in Paes and Bugarin (2006).

In line with previous literature, the elasticity of substitution ε between goods is set to 6, which corresponds to a markup of 20 percent. The parameter κ_P, which measures the degree of price stickiness in the retail sector, is calibrated to 50. As usual, this parameter can be mapped into a degree of price stickiness of 0.75 in the Calvo (1983) model, once the quadratic adjustment cost model and the Calvo model are cast as log-linear approximations around a zero inflation steady state. Finally, ι, which governs indexation, is set to 0.158, as in Gerali et al. (2010).

We follow De Castro et al. (2011) to calibrate the parameters associated with the Taylor rule. In particular, $\phi_y = 0.16$, $\phi_\pi = 2.43$ and $\rho = 0.79$.

Regarding the banking sector, we set $\eta = 0.0309$ and $\gamma = 2$ to generate a spread of roughly 4 percent per year – the average difference between the Brazilian prime rate, which reflects interest rates on loans made to firms that are considered preferential borrowers, and the average rate on overnight deposits during the sample. Loans to these firms embed lower default risk than loans to other firms. Hence, the targeted value of 4 percent per year underestimates the average spread in the Brazilian economy. As we show below, this calibration of η and γ also helps the model produce more meaningful aggregate effects in response to the credit deepening process.

We postpone the discussion of how we calibrate the sequence $\{\tau_t^{WL}, \tau_t^S, \tau_t^K\}$ to the next section. Finally, we set masses μ^p, μ^i and μ^e equal to one. Table 1 summarizes the calibration procedure.

[11] For a recent article that deals with credit constraints that bind occasionally, see Guerrieri and Iacoviello (2013).

4.2 Macroeconomic Effects of Credit Deepening

In order to assess the macroeconomic effects of the credit expansion we observe in Brazil, we solve for the time-varying paths of τ_t^{WL}, τ_t^S, and τ_t^K that generate paths for non-collateralized credit, collateralized credit to households, and credit to non-financial corporations that resemble their counterparts in the data. We smooth the trajectories for τ_t^{WL}, τ_t^S, and τ_t^K using a third degree polynomial. As in Justiano et al. (2014), we assume that the evolution of τ_t^{WL}, τ_t^S, and τ_t^K is perfectly foreseen after the initial unforeseen shock in 2004, when the credit deepening process arguably started. We keep τ_t^{WL}, τ_t^S, and τ_t^K constant after 2012.[12]

Figure 4 shows the calibrated paths for τ_t^{WL}, τ_t^S, and τ_t^K, whereas Figure 5 compares the credit deepening experiment in the model with the data. Notice that the model is able to replicate the evolution of the credit series fairly well, except for the last years of the data on credit to non-financial corporations ("entrepreneurs").[13]

Figure 6 reports the trajectories of GDP, consumption, investment, and inflation in the model economy. The macroeconomic effects of credit deepening are small in absolute terms. GDP increases by less than 2 percent, consumption by 1 percent, and investment by 3 percent.

Consumption in the model aggregates nondurable consumption across types of agents, whereas investment aggregates investment in both durable goods byv households and capital by entrepreneurs. Figure 7 reports the evolution of these variables, as well as the evolution of the stock of durable goods and capital by types of agents.

Once the credit deepening process started, credit constraints faced by both impatient households and entrepreneurs ease, which make them consume and invest more. In order to clear markets, the price of the nondurable good must increase (as the spike in the inflation rate in Figure 6 illustrates) and, thus, patient households reduce their consumption of nondurable goods and investment in durable goods.

As the credit deepening process evolves, consumption and investment of patient households increase. After the initial spike of 40 percent, investment of impatient households declines, whereas consumption displays an inverse U-shaped pattern. Notice that the impatient households' stock of durable goods increases monotonically, while that of patient households follows a U-shaped pattern. Intuitively, durable goods have a dual role in the model. First, they generate utility for both types of households. Second, they relax credit constraints of impatient households. Hence, impatient households have more incentives to accumulate durable goods than patient households. In the first years of the credit deepening process, market clearing prices imply that patient households exchange durable for nondurable goods, whereas in the later years, impatient households do the opposite.

Similarly, as the credit deepening process evolves, investment in capital follows an inverse U-shaped path, allowing entrepreneurs to increase their stock of capital by 3 percent. Overall, the

[12]To implement this exercise, we apply the shooting algorithm in Dynare to solve the system of equations given by the first order conditions of the agents' optimization problems and the market clearing conditions. These equations are described in a separate appendix, available upon request.

[13]To be precise, in that case the fitted third degree polynomial would decrease towards the end of the sample period, so we restricted it to be strictly monotonic. In the next section, as a robustness check, we report results for paths of τ_t^{WL}, τ_t^S, and τ_t^K chosen to fit the trajectories of the credit variables point by point.

effects on entrepreneurs' consumption of nondurable goods are quite small.

In terms of magnitude, the strongest effects are on investment in durable goods by impatient households and investment in capital, which increase by 9 and 4.5 percent, respectively. In contrast, consumption by each type of agent increased by at most one percent.

Figure 8 shows the evolution of labor market outcomes. As in Justiano et al. (2014), once credit deepening starts, labor services of patient and impatient households move in opposite directions. However, as the process evolves, labor services supplied by impatient households increase by 2 percent, whereas those supplied by patient households barely increase. Moreover, notice that for impatient households, wage and labor services are negatively associated, whereas for patient households they are positively associated. Hence, for patient households, demand for labor services seems to be the driving force behind these movements. In contrast, as the credit deepening process evolves, impatient households have an extra motive to supply labor in order to further relax their credit constraints.

Figures 9 shows the evolution of interest rates as well as the spread. After an initial increase of roughly 0.6 percentage point (from the steady state value of 11.8 percent per year), the interest rate that accrues on deposits fluctuates a bit around 12.3-12.5 percent. As the credit deepening process evolves, the interest rate faced by entrepreneurs increases substantially – and so does the spread. Intuitively, as entrepreneurs get into debt, the intermediation costs to generate these funds increase, yielding higher interest rates and spreads. Notice that the model can replicate fairly well the trend of the spread observed in the data. Finally, Figure 10 reports the evolution of average household debt to annual income. Again, the model can replicate fairly well the trend observed in the data.

In absolute terms, the effects of the credit deepening process are modest. However, the model lacks trend growth. Hence, depending on the actual level of trend growth in Brazil, the effects of credit deepening as quantified by our model might nevertheless explain a sizeable share of above-trend growth in actual GDP, consumption and investment during the 2004-2012 period.

Table 2 describes five scenarios for trend growth, ranging from 1.5 to 3.5 percent per year. For each scenario, we divide the percentage increase in GDP, consumption, and investment produced by the model for the 2004-2012 period by the cumulative above-trend growth in the data for each of those variables. This yields the share of above-trend growth that can be attributed to the credit deepening process, according to the calibrated model. In our preferred scenario, which considers a growth trend of 2.5 percent per year, the credit deepening process accounts for 13.4, 4.8, and 9.7 percent of above-trend growth in GDP, consumption, and investment, respectively. [14] Under more optimistic assumptions about trend growth, the model can account for up to 52.5 percent of the gap for GDP. In contrast, if trend growth is only 1.5 percent, the credit deepening process accounts for only 7.4 percent of above-trend GDP growth.

Altogether, these results highlight the relatively poor performance of the Brazilian economy

[14] In the National Accounts, the measure of consumption includes the service flow of some durable goods, such as housing. Hence, in the model we also consider an alternative measure of consumption that includes investment in durable goods. In this case, the credit deepening process accounts for 8 percent of above-trend growth.

during the 2000s. As a result, the modest (in absolute terms) aggregate effects of the credit deepening process might still have played a relatively important role in the Brazilian context.

4.3 Sensitivity Analysis

In our calibration procedure, we set β^e, β^i, γ and η to enhance the ability of the model to produce above-trend growth as a result of the credit deepening process. In this section, we show that more extreme calibrations of these parameters also fail to generate sizeable effects on consumption, investment, and output. Also, we show that our conclusions do not change when we consider a transition that matches the paths of credit variables pointwise. Finally, results barely change once we vary the impatient labor share, θ, from 0.5 to 0.8; and the capital share, α, from 0.4 to 0.5 (results available upon request, but not reported for brevity).

Borrower Impatience We vary the discount factors of the borrowers, $\beta^e = \beta^i$, and analyze its effect on the paths of consumption, investment, output, and inflation. Results are reported in Figure 11. Notice that the lower β^e and β^i are, the higher the impact of the credit deepening process is. Under the extreme assumption of $\beta^e = \beta^i = 0.85$, which is associated with an annual "subjetive time-discount rate" of 100 percent, GDP, consumption and investment increase, respectively, by nearly 4, 2, and 6 percent between 2004 and 2012. These figures are substantially higher than their counterparts in the benchmark calibration, but still relatively small given the long horizon between 2004 and 2012 and the marked increase in measures of credit over GDP.

Spread As we argue above, a spread of 4 percent per year might be too low. Hence, we vary separately the parameters γ and η, associated with the financial intermediation technology, in order to assess how results change with different levels of spread. Results are reported in Figures 12 and 13. Notice that higher – and perhaps more realistic – levels of spread are associated with even smaller macroeconomic effects of the credit deepening process. Similarly, lower levels of spread amplify its macroeconomic effects. Intuitively, spreads are positively associated with intermediation costs, which drain resources from the economy.

Non-Smooth Transition Finally, we consider a transition between steady-states, in which the paths of τ_t^{WL}, τ_t^S, and τ_t^K are chosen to fit the trajectories of the credit variables pointwise (see Figure 14). Figure 15 shows the transition paths for the macroeconomic variables, which are more volatile in this case. Importantly, this non-smooth transition does not change our conclusion that, through the lens of the model, the macroeconomic effects of the credit deepening process we observe in Brazil are modest, in absolute terms.

4.4 The Propagation of Shocks in High- and Low-Credit Economies

In this section, we analyze the propagation of two shocks in a stochastic version of the model. In particular, we compare impulse response functions of several variables to technology and monetary

policy shocks (which we add to the model for this exercise only) around two steady states: One with low and the other with high levels of credit.[15]

In the first steady state, we calibrate $\tau^{WL} = 0.28$ to match the ratio of individual non-collateralized credit to GDP of 4 percent, $\tau^{S} = 0.07$ to match the ratio of individual collateralized credit to GDP of two percent, and $\tau^{K} = 0.031$ to match the ratio of firm credit to GDP of 9 percent. These figures correspond to the amount of credit we observe in the Brazilian economy at the beginning of 2004 (see Figure 3), when the credit deepening process described above arguably started. This is the steady state with a low credit-to-GDP ratio.

In the second steady state, we calibrate $\tau^{WL} = 0.759$ to match the ratio of individual non-collateralized credit to GDP of 10 percent, $\tau^{S} = 0.175$ to match the ratio of individual collateralized credit to GDP of 6 percent, and $\tau^{K} = 0.057$ to match the ratio of firm credit to GDP of 16 percent. These figures are close to the amount of credit we observe in the Brazilian economy by mid-2012 (see Figure 3). Although it is not clear whether the credit deepening process we observe in Brazil is over, we set this calibration to represent the steady state with a high credit-to-GDP ratio.

We assume that the technology shock follows an AR(1) process with an autocorrelation coefficient of 0.91, as in De Castro et al. (2001). Monetary shocks are assumed to be i.i.d.

Figures 16 and 17 plot the impulse response functions for selected variables (GDP, consumption, investment, household interest rate, and inflation) to the technology and monetary policy shocks, respectively.

Regarding the response to a technology shock, notice that the impulse response functions in both economies (with low- and high-credit) overlap almost perfectly (Figure 16). This result is in congruence with previous literature, which argues that credit constraints do not propagate technology shocks.[16] For example, Liu et al. (2013) argue that a technology shock does not have meaningful effects on asset prices, which are the key variables to determine the degree of slackness (or tightness) of the credit constraints.

Similarly, the impulse response functions to a monetary policy shock in both economies (with low- and high-credit) overlap almost perfectly (Figure 17). Importantly, this overlapping of the impulse response functions to these keys shocks suggests that business cycle moments across economies would barely change.

5 Conclusion

In this paper, we calibrate a relatively standard new Keynesian dynamic general equilibrium model, augmented with financial frictions, to study the macroeconomic effects of the credit deepening process experienced recently by Brazil and other LA economies. We conclude that, even under arguably extreme calibrations – chosen to enhance the ability of the model to generate meaningful macroeconomic effects in response to a credit deepening process – the effects we find are modest in

[15] We consider a log-linearized version of the model to perform these exercises. The log-linearized equations are in a separate appendix, available upon request.

[16] See, for instance, Section IV.4 of Liu et al. (2013) and the references therein.

absolute terms.

As Figure 1 illustrates, Brazil has experienced one of the most intense credit deepening process among LA countries. We conclude that, through the lens of the model, the macroeconomic effects of the credit deepening processes experienced by countries in the region are unlikely to be sizeable.

We advance two plausible interpretations for this result. First, these credit deepening processes coincided with surges in commodity prices, which improved substantially the terms of trade of most of Latin American countries. These surges might be the leading driving force behind the economic growth experienced during the 2000s. Second, there might be a missing ingredient in the model that potentializes the role of credit deepening processes. The almost perfect overlapping of impulse response functions to technology and monetary policy shocks across two steady states (with low- and high-credit) echoes this interpretation.

One possible extension, as in Justiniano et al. (2014), is to consider a small open economy, in which the supply of credit is perfectly elastic at a given interest rate. In this case, macroeconomic effects can be amplified as an expansion of the demand for credit by impatient households and entrepreneurs does not need to be compensated by higher savings of patient households. Moreover, in a small open economy model, the trajectory of terms of trade can be inputted exogenously in the model. Hence, a horse race aiming to explain economic growth between surges in commodity prices and credit deepening processes is possible. We leave these questions for future research.

References

[1] Bernanke, B., and M. Gertler. 1989. "Agency Costs, Net Worth and Business Fluctuations." *American Economic Review* 79(1): 14-31.

[2] Bernanke, B., M. Gertler and S. Gilchrist. 1999. "The Financial Accelerator in a Quantitative Business Cycle Framework." In: J. Taylor and M. Woodford, editors. *Handbook of Macroeconomics*, Volume 1. Amsterdam, The Netherlands: North Holland.

[3] Calvo, G.A. 1983. "Staggered Prices in a Utility-Maximizing Framework," *Journal of Monetary Economics* 12(3): 383-398.

[4] Carvalho, F., M. Castro and S. Costa. 2013. "Traditional and Matter-of-fact Financial Frictions in a DSGE Model for Brazil: The Role of Macroprudential Instruments and Monetary Policy." *Banco Central do Brasil* Working Paper 336.

[5] Curdia, V., and M. Woodford. 2010. "Credit Spreads and Monetary Policy." *Journal of Money, Credit and Banking* 42: 3-35.

[6] Da Silva, M.F. et al. 2012. "Financial Frictions in the Brazilian Banking System: A DSGE Model with Bayesian Estimation. "Working Paper.

[7] De Castro, M. et al. 2011. "SAMBA: Stochastic Analytical Model with a Bayesian Approach." *Banco Central do Brasil* Working Paper No 239.

[8] Fernndez-Villaverde, J., and D. Krueguer. 2004. "Life-Cycle Consumption, Debt Constraints and Durable Good.," *Macroeconomic Dynamics* 15(5): 725-770.

[9] Gerali, A. et al. 2010. "Credit and Banking in a DSGE Model of the Euro Area." *Journal of Money, Credit and Banking* 42: 107-141.

[10] Gertler, M., and N. Kiyotaki. 2010. "Financial Intermediation and Credit Policy in Business Cycle Analysis." In: B. Friedman and M. Woodford, editors. *Handbook of Monetary Economics.* Volume 3. Amsterdam, The Netherlands: North Holland.

[11] Guerrieri, L., and M. Iacoviello. 2013. "Collateral Constraints and Macroeconomic Asymmetries." Working paper.

[12] Iacoviello, M. 2005. "House Prices, Borrowing Constraints, and Monetary Policy in the Business Cycle." *American Economic Review* 95(3): 739-764.

[13] Iacoviello, M., and S. Neri. 2010. "Housing Market Spillovers: Evidence from an Estimated DSGE Model." *American Economic Journal: Macroeconomics* 2: 125-164.

[14] Justiniano, A., G. Primiceri and A. Tambalotti. 2014. "Household Leveraging and Deleveraging." NBER Working Paper 18941. Cambridge, United States: National Bureau of Economic Research.

[15] Kanczuk, F. 2013., "Um Termômetro para as Macro-Prudenciais," *Revista Brasileira de Economia* 67(4): 739-764.

[16] Kiyotaki, N., and J. Moore. 1997. "Credit Cycles." *Journal of Political Economy* 105(2):211-248.

[17] Liu, Z., P. Wang and T. Zha. 2013. "Land-Price Dynamics and Macroeconomic Fluctuations." *Econometrica* 81(3): 1147-1184.

[18] Mendoza, E. 2002. "Credit, Prices, and Crashes: Business Cycles with a Sudden Stop. " In: S. Edwards and J. Frankel, editors. *Preventing Currency Crises in Emerging Markets.*

[19] Paes, N., and M. Bugarin. 2006. "Parâmetros Tributários da Economia Brasileira," *Estudos Econômicos* 36(4): 699-720.

Parameter	Description	Value
β^p	Discount Factor - Patients	0.9834
β^i, β^e	Discount Factor - Impatients and Entrepreneurs	0.91
μ^p, μ^i, μ^e	Mass - Patients, Impatients and Entrepreneurs	1
φ	Inverse of the Frisch Elasticity	1
σ	Elasticity Between Nondurable and Durable Goods	0
ξ	Weight of the Nondurable Good on the Utility Function	0.8
δ_K, δ_S	Depreciation - Capital and Durable Goods	0.025
κ_K, κ_S	Adjustment Cost - Capital and Durable Goods	2.53
α	Capital Share in the Production Function	0.44
θ	Share of Patient Households in the Production Function	0.7
κ_P	Price Adjustment Cost - Final Good	50
ι	Steady State Inflation Weight - Indexation	0.158
ε	Elasticity of Substitution - Final Good	6
ρ	Smoothing Parameter of the Taylor Rule	0.79
ϕ_y	Output Weight of Taylor Rule	0.16
ϕ_π	Inflation Weight of Taylor Rule	2.43
η	Spread	0.0309
γ	Spread	2

Table 1: Calibration. See Section 4.1 for details.

	GDP		**Consumption**		**Consumption + I. in Durables**		**Investment (capital)**	
	Growth (data): 40.7%		Growth (data): 48.4%		Growth (data): 48.4%		Growth (data): 82.6%	
	Growth (model): 1.7%		Growth (model): 0.9%		Growth (model): 1.5%		Growth (model): 4.5%	
Trend growth	Above trend	Model	Above trend	Model	Above trend	Model	Above trend	Model
(% p.y.)	growth (%)	share (%)	growth (%)	share (%)	growth (%)	share (%)	growth (%)	share (%)
1.5%	23.1%	7.4%	29.8%	3.0%	29.8%	5.0%	59.7%	7.5%
2.0%	17.7%	9.6%	24.2%	3.7%	24.2%	6.2%	52.8%	8.5%
2.5%	12.7%	13.4%	18.8%	4.8%	18.8%	8.0%	46.2%	9.7%
3.0%	7.8%	21.7%	13.7%	6.6%	13.7%	10.9%	39.9%	11.3%
3.5%	3.2%	52.5%	8.9%	10.1%	8.9%	16.9%	34.0%	13.2%

Table 2: Credit deepening experiment: comparison with the data. Growth rates between 2004 and 2012. Data on GDP, consumption and investment in capital are obtained from National Accounts, available at www.ipeadata.gov.br.

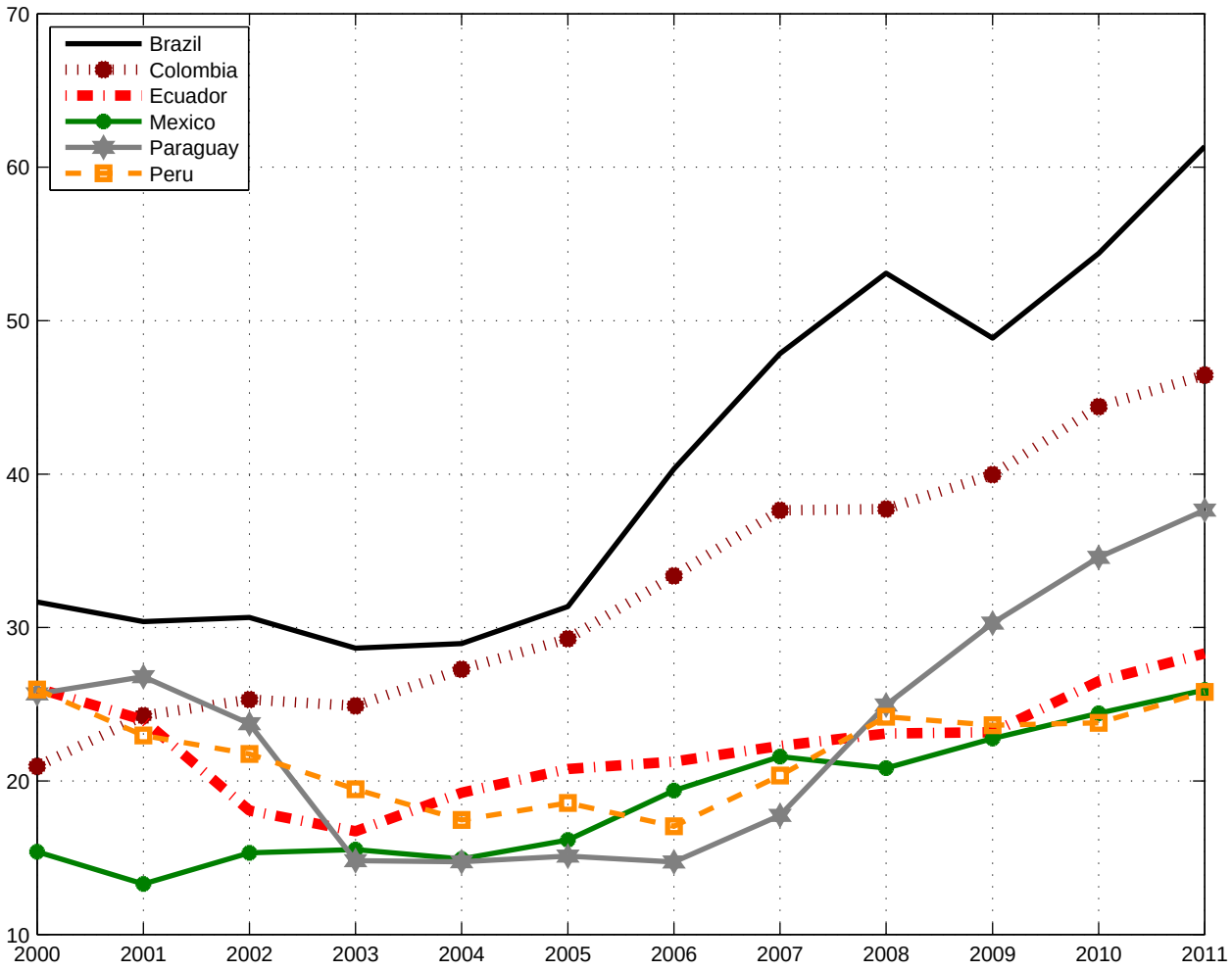

Figure 1: Domestic Credit to Private sector over GDP. Domestic credit to private sector refers to financial resources provided to the private sector, such as through loans, purchases of non-equity securities, and trade credits and other accounts receivable, that establish a claim for repayment. For some countries these claims include credit to public enterprises. Source: World Bank, available at data.worldbank.org.

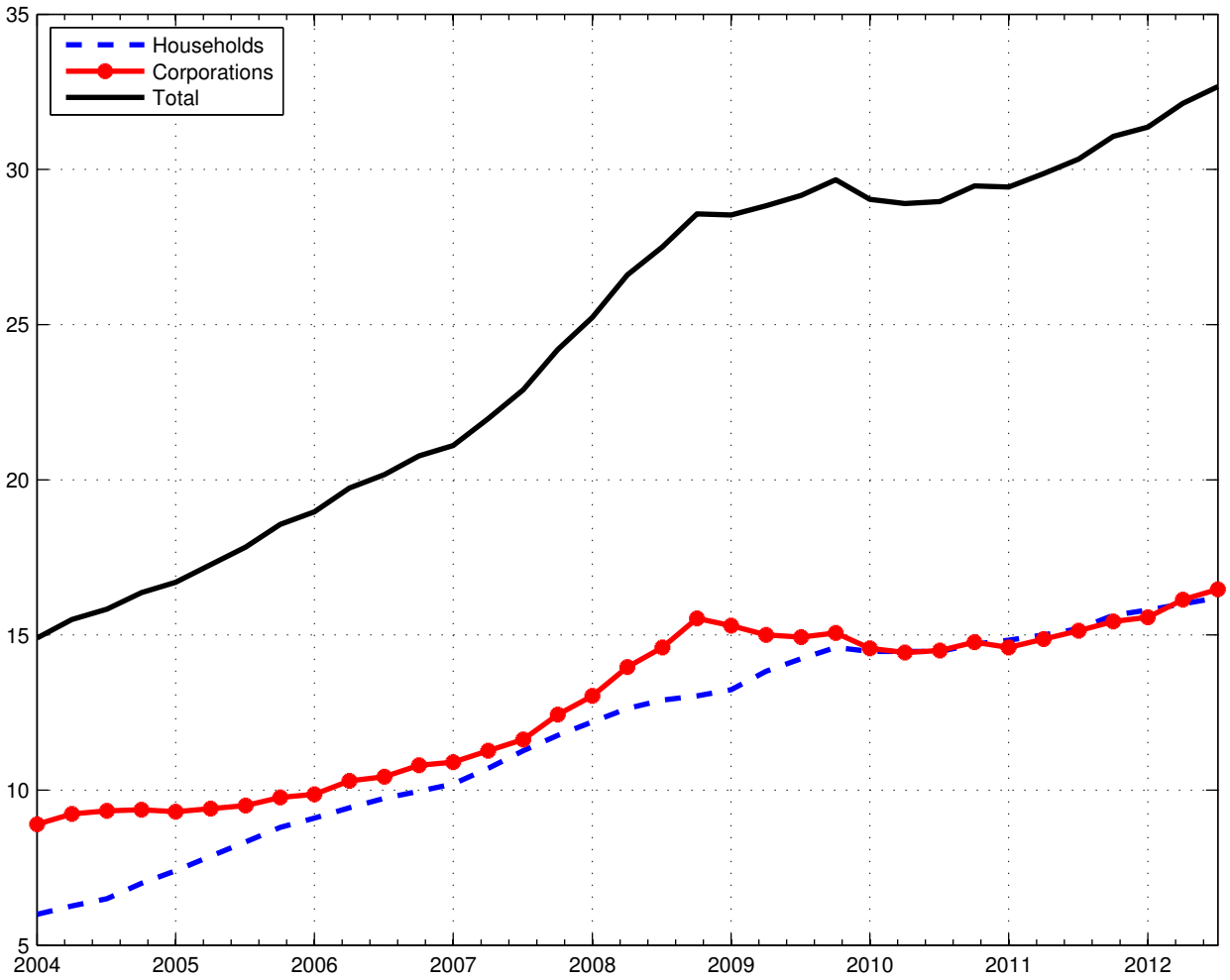

Figure 2: Non-Earmarked Credit Outstanding to GDP Ratio in Brazil, by Borrower Type. Non-earmarked credit is the nominal outstanding balance of credit operations by the National Financial System. Nonearmarked funds refer to financing and loans in which rates and destination are freely negotiated between financial institutions and borrowers, i.e., the financial institution has autonomy to decide in which economic sectors it will apply the funds raised in the market through time deposits, by Bank Certificates of Deposit (CDB), funds raised in foreign markets, part of demand deposits, among other instruments. Source: Central Bank of Brazil, available at www.bcb.gov.br.

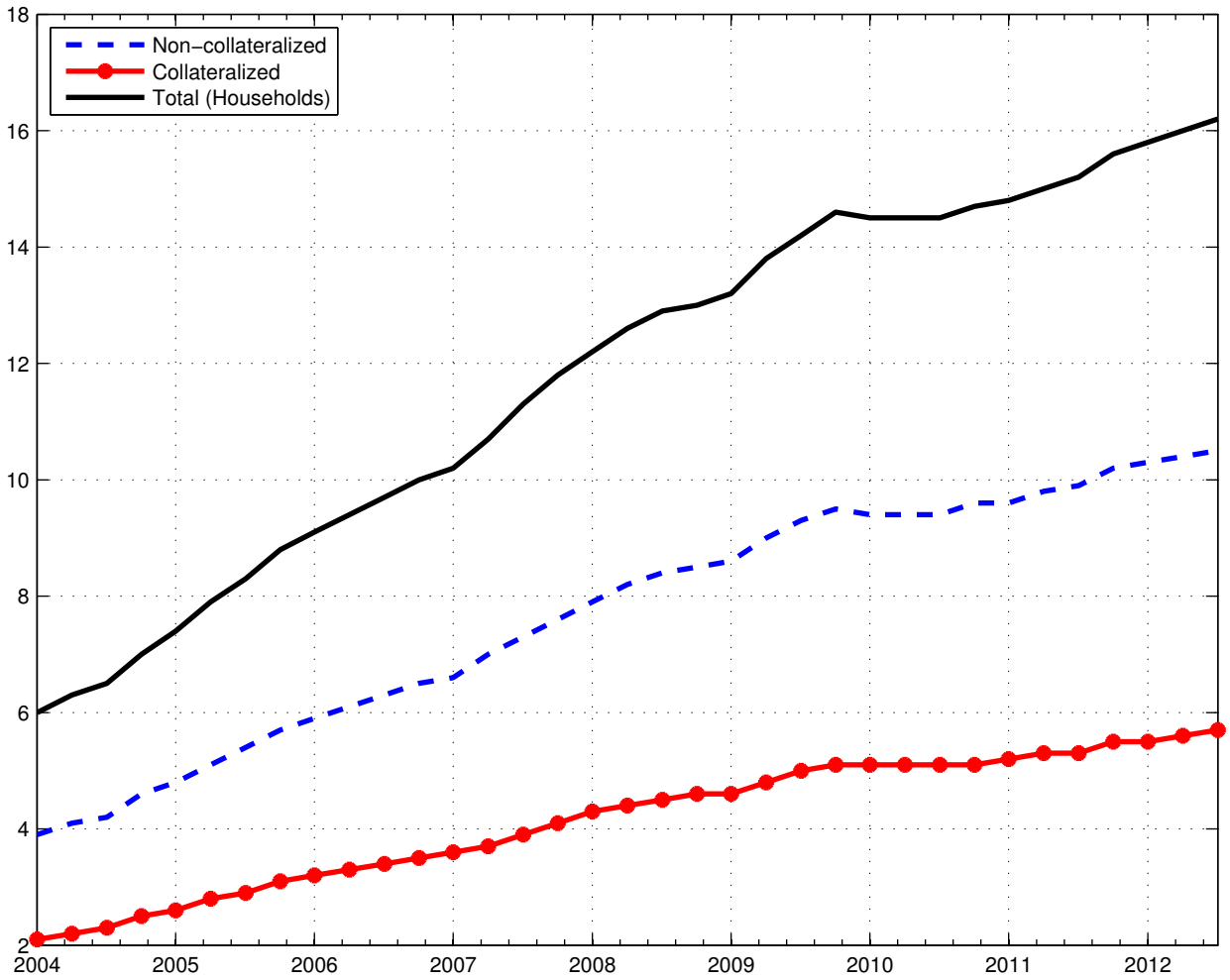

Figure 3: Ratio of Households? Non-Earmarked Credit Outstanding to GDP in Brazil, by Type. Collateralized credit consists of vehicles financing, other goods financing and mortgages. Non-collateralized credit consists of credit card, personal credit, overdraft and other non-earmarked credit instruments that were not classified in previous types of credit. Source: Brazilian Central Bank, available at www.bcb.gov.br.

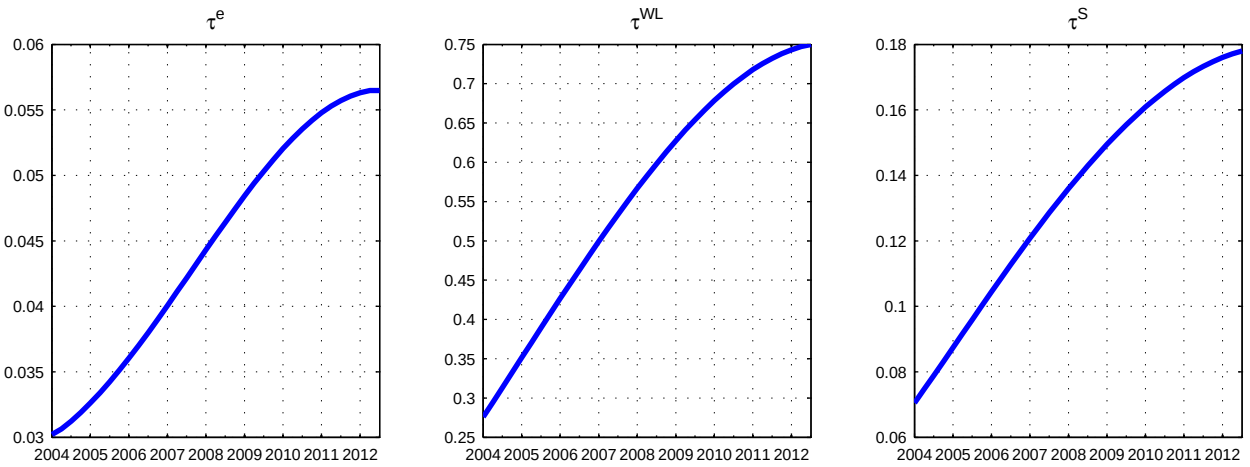

Figure 4: Credit Deepening Experiment: Evolution of τ_t^{WL}, τ_t^S and τ_t^K.

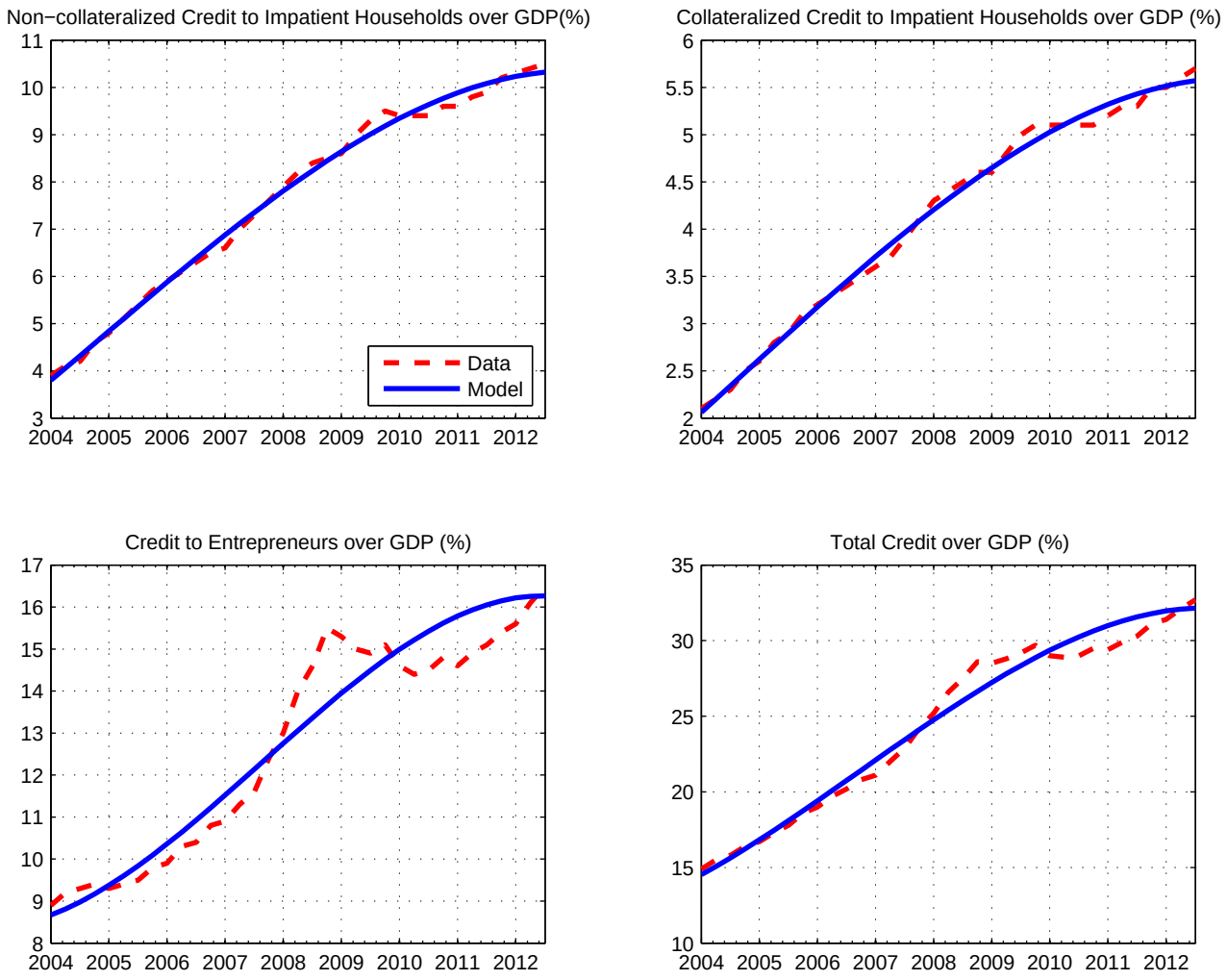

Figure 5: Credit Deepening Experiment: Credit Variables (model and data). See notes in Figure 2 and 3 on how these credit variables are constructed.

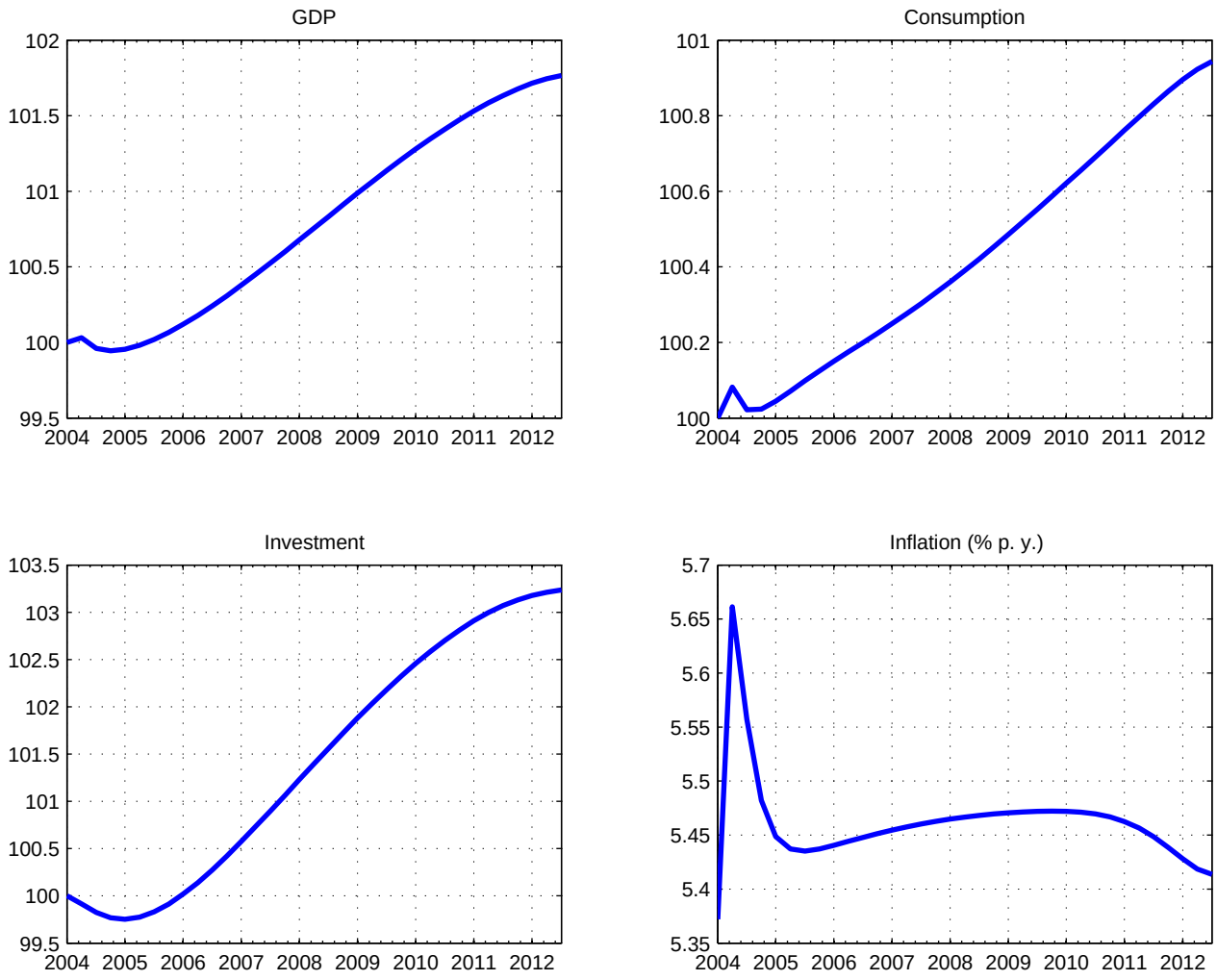

Figure 6: Credit Deepening Experiment: Macro Variables (model).

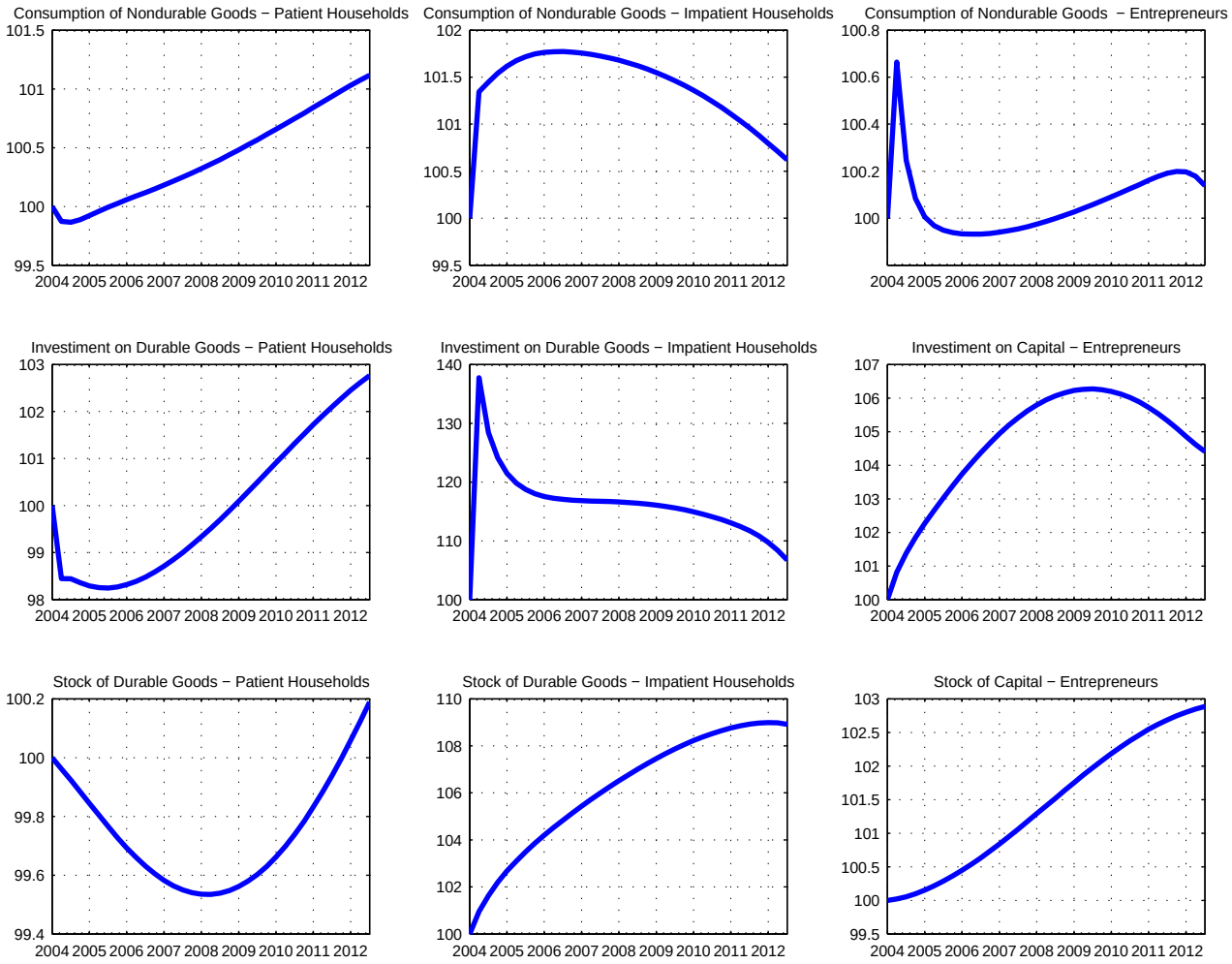

Figure 7: Credit Deepening Experiment: Consumption, Investment and Stocks.

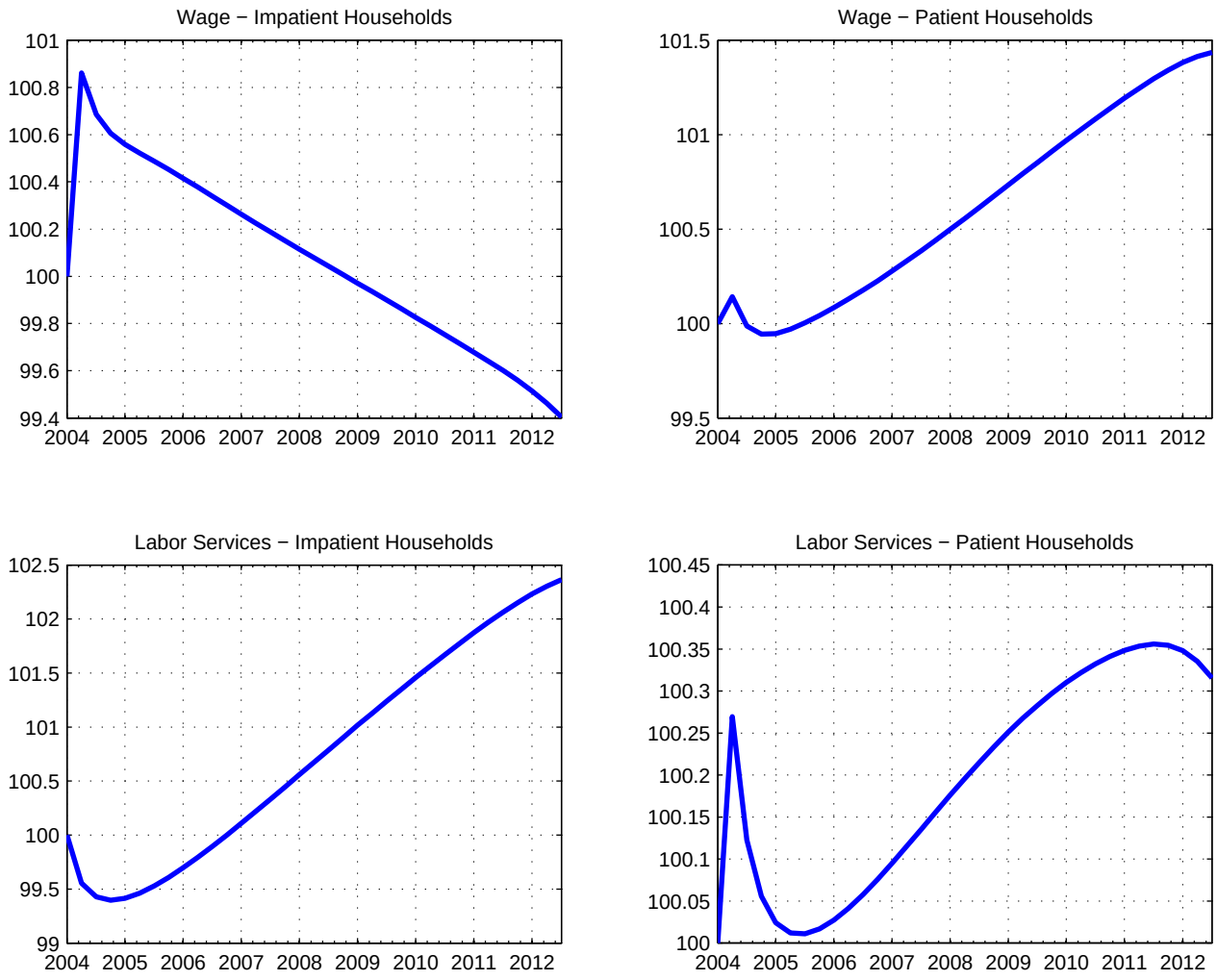

Figure 8: Credit Deepening Experiment: Labor Market Outcomes.

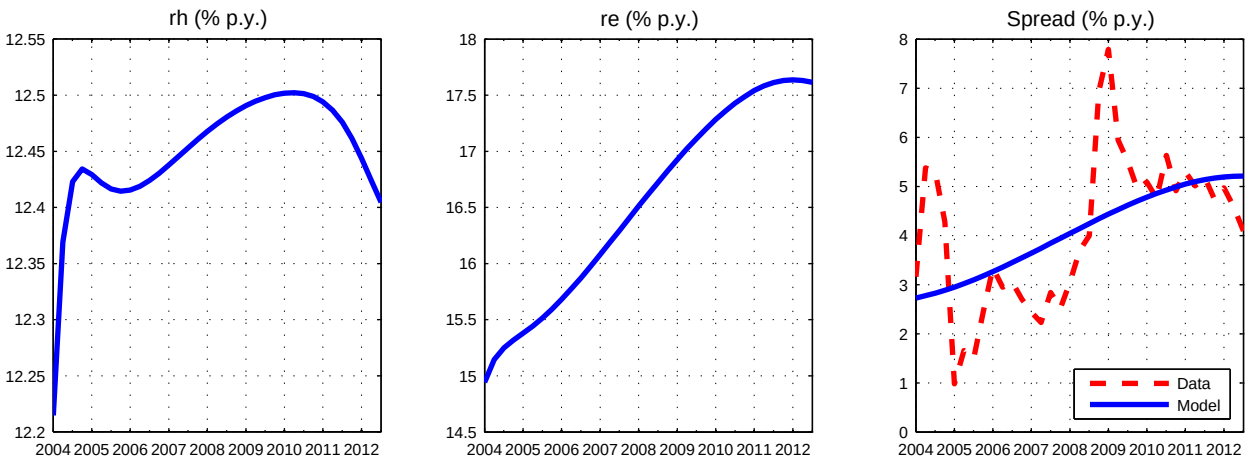

Figure 9: Credit Deepening Experiment: Financial Market Outcomes. The spread is calculated using the SELIC rate, which is the overnight rate in the interbank market targeted by monetary policy, and the Brazilian prime rate, which averages interest rates on loans made to firms that are considered preferential borrowers. For more details on the computation of the Brazilian prime rate, see www.bcb.gov.br/pec/depep/spread/REBC_2011.pdf. Source: Brazilian Central Bank, available at www.bcb.gov.br.

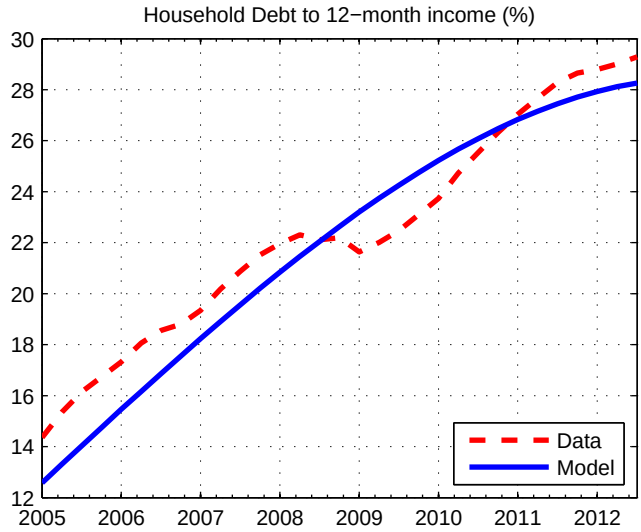

Figure 10: Credit Deepening Experiment: Ratio of Household Debt to Annual Income. Household debt considers only non-earmarked funds held by financial institutions. Annual income is disposable income accumulated over the past 12 months. Source: Central Bank of Brazil, available at www.bcb.gov.br.

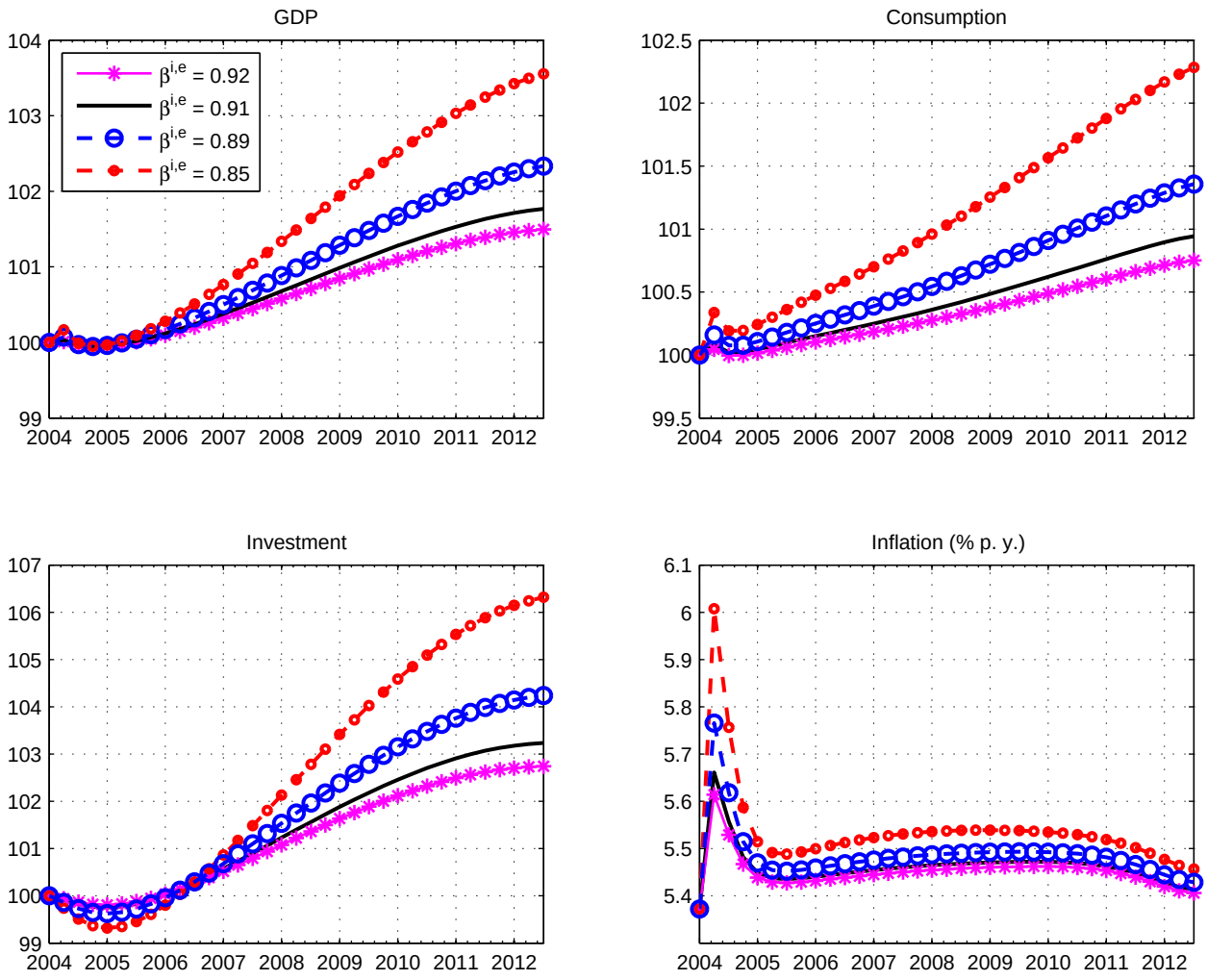

Figure 11: Sensitivity Analysis: β^e and β^i.

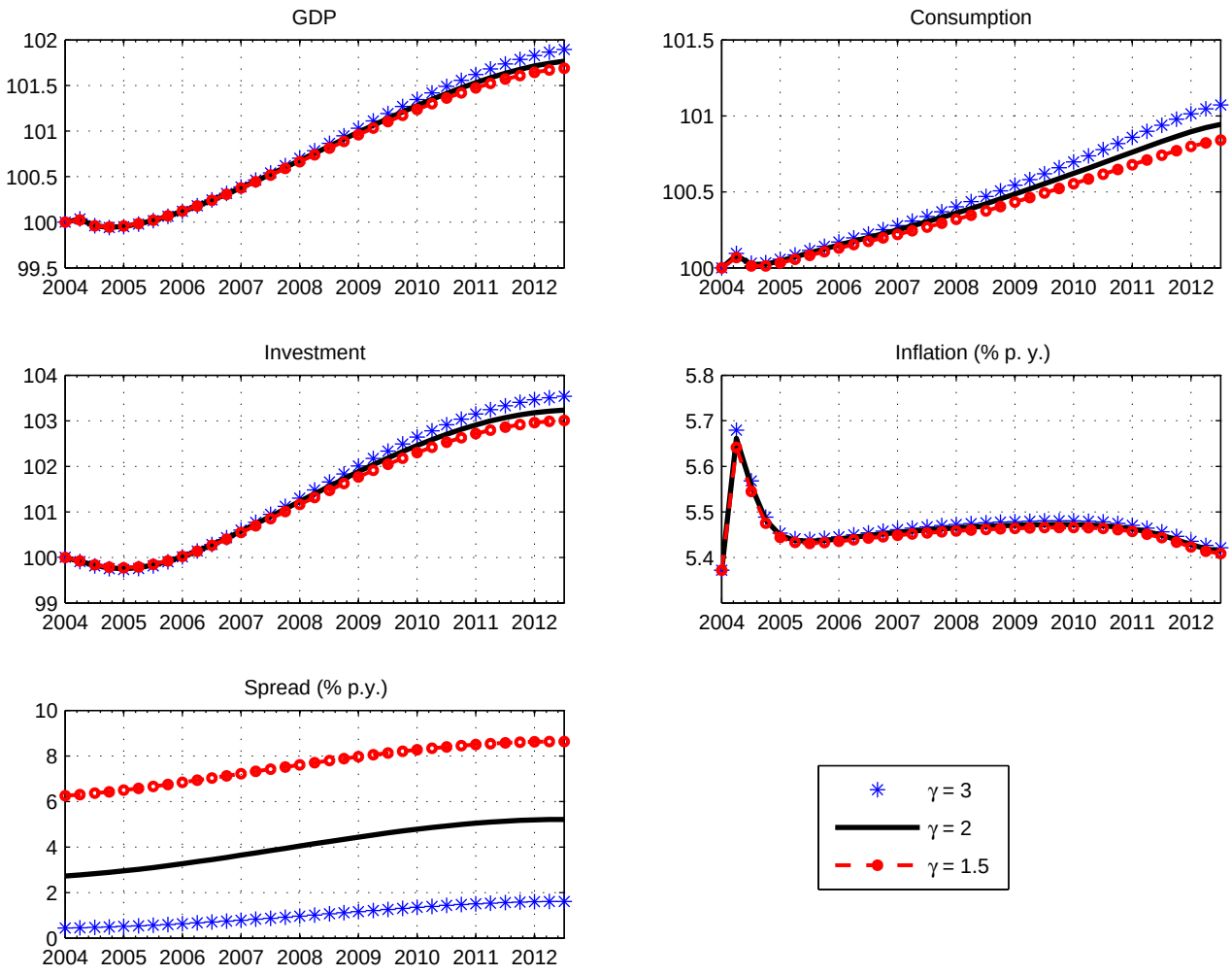

Figure 12: Sensitivity Analysis: γ.

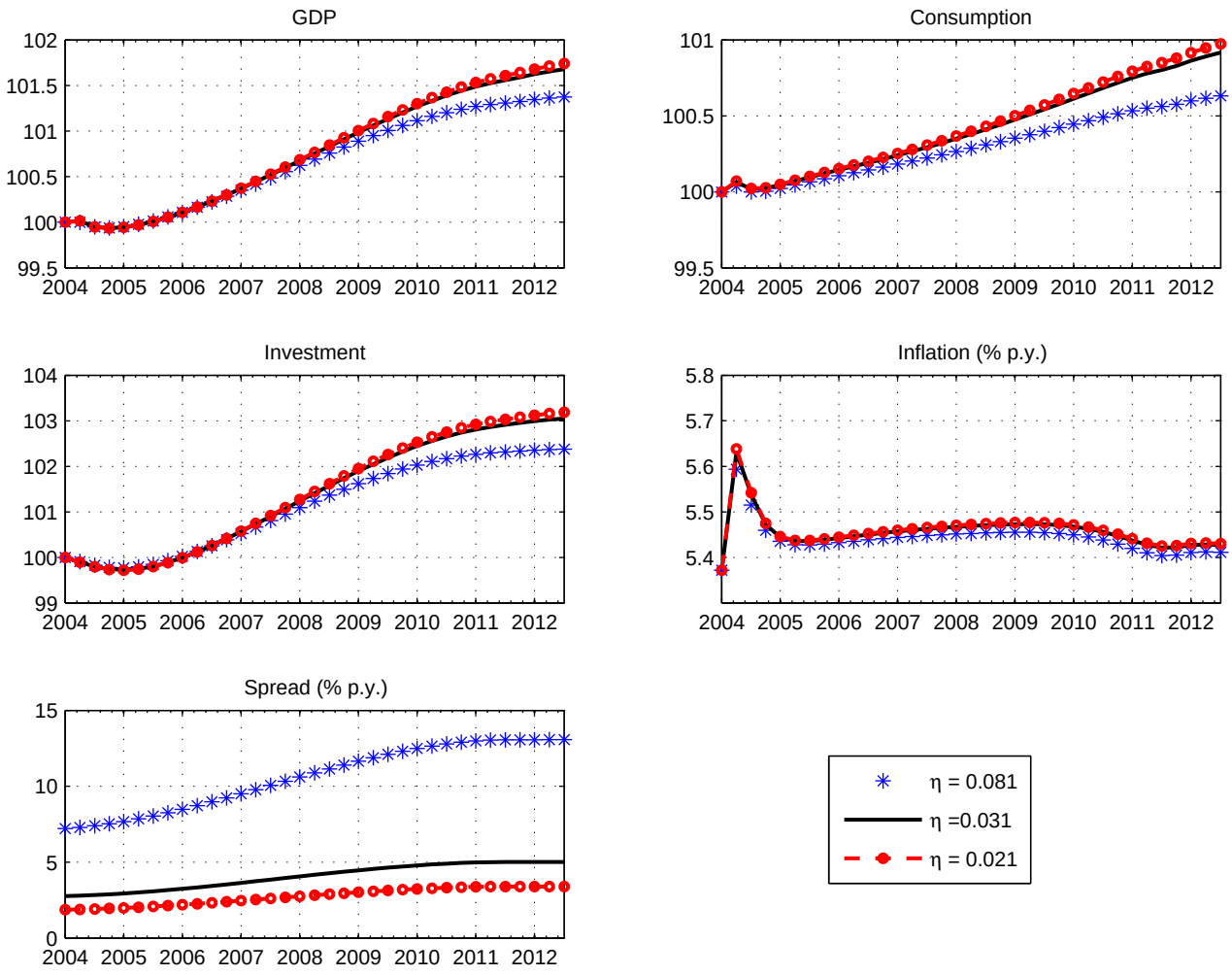

Figure 13: Sensitivity Analysis: η.

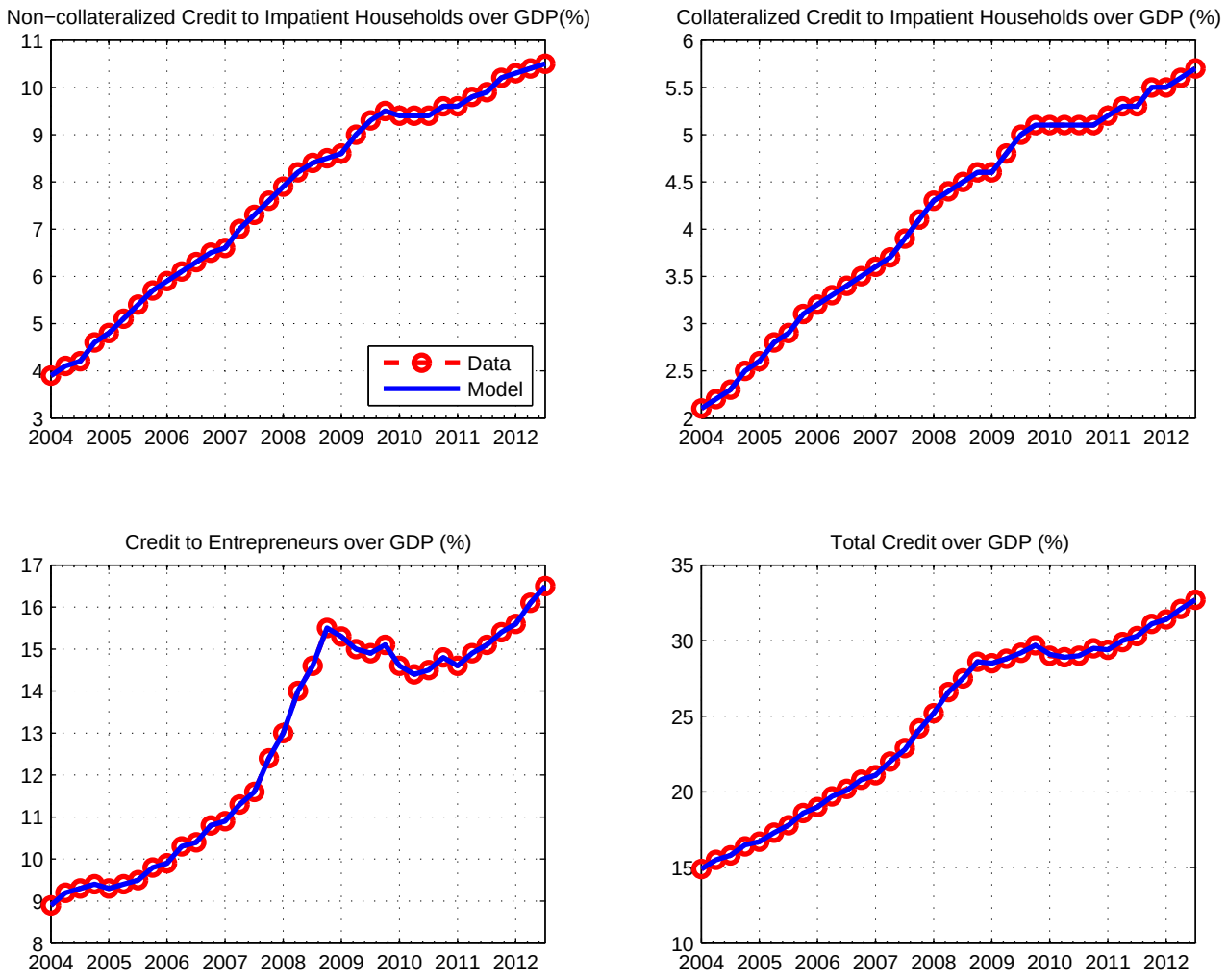

Figure 14: Credit Deepening Experiment (non-smooth): Credit Variables (data and model).

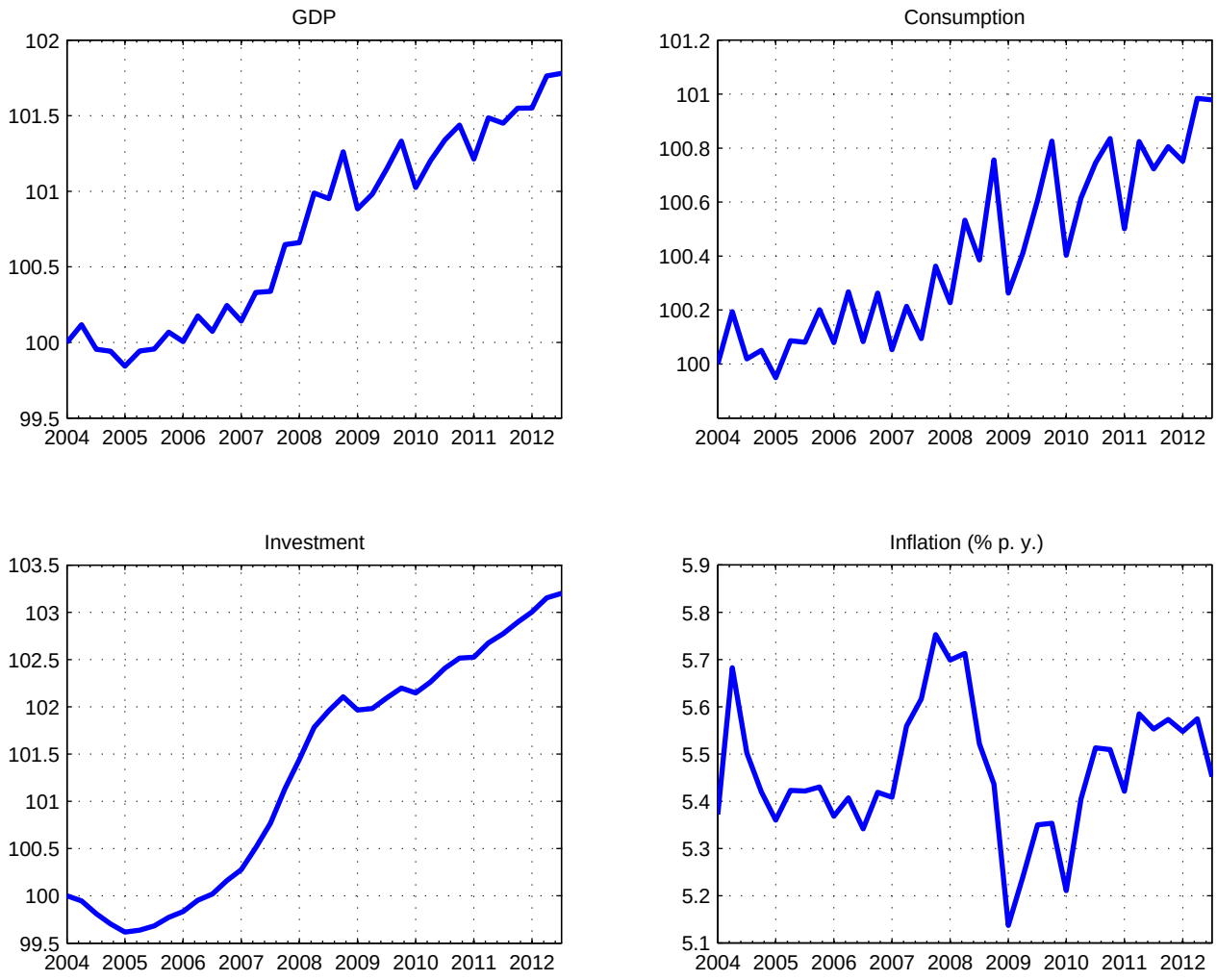

Figure 15: Credit Deepening Experiment (non-smooth): Macro Variables (model).

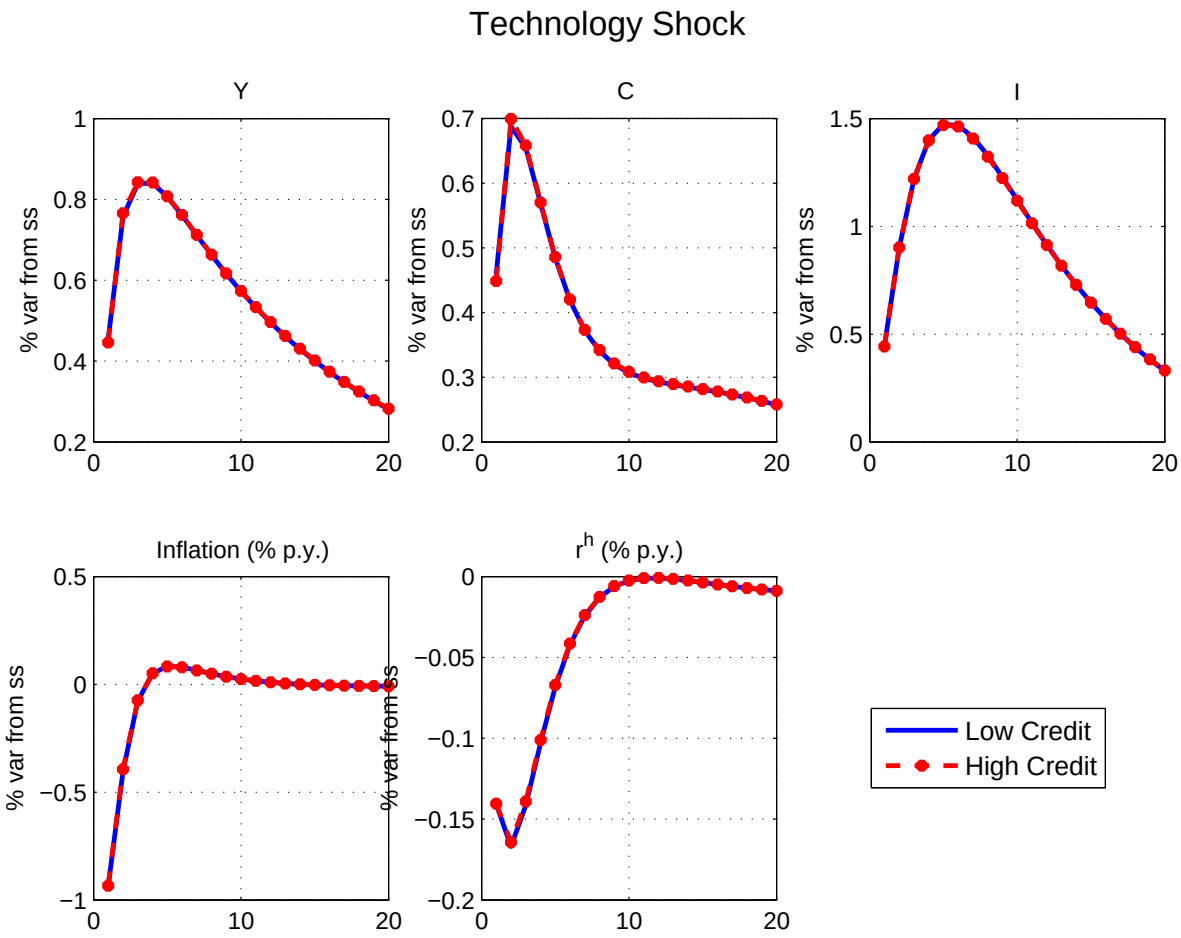

Figure 16: Impulse Response Functions for Selected Variables to a Technology Shock.

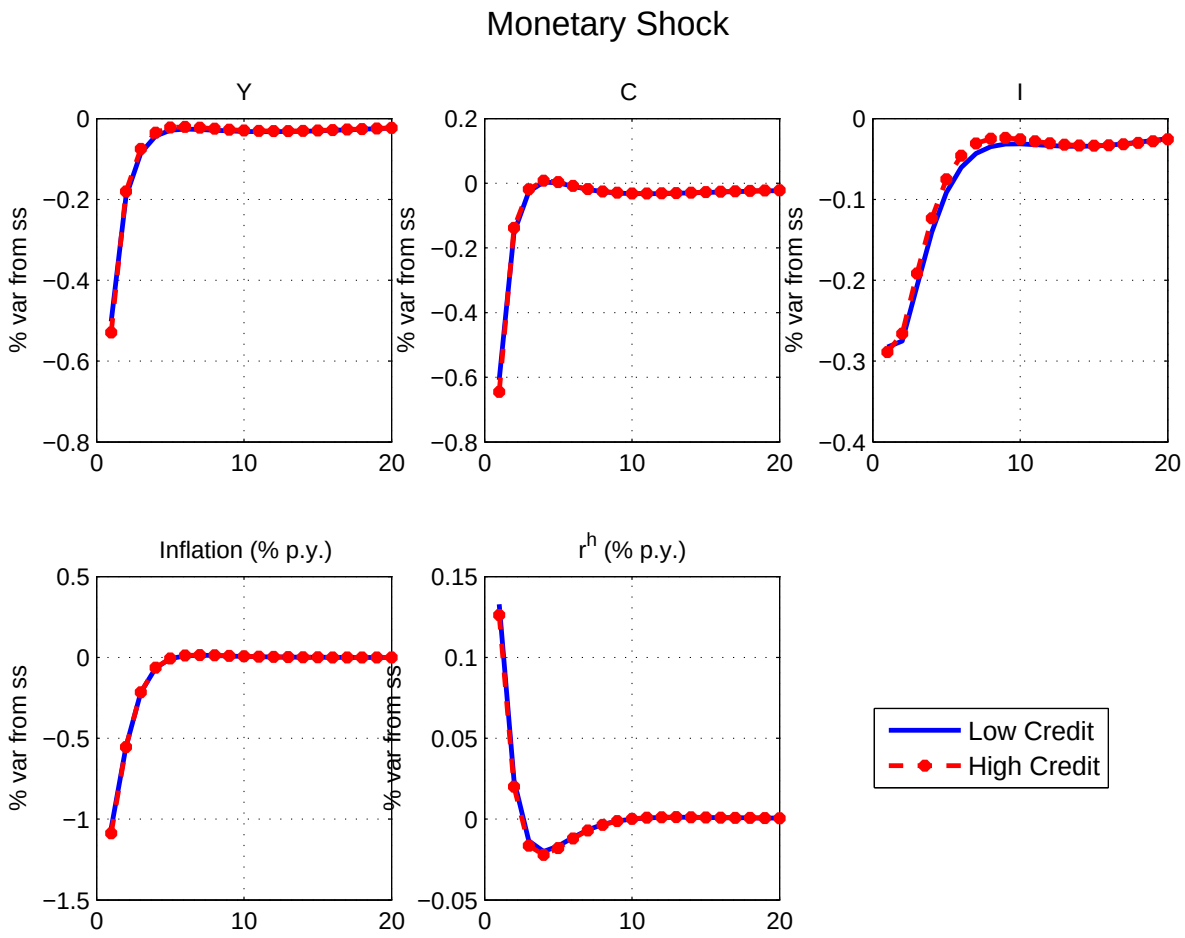

Figure 17: Impulse Response Functions for Selected Variables to a Monetary Policy Shock.

A Detailed Data Sources

A.1 Domestic Credit to Private Sector/GDP

Domestic credit to private sector refers to financial resources provided to the private sector by financial corporations, such as through loans, purchases of non-equity securities, and trade credits and other accounts receivable, that establish a claim for repayment. For some countries these claims include credit to public enterprises. The financial corporations include monetary authorities and deposit money banks, as well as other financial corporations where data are available (including corporations that do not accept transferable deposits but do incur such liabilities as time and savings deposits). Examples of other financial corporations are finance and leasing companies, money lenders, insurance corporations, pension funds, and foreign exchange companies. Source: World Bank (http://data.worldbank.org/indicator/FS.AST.PRVT.GD.ZS).

A.2 Non-Earmarked Credit Outstanding/GDP

Non-earmarked credit outstanding is the nominal balance of credit operations by the National Financial System. Non-earmarked funds refer to financing and loans in which rates and destination are freely negotiated between financial institutions and borrowers, i.e., the financial institution has autonomy to decide to which economic sectors it will lend the funds raised in the market through time deposits, funds raised in foreign markets, part of demand deposits etc. We consider the ratio of the outstanding balance of credit operations at the end of a period to GDP, which is calculated by the Central Bank of Brazil (CBB) through interpolation of available quarterly data. Source: CBB - Data code: 17461.[17]

A.2.1 Non-Earmarked Household Credit Outstanding/GDP

The following types of credit are considered: vehicles financing, other goods financing, mortgages, credit card, personal credit, overdraft and other non-earmarked credit instruments that were not classified in previous types of credit. Source: CBB - Data code: 17483.

A.2.2 Non-Earmarked Corporate Credit Outstanding/GDP

The following types of credit are considered: working capital up to 29 days, working capital over 30 days, discount of trade bills, discount of checks, mortgages, goods financing, vendor credit, advances on exchange contracts (ACC), exports financing, foreign transfers and other non-earmarked credit instruments that were not classified in previous types of credit. Source: CBB - Data code: 17488.

[17] We collected the data from the Portuguese version of the website. Some data are not available in the English version.

A.3 Spread

We construct the spread series as the difference between the Brazilian prime rate and the SELIC overnight interest rate.

A.3.1 Brazilian Prime Rate (% p.y.)

The Brazilian prime rate is calculated as the average of the operations agreed upon between financial institutions and their preferred customers. It tends to reflect the cost of loans for customers with lower risk. Source: CBB - Data code: 20019.

A.3.2 Effective Selic Rate (% p.y.)

Selic rate is defined as the average rate of daily financing in the Special System of Clearance and Custody (Selic) for federal bonds. Source: CBB - Data code: 4189.

A.4 Household Debt

We calculate household debt as the ratio of household non-earmarked debt held by financial institutions to disposable income accumulated over the past 12 months (MSAD). MSAD is a measure of the aggregated total household earnings. It comprises labor income as measured in the Monthly Employment Survey ("Pesquisa Mensal de Emprego") and the National Household Survey ("Pesquisa Nacional por Amostra de Domicílios") from the Brazilian Institute for Geography and Statistics (Instituto Brasileiro de Geografia e Estatística), social security benefits and pensions, and revenues from households' investments in savings deposits, time deposits, Treasury bonds and investment funds, net of income tax on labor earnings, social security collections and taxes on financial investments. Source: CBB - Data code: 19959.