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Working Paper

Macroeconomic Effects of Credit Deepening in Latin America

Texto para discussão, No. 629

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Suggested Citation: Carvalho, Carlos; Pasca, Nilda; Souza, Laura; Zilberman, Eduardo (2014) : Macroeconomic Effects of Credit Deepening in Latin America, Texto para discussão, No. 629, Pontifícia Universidade Católica do Rio de Janeiro (PUC-Rio), Departamento de Economia, Rio de Janeiro

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TEXTO PARA DISCUSSÃO

No. 629

Macroeconomic Effects of Credit
Deepening in Latin America

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Macroeconomic Effects of Credit Deepening in Latin America*

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November, 2016

Abstract

We augment 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 entrepreneurs. Motivated by the Brazilian experience, we allow the credit constraint faced by households to depend on current and/or future labor income. Our model is designed to isolate the effects of credit deepening through demand-side channels. Hence, it abstracts from potential effects of credit supply on total factor productivity, though factor reallocation. 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, we argue that the quantitative effects that hinge on the channels captured by the model are unlikely to be sizable for other LA economies.

JEL classification codes: E20; E44; E51.

Keywords: credit deepening; financial frictions; *consignado* credit; payroll lending.

*For comments and suggestions we thank Sergio Alves, Juliano Assunção, Tiago Berriel, Alan Finkelstein-Shapiro, Douglas Gollin, Cezar Santos, two anonymous referees, and participants at the “Macroeconomics in Emerging Economies” conference held at EESP-FGV, LACEA 2014, INSPER, SBE 2014, and the IDB Discussion Workshop. Authors gratefully acknowledge funding from the IDB under the project “Macroeconomic and Financial Challenges Facing Latin America and the Caribbean after the Crisis”. We also thank Cauê Dobbin for superb research assistance. All errors are ours. The views expressed in this paper are those of the authors and do not necessarily reflect the position of the Central Bank of Brazil or the Central Reserve Bank of Peru. Emails: cvianac@econ.puc-rio.br, nildis87@gmail.com, laurac.souza@gmail.com, zilberman@econ.puc-rio.br.

1 Introduction

In the last decade or so, 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. By credit deepening processes, we mean credit expansions fueled by 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. Figure 1 plots the ratio of domestic credit to GDP for Brazil, Colombia, Ecuador, Mexico, Paraguay and Peru. It shows that these Latin American countries experienced large expansions of domestic credit – most notably, Brazil.

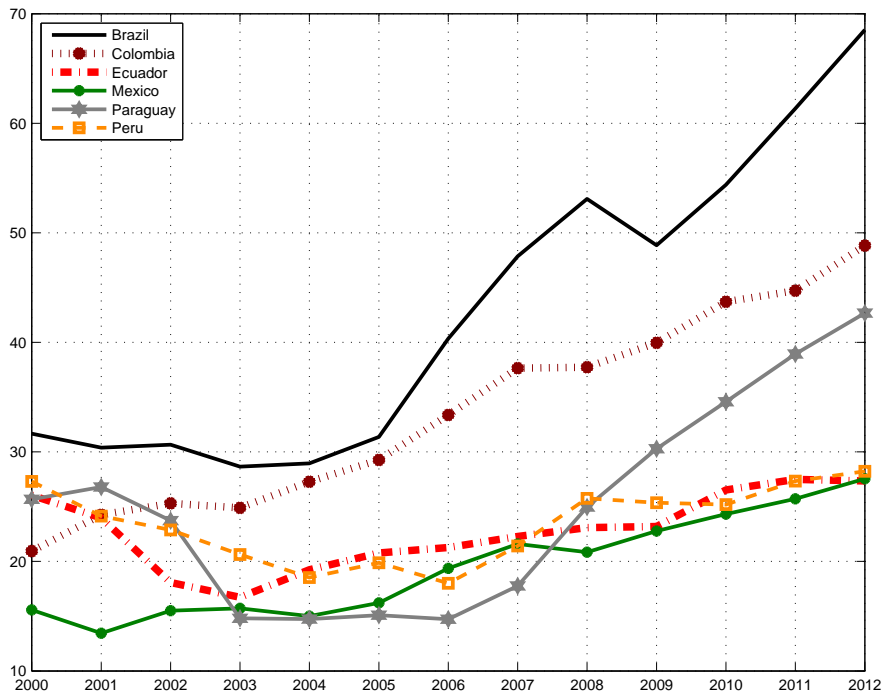


Figure 1: Domestic credit to private sector over GDP. Domestic credit to private sector refers to financial resources provided to the private sector, such as through loans, purchases of nonequity securities, and trade credits and other accounts receivable, that establish a claim for repayment. For some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

While credit deepening is often cited as a factor that contributed to above-trend growth in LA during the 2000s 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. More specifically, our goal is to study the role of credit deepening processes as a source of short-to-medium-run (“above-trend”) growth.¹

¹Hence, our analysis does not speak to the relationship between the functioning of credit markets and long-run

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, our paper departs from these contributions in one specific way. We model the credit constraint faced by (impatient) households as a function of current and/or future labor income.² We do so motivated by the Brazilian experience, which featured a sizable increase in household credit that was *not* associated with purchases of real estate or other collateralizable assets (e.g., durable goods). In Brazil, an important factor behind the credit expansion was the emergence of the 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 the borrower’s stream of 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.³

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 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 meaningfully in the last decade in Brazil (Figure 2 - top plot).⁴

growth. For a review of that literature, see Levine (2005).

²Mendoza (2002) develops a model in which a fraction of consumption has to be financed with current income. This assumption leads to a debt limit that depends on current labor income. In contrast, creditors in our model are repaid out of debtors’ paychecks. The papers that come closest to ours in terms of motivation for the credit limit based on future labor income are Carvalho et al. (2014) and Arruda et al. (2015). Both papers develop a DSGE model for Brazil with financial frictions. The former is interested in the role of macroprudential policies, whereas the latter focuses on the effects of monetary policy.

³Anecdotal evidence suggests that payroll lending has also been growing rapidly in other countries, such as in Mexico: <http://online.wsj.com/news/articles/SB10001424127887323689604578222130866020660>.

⁴As the data in Figure 2 include only non earmarked credit, the ratio of total credit to GDP differs from Figure 1.

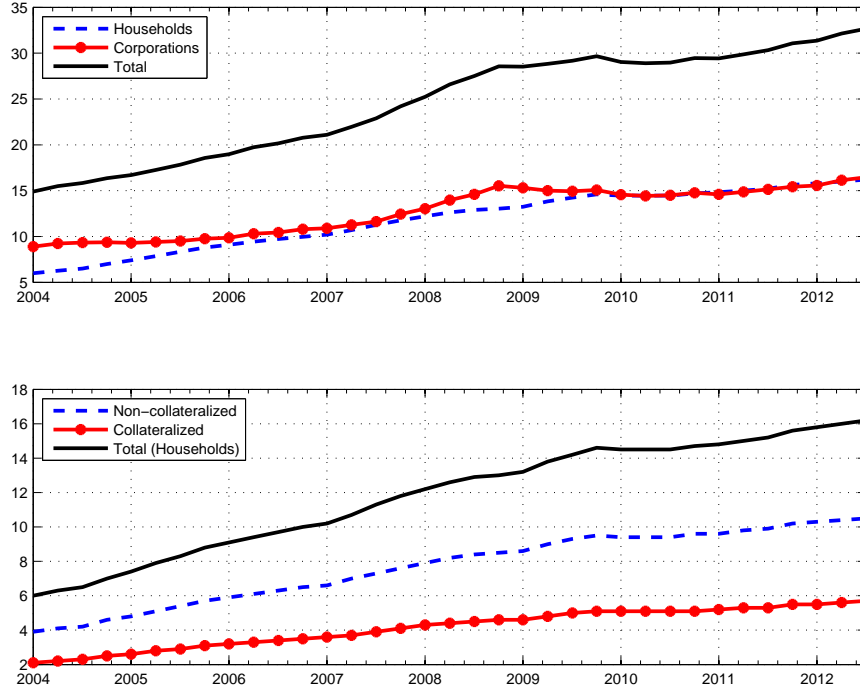


Figure 2: Nonsecured credit outstanding to GDP ratio in Brazil. Nonsecured credit is the nominal outstanding balance of credit operations by the National Financial System. Nonsecured funds refer to financing and loans in which rates and destination are freely negotiated between financial institutions 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. Collateralized credit consists of vehicles financing, other goods financing and mortgages. Non-collateralized credit consists of credit card, personal credit, overdraft and other nonsecured credit instruments that were not classified in previous types of credit. Source: Central Bank of Brazil, available at www.bcb.gov.br.

We calibrate the model to replicate the credit deepening process witnessed in Brazil since 2004. In particular, by emulating a transition from a low-credit to a high-credit steady state, 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 2 - bottom plot).⁵ 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.⁶ We believe that all these

⁵ *Consignado* credit accounts for roughly 60 percent of the increase in non-collateralized credit.

⁶ Of course, other developments – some of each might be induced by policies – may interact with credit deepening. However, due to the arguably exogenous nature of the credit innovations that we emphasize, attributing all of the credit deepening to these innovations within a general equilibrium model seems a natural starting assumption. Investigating

characteristics of the Brazilian economy make it an interesting 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 quite small in absolute terms. Credit deepening increased GDP by only 0.5 percent between 2004 and 2012 (that is, an annual increase of 0.06 percent). Still according to the model, during the same period consumption and investment increased by 0.2 and 0.4 percent, respectively. The effects are also small for arguably extreme calibrations, chosen to generate more sizable aggregate effects in response to such a credit deepening process.⁷ Given that Brazil has experienced one of the most intense credit deepening processes in LA, we argue that analogous parametrizations of the model for other countries are unlikely to produce sizable macroeconomic effects.

Because our model does not feature trend growth, in order to assess the contribution of credit deepening for above-trend growth in Brazil during the period of our analysis, we need to compare the results generated by the model with measures of 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 3.9, 1.1, and 0.9 percent of above-trend growth in GDP, consumption, and investment, respectively. If one is willing to assume an optimistic trend growth of 3.5 percent, the model is able to account for 15.6 percent of above-trend growth in GDP. We conclude that, unless the trend growth rate was quite high during the sample period, the credit deepening process did not play an important role in terms of short-to-medium-term growth.

Almost goes without saying that these conclusions are conditional on our model. In principle, some features that are absent from the model may amplify the macroeconomic effects of credit deepening. We assume, for instance, that Brazil is a closed economy. However, as Justiniano et al. (2015a) conjecture, results could be amplified in small open economies. In that case the demand for credit of one agent does not need to be compensated by higher savings (less consumption) by other agents. Although the assumption that Brazil is relatively closed to trade is realistic, some empirical evidence suggest that Brazil is not closed to financial flows.⁸ Hence, in Appendix C, we address this concern by considering a small open economy version of the model. The macroeconomic effects stemming from the credit deepening process are not amplified. In particular, the effects on GDP are similar, although the dynamics of consumption and investment change somewhat.

In a context of heterogeneous agents and/or firms, credit deepening might interact with occupational choice and/or firm entry. Models with financial frictions and heterogeneous firms can generate misallocation of resources, which has been documented to decrease total factor productivity (Hsieh and Klenow 2009, and subsequent literature).⁹ In addition, financial frictions may be a

possible interactions with other developments is an interesting question for future research.

⁷In our extensive sensitivity analysis, we modify many features of the model. None of these modifications was able to generate sizeable effects.

⁸See, for instance, the financial openness indices reported by Quinn et al. (2011).

⁹Recently, Midrigan and Xu (2014) argue that misallocation generates fairly small losses in a model disciplined by establishment-level data.

barrier to entry of talented, but credit constrained entrepreneurs. Since credit deepening tends to mitigate these financial frictions, one might expect a boost in total factor productivity during the process.¹⁰ As we use a model with representative agents, these channels are shut down.

The innovations mentioned previously (*consignado* credit and change in fiduciary law) are arguably more related to consumer, rather than firm, credit. This led to a common view that the credit deepening process in Brazil fostered growth because it generated a boom in consumption. Put differently, a view that credit deepening stimulated demand, and fostered above-trend growth.¹¹ Our medium-scale dynamic general equilibrium model was designed to study the relevance of this “demand channel” in isolation. By abstracting from the effects of credit deepening on total factor productivity through resource allocation, our analysis isolates this “demand story.” Our findings do not corroborate the view that credit deepening has been an important source of above-trend growth in Brazil – at least not through this “demand channel.”

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. Section 5 concludes.¹²

2 Brief review of the literature

There is a large empirical literature that studies the connections between finance and growth (for a survey, see Levine 2005). This literature suggests that financial development is positively correlated with economic growth. However, purely empirical research may leave some questions unanswered, as the underlying mechanisms that cause growth are hard to identify. Moreover, as Townsend

¹⁰Buera et al. (2011), Buera and Shin (2013) and Dabla-Norris et al. (2015) combine heterogeneous agents (with respect to wealth and entrepreneurial ability) and occupational choice. They find sizable macroeconomic effects stemming from financial frictions. If this channel was relevant in Brazil during the credit deepening process, one might expect the share of entrepreneurs in the labor force to have increased from 2004 to 2012. This can be checked in the data. By using microdata from a Brazilian household survey – *Pesquisa Nacional por Amostra de Domicílios* (PNAD) – we calculate the shares of self-employed and employers (who earn more than the minimum wage) in the labor force from 2004 to 2012. These series remained roughly constant around 10-12% and 3-4%, respectively, during the sample period. This evidence suggests that the credit deepening process in Brazil may not have had much of an effect on total factor productivity through the extensive margin. Although suggestive, this evidence is not conclusive, since the composition of the pool of entrepreneurs may have changed during the process, or other developments may have induced the exit of entrepreneurs.

¹¹This view is reflected in articles in the main newspapers, magazines and web portals in Brazil during the period of analysis. Here we list a few examples. At “InfoMoney.com.br”, a web portal, a 2006 article explains how credit expansion fosters growth by stimulating demand. Similarly, a 2008 article in “Veja” (the largest weekly magazine in Brazil) also endorses this view. As a third example, a 2013 article in “Estadão” (one of the largest daily newspapers in Brazil) argued that consumer credit no longer induced growth in Brazil. These articles are available in Portuguese at <http://www.infomoney.com.br/educacao/guias/noticia/528174/saiba-por-que-aumento-concessao-credito-favorece-economia>, http://veja.abril.com.br/idade/exclusivo/perguntas_respostas/expansao_credito/index.shtml, and <http://www.estadao.com.br/noticias/geral,analise-credito-ao-consumo-nao-e-mais-indutor-do-crescimento-nobrasil,1103864>, respectively.

¹²In Appendix D we use a stochastic version of our calibrated model to study whether credit deepening changes the way in which monetary policy and technology shocks affect the economy. We find that the impulse response functions to both technology and monetary policy shocks are almost identical in economies with low and high levels of credit relative to GDP. That is, the financial frictions we introduce in 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.

and Ueda (2006) emphasize, standard assumptions in regression analysis, such as stationarity and linearity, are often inconsistent with transitional growth paths in theoretical models. Hence, this literature should benefit from insights generated by quantitative analysis, in general equilibrium settings.

Our paper fits a fast growing literature that integrates financial frictions into the new Keynesian workhorse model. Bernake 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 some collateral in a general equilibrium model, and Iacoviello (2005), who introduces this financial friction in 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 the capacity to borrow of an impatient household to some collateral as well. This financial friction allows us emulate the consumer credit expansion we observe in practice. However, instead of using only durable goods (such as housing) as collateral, we also allow some valuation of the borrower's stream of labor income to serve as collateral. This is arguably in line with the Brazilian experience, where housing-related credit is still a relatively a small fraction of household credit and *consignado* credit plays a prominent role.

Financial intermediaries in our model are in line with Curdia and Woodford (2010). In particular, we assume that there is a cost to some intermediation activities, 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 along the transition from a low-credit to a high-credit steady state. In that sense, our work is similar in spirit to Campbell and Hercowitz (2009), who use a general equilibrium model to study the welfare effects of the increase in collateralized debt in the U.S. since the early 1980s. The authors interpret this increase as a direct consequence of the deregulation of the mortgage market triggered by financial innovations. These innovations are modeled as unexpected changes in two key parameters of their model. Our exercise is similar in spirit, as we interpret the credit deepening process in Brazil since 2004 as a direct consequence of the aforementioned innovations in credit markets. In focusing on positive – as opposed to normative – effects of changes in the tightness of borrowing constraints, our paper is also related to Justiniano et al. (2015a), who study the macroeconomic effects of household leveraging and deleveraging in the United States. Similarly, Justiniano et al. (2015b) show that a progressive relaxation of lending – rather than borrowing constraints in the U.S. mortgage market – explains some empirical features of the housing boom between 2000 and 2006, before the Great Recession.

Recent papers use new Keynesian DSGE models with financial frictions to address questions that matter for the Brazilian economy – e.g., De Castro et al. (2011), Da Silva et al. (2012), Kanczuk (2013), Carvalho et al. (2014) and Arruda et al. (2015). However, we are not aware of

other studies of the credit deepening process in Brazil or other Latin American countries using such a model.

Finally, many papers rely on other frameworks with financial frictions to study somewhat related, but different, questions (see the references cited in Dabla-Norris et al., 2015). A recent example is Dabla-Norris et al. (2015), who develop a general equilibrium model in order to identify the relevant financial friction that prevents financial inclusion, in a model with heterogeneous agents (with respect to both wealth and skills) and occupational choice. Some of these papers, such as Buera et al. (2011), Buera and Shin (2013) and Greenwood et al. (2013), find sizable macroeconomic effects stemming from financial frictions.

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.¹³ 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 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 Appendix D 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:

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

where L_t^j , $j \in \{i, p\}$ denotes labor supply. Nondurable and durable consumption are combined in a CES aggregator with elasticity $\frac{1}{1-\sigma}$.

¹³Although many Latin American countries are considered small open economies, we focus on Brazil, which is relatively closed to trade. As one may argue that Brazil is not closed to financial flows, in Appendix C we consider a small open economy version of the model.

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 along 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

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

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 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 inclined to borrow, but face borrowing constraints. 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

$$B_t^i \leq \tau_t^{WL} \tilde{b}_t + \tau_t^S \frac{q_{t+1}^S \pi_{t+1} (1 - \delta_S) S_t^i}{1 + r_t^h},$$

where

$$\tilde{b}_t = \lambda b_t^{fut} + (1 - \lambda) W_t L_t, \quad \text{and} \quad b_t^{fut} = \chi \frac{\pi_{t+1} b_{t+1}^{fut}}{1 + r_t^h} + (1 - \chi) \frac{\pi_{t+1} W_{t+1} L_{t+1}}{1 + r_t^h}.$$

The borrowing constraint above can accommodate several possibilities. If $\lambda = 1$ and $\chi = 0$, as we assume in the benchmark calibration, these equations collapse to

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

This borrowing constraint states that impatient households can borrow in proportion (governed by τ_t^{WL}) to the value of next period's labor income plus an amount in proportion (governed by τ_t^S) to the value of next period's stock of durable goods.

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). Relative to these papers, we also allow the credit constraint to depend on the borrower's stream of labor income. However, in principle, it is not clear how borrowing might depend on income. As a robustness check for our quantitative results, one can set the parameters λ and χ to accommodate different hypothesis. If $\lambda = 0$, for example, current rather than future income enters the borrowing constraint. In contrast, if $\lambda = 1$ and $\chi \rightarrow 1$, the present value of the entire flow of future incomes is used as collateral. Of course, any convex combination of current and the entire flow of discounted future income is possible.¹⁴

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 calibrate τ_t^S to study the expansion of collateralized credit to households.

Finally, 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 (such as car loans) 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.

3.2 Entrepreneurs

Entrepreneurs have preferences given by

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

where, again, $\beta^e < \beta^p$. Moreover, they have access to a production technology that combines labor (L_t^p, L_t^i) and capital K_t to produce a wholesale good Y_t^e . After factoring in market clearing conditions for capital and labor,¹⁵ the production function reads:

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

where A_t is the level of technology,¹⁶ 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.

¹⁴We thank an anonymous referee for suggesting such a recursive structure, nesting different assumptions for how labor income enters the borrowing constraint.

¹⁵Notice that the demand for labor and capital must be weighted by the mass of entrepreneurs, μ^e , whereas the respective supplies must be weighted by the mass of the suppliers. In particular, patient households, impatient households and capital producers have masses μ^p , μ^i and unity, respectively.

¹⁶In our analysis of the transition effects of credit deepening we abstract from technology shocks. In Appendix D we use a stochastic version of the model to analyze their aggregate effects around low-and high-credit steady states.

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 constraint

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

and the borrowing constraint

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

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 . The nominal interest rate faced by entrepreneurs is denoted by r_t^e . We explain below 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 final goods 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 quadratic adjustment costs. 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

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

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 adjustment costs, and Δ_t is the stochastic discount factor of patient households. Any profits originated in this sector are transferred to 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 at relative price q_t^S from both patient and impatient households. The stock of undepreciated durable goods $(1 - \delta_S)(S_{t-1}^p + S_{t-1}^i)$ is transformed one-to-one into new durable goods, while the transformation of final goods into new durable goods is subject to quadratic adjustment costs. 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, and $S_{t-1} = S_{t-1}^p + S_{t-1}^i$. Any profits originated in this sector are transferred to patient households.

3.3.3 Retail firms and final goods producers

In order to introduce price rigidities, we assume monopolistic competition among retail firms.¹⁷ Each retail firm m buys the wholesale good Y_t^e from entrepreneurs at the price P_t^W and differentiates it at no cost. They 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 goods producers are competitive, and they simply aggregate the continuum of differentiated varieties produced by retailers in a CES composite. 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.

¹⁷Price rigidities are really only needed in Appendix D, where we turn to a stochastic version of the model to study the role of credit in propagating a monetary policy shock. We keep them in the baseline specification to avoid switching between different frameworks, and analyze the case of flexible prices in a robustness exercise.

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

$$\sum_{t=0}^{\infty} \frac{P_0}{P_t} \Delta_t \left[P_t(m) Y_t(m) - P_t^W Y_t(m) - \frac{\kappa_P}{2} \left(\frac{P_t(m)}{P_{t-1}(m)} - \pi_{t-1}^t \bar{\pi}^{1-t} \right)^2 P_t Y_t \right],$$

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 originated in this sector are transferred to patient households.

3.4 Banks

For simplicity, we model a single bank that takes 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, the bank collects 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 such cost is given by $\eta(\mu^e B_t^e)^\gamma$, 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 the bank lends to impatient households.

The excess funds of the bank are given by

$$\mu^p D_t - \mu^e B_t^e - \mu^i B_t^i - \eta(\mu^e B_t^e)^\gamma, \quad (4)$$

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

$$\mu^p D_t = (1 + \omega_t) \mu^e B_t^e + \mu^i B_t^i. \quad (5)$$

By plugging (5) into (4), we obtain the following expression for excess funds:

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

which is maximized at $B_t^e = (1/\mu^e)(\mu^e \omega_t / \eta \gamma)^{1/(\gamma-1)}$. 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,

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

where ϕ_π and ϕ_y determine the responses of interest rates to inflation and output stabilization, respectively, $\bar{\pi}$ and \bar{r} are the steady-state levels of inflation and the policy rate, respectively, and u_t^r is a monetary policy shock.¹⁸

3.6 Market clearing and aggregation

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. 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

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

Finally, notice that transfers to impatient households are given by

$$T_t = \frac{\text{sum of profits of all firms, except entrepreneurs, and bank}}{\mu^p}.$$

4 Quantitative analysis

After calibrating the model outlined above, we use it to perform the following exercise. 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 Figure 2). In particular, we emulate a transition from a low-credit to a high-credit steady state. Notice that, by modeling the evolution of τ_t^{WL} , τ_t^S , and τ_t^K , this quantitative exercise is consistent with the idea that a large fraction of the credit expansion was due to institutional changes that fueled the credit deepening process.

In Appendix D, we consider a stochastic version of the model. The aim is to evaluate the propagation mechanism of both technology and monetary policy shocks (which we add to the

¹⁸In our analysis of the transition effects of credit deepening we abstract from monetary policy shocks. In Appendix D we analyze their aggregate effects around low- and high-credit steady states.

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

Steady state inflation is set to 5.5% per year (5.35% on a logarithmic basis). 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% on a logarithmic basis). This value is in line with the sample average of the SELIC interest rate, which is the short rate targeted by the Central Bank of Brazil.

Regarding the discount factors for borrowers, we set $\beta^i = \beta^e = 0.96$, which is associated with an annual “subjective time-discount rate” of 18 percent. We pick this arguably extreme value for two reasons. First, as we show below, lower values for β^i and β^e enhance the ability of the model to produce meaningful aggregate effects in response to credit deepening. Second, with higher values for β^i and β^e , the borrowing constraints for impatient households and entrepreneurs do not bind at times during the transition.¹⁹ In particular, we set $\beta^i = \beta^e$ at the maximum level that guarantees that credit constraints always bind along the transition.

The Frisch elasticity $1/\varphi$ is set to one, which is within the range commonly used in the literature. We follow Fernandez-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 consumption composite becomes a Cobb-Douglas aggregate, $(C_t^j)^\xi (S_t^j)^{1-\xi}$, $j = i, p$, 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).

¹⁹For a recent article that deals with credit constraints that bind occasionally, see Guerrieri and Iacoviello (2014).

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 $\eta = 0.0122$ 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 helps the model produce more meaningful aggregate effects in response to the credit deepening process.

Recall that we set $\lambda = 1$ and $\chi = 0$ such that the borrowing constraint of the impatient household depends on next period’s labor income. 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 the masses μ^p , μ^i and μ^e equal to one. Table 1 summarizes the calibration procedure.

Parameter	Description	Value
β^p	Discount Factor - Patient HH	0.9834
β^i, β^e	Discount Factor - Impatient HH and Entrepreneurs	0.96
μ^p, μ^i, μ^e	Mass - Patient HH, Impatient HH and Entrepreneurs	1
φ	Inverse of the Frisch Elasticity	1
$\frac{1}{1-\sigma}$	Elasticity Between Nondurable and Durable Goods	1
ξ	Weight of the Nondurable Good in 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 HH 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	Interest Rate Smoothing Parameter	0.79
ϕ_y	Response to Output in Taylor Rule	0.16
ϕ_π	Response to inflation in Taylor Rule	2.43
η	Scale of Intermediation Cost Function	0.0122
γ	Convexity of Intermediation Cost Function	2

Table 1: Calibration. See Section 4.1 for details.

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 Justiniano et al. (2015a), 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. Notice that this economy starts from a low-credit steady state and, then, converges to a new high-credit steady state.²⁰ We focus the analysis on the first eight years (short-to-medium-term) of the transition. In Appendix A, we report the calibrated paths for τ_t^{WL} , τ_t^S , and τ_t^K .

Figure 3 compares the credit deepening experiment in the model with the data.²¹ 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”).²²

²⁰To 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.

²¹Because we use a model with “representative agents” for each type of agent in the economy, the resulting paths for τ_t^{WL} , τ_t^S , and τ_t^K should be interpreted as encompassing both the intensive and extensive (“adoption”) margins underlying the credit deepening process.

²²To 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 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.

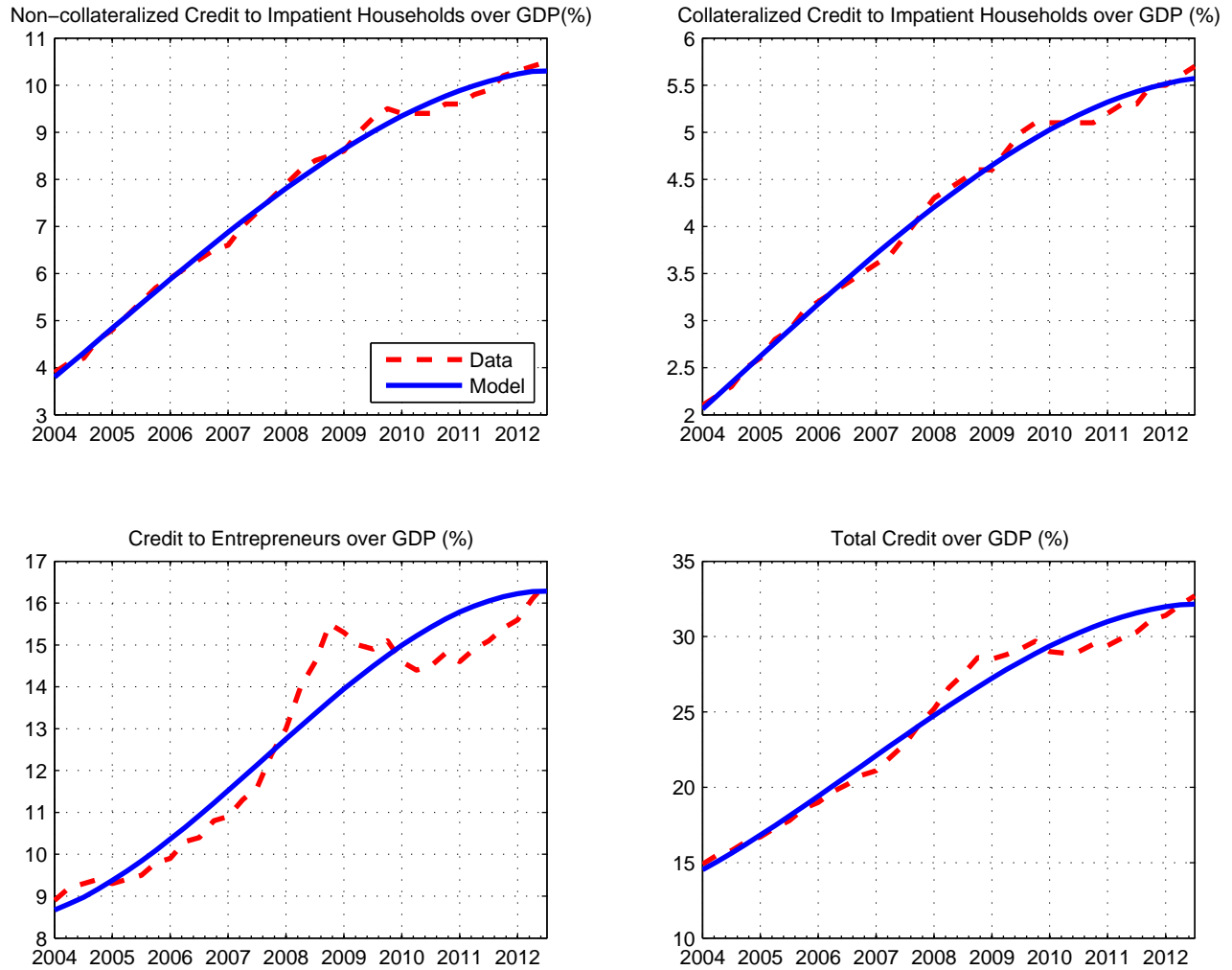


Figure 3: Credit deepening experiment: credit variables (model and data). See notes in Figure 2 on how these credit variables are constructed.

Figure 4 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 approximately 0.5 percent, consumption by 0.2 percent, and investment by 1.2 percent.

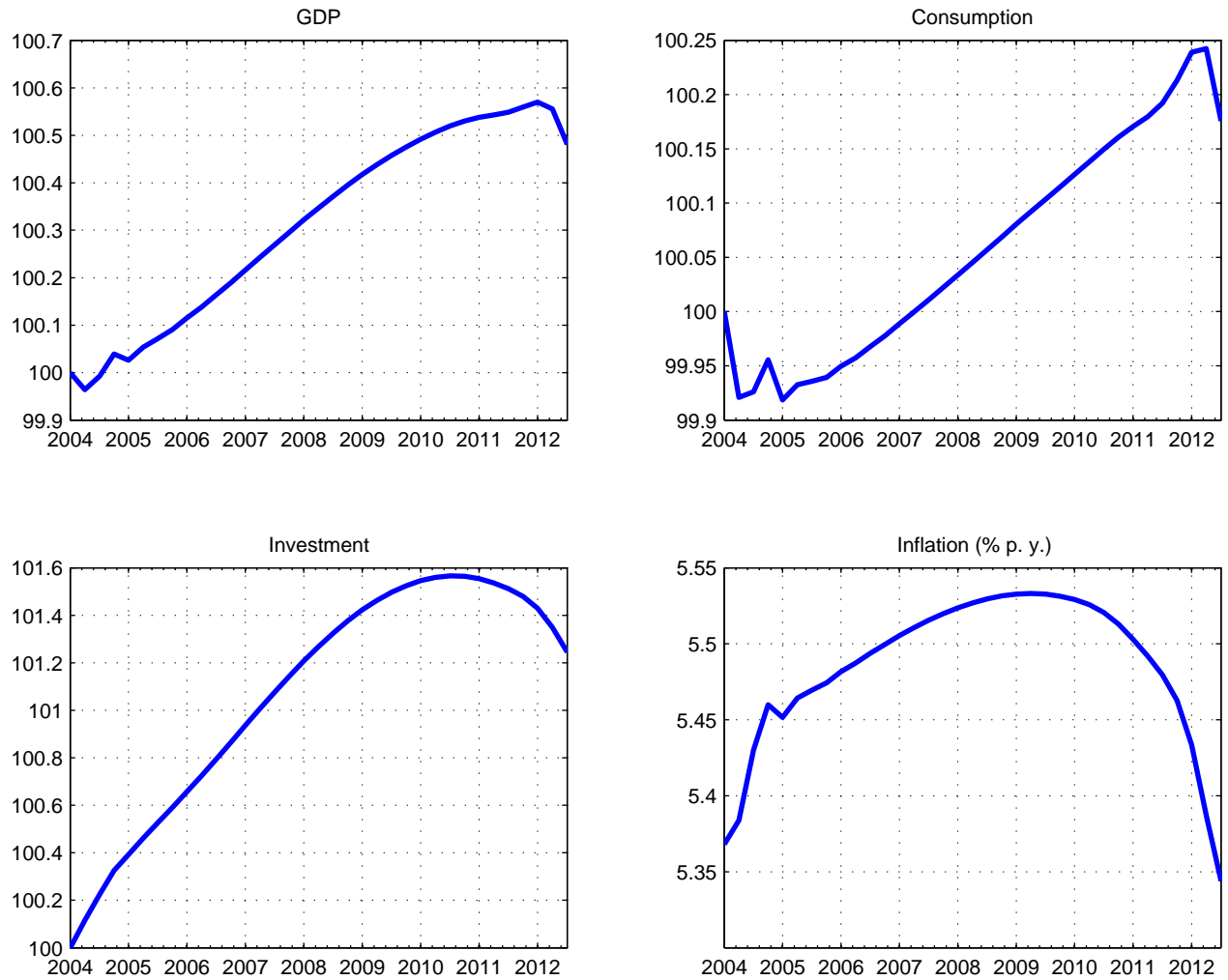


Figure 4: Credit deepening experiment: macro variables (model).

Consumption in the model aggregates nondurable consumption across types of agents, whereas investment aggregates investment in both durable goods by households and capital by entrepreneurs. Figure 5 reports the evolution of these variables, as well as the evolution of the stock of durable goods and capital by types of agents.

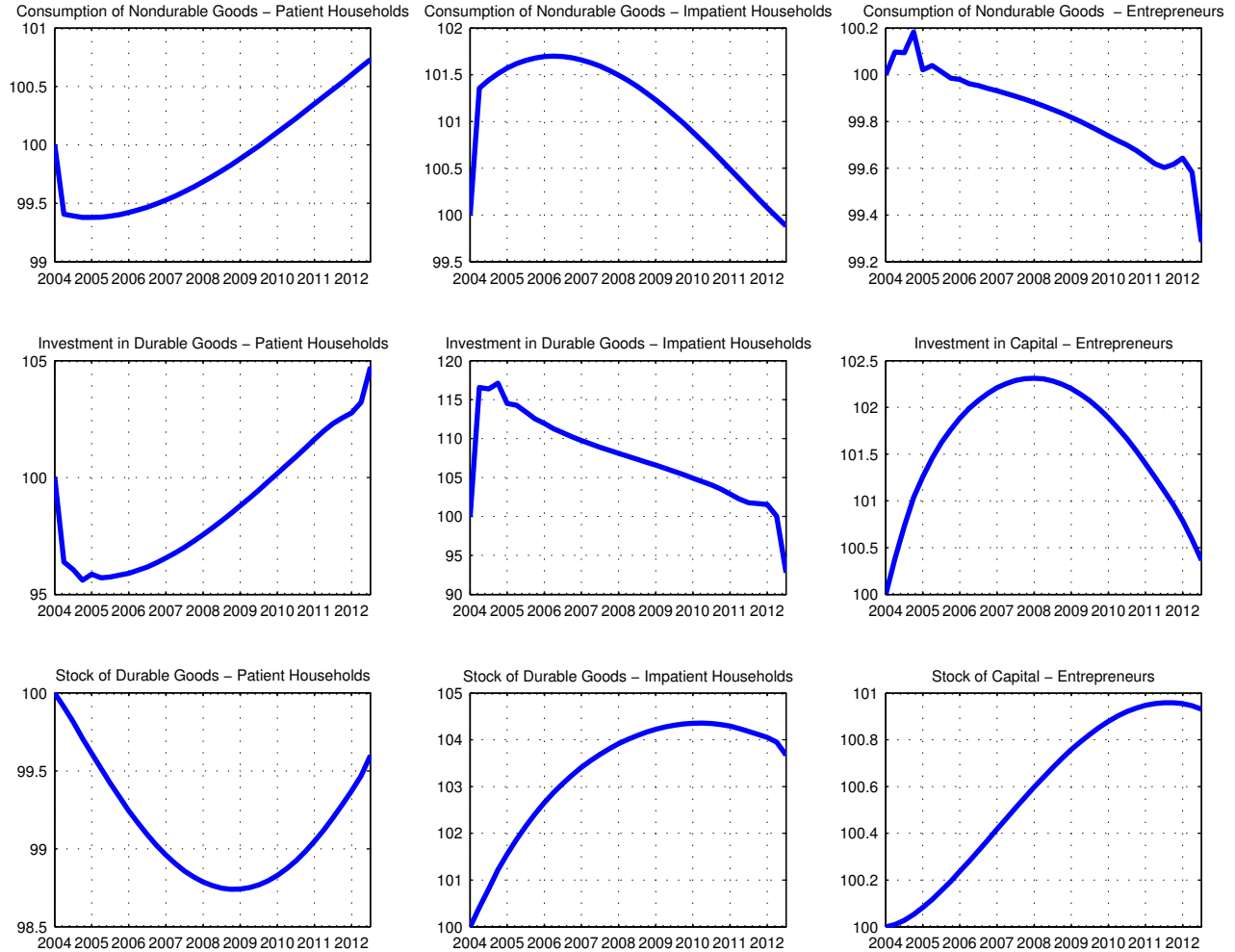


Figure 5: Credit deepening experiment: macro variables (model), by type of agents.

Once the credit deepening process starts, credit constraints faced by both impatient households and entrepreneurs ease, leading them to consume and invest more. In order to clear markets, the price of the nondurable good must increase 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, whereas the stock of durable goods follows a U-shaped pattern. In the first years of the process, market clearing prices imply that patient households exchange durable for nondurable goods. As patient households accumulate more wealth during the transition, they can eventually sustain a higher level of consumption of both durables and non-durables.

After the initial spike of 17 percent, investment of impatient households declines, whereas, after reaching its peak in 2006, consumption starts to decline. Notice also that the impatient households' stock of durable goods follows an inverse U-shaped pattern. At the beginning of the credit deepening process, credit-constrained households can expand consumption of both durables and non-durables.

As patient households get wealthier and, thus, increase the demand for these goods, market clearing prices lead the impatient ones to reduce their purchases.

In terms of magnitude, the strongest effects of credit deepening are on investment in durable goods by patient households, which increases by almost 5 percent from 2004 to 2012. In contrast, investment in durable goods by impatient households falls by 7 percent.

Along the transition, investment in capital follows an inverse U-shaped path, leading to an increase in the stock of capital by almost 1 percent. Notice also that entrepreneurs' consumption of nondurable goods falls by almost 0.7 percent, whereas investment increases by 0.4 percent (after reaching a peak of 2.3 percent). Finally, in Appendix A we report and discuss results pertaining to both labor and financial market outcomes.

Figure 6 shows that the model can replicate reasonably well the trends of both the spread and the average household debt to annual income observed in the data. While our calibration targets their average levels, it is not disciplined by their time paths. Hence, as these variables directly relate to the credit market conditions, the model seems to be capturing at least some important aspects of the credit deepening process witnessed in Brazil.

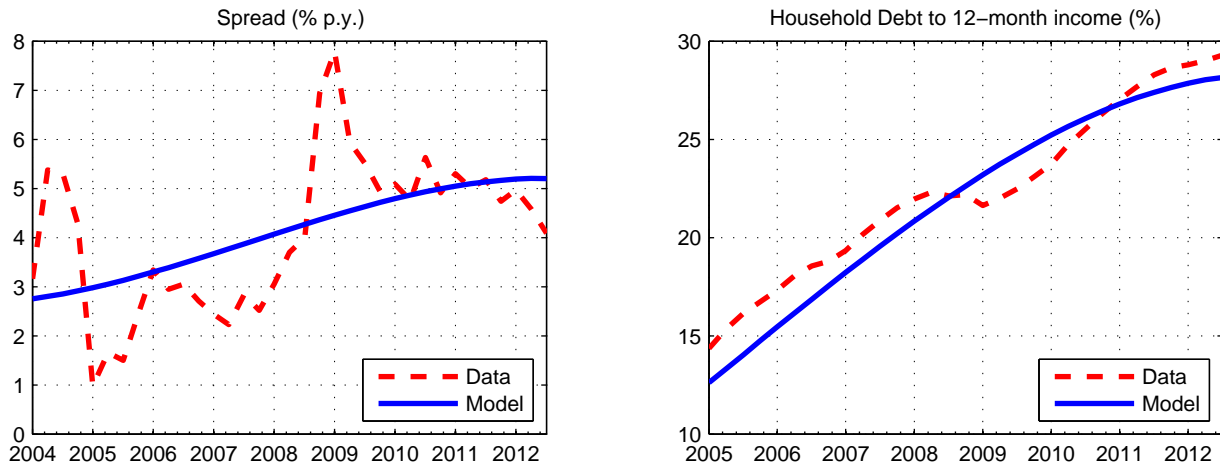


Figure 6: Credit deepening experiment: spread and ratio of household debt to annual income. The spread is calculated using the SELIC rate, which is the overnight rate in the interbank market targeted by monetary policy, and the Brazilian prime rate, which averages interest rates on loans made to firms 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. Household debt considers only non earmarked funds held by financial institutions. Annual income is disposable income accumulated over the past twelve months. Source: Central Bank of Brazil, available at www.bcb.gov.br.

In absolute terms, the effects of the credit deepening process are small. 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 more sizable 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 3.9, 1.1, and 0.9 percent of above-trend growth in GDP, consumption, and investment, respectively.²³ Under more optimistic assumptions about trend growth, the model can account for up to 15.6% of the gap for GDP. In contrast, if trend growth is only 1.5 percent, the credit deepening process accounts for only 2.2 percent of above-trend GDP growth.

	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): 0.5%		Growth (model): 0.2%		Growth (model): 0.4%		Growth (model): 0.4%	
Trend growth (% p.y.)	Above trend growth (%)	Model share (%)	Above trend growth (%)	Model share (%)	Above trend growth (%)	Model share (%)	Above trend growth (%)	Model share (%)
1.5%	23.1%	2.2%	29.8%	0.7%	29.8%	1.3%	59.7%	0.7%
2.0%	17.7%	2.8%	24.2%	0.8%	24.2%	1.6%	52.8%	0.8%
2.5%	12.7%	3.9%	18.8%	1.1%	18.8%	2.1%	46.2%	0.9%
3.0%	7.8%	6.4%	13.7%	1.5%	13.7%	2.9%	39.9%	1.0%
3.5%	3.2%	15.6%	8.9%	2.2%	8.9%	4.5%	34.0%	1.2%

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.

Altogether, these results highlight that, unless trend growth rate was very high during this period, the credit deepening process did not play an important role in Brazil in terms of generating short-to-medium-term growth – at least not through the lens of this model.

4.3 Sensitivity analysis

In this section, we show that even “extreme” calibrations of time-discount rate parameters, chosen to enhance the ability of the model to produce above-trend growth in response to credit deepening process, fail to generate sizable macroeconomic effects. We also argue that price stickiness is not the driving force behind our results. We show that the magnitude of the macroeconomic effects barely changes with alternative modeling of borrowing constraints. Moreover, we show that our conclusions do not change when we consider a transition that matches the paths of credit variables pointwise. Furthermore, we show that the macroeconomic effects are slightly higher if we drop the assumption that the credit deepening process is perfectly foreseen. 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

²³In 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 2.1 percent of above-trend growth.

(results available upon request, but not reported for brevity). We summarize our findings below, and present the associated figures in Appendix B, for brevity. In addition, Appendix C shows that the macroeconomic effects are not amplified in a small open economy version of the model.

Borrower impatience Recall that we calibrate $\beta^e = \beta^i = 0.96$. This is the maximum level of $\beta^e = \beta^i$ that guarantees that borrowing constraints are binding throughout the transition. This value is associated with an annual “subjective time-discount rate” of 18 percent, which may already seem high. In this section, we further decrease $\beta^e = \beta^i$ to 0.93 and 0.91, corresponding to even higher annual “subjective time-discount rates” of 34 and 46 percent, respectively. The lower β^e and β^i are, the higher the impact of the credit deepening process on aggregate variables is.

For $\beta^e = \beta^i = 0.93$ (0.91), GDP, consumption and investment increase, respectively, by nearly 1.2 (1.7), 0.6 (1.0), and 3.5 (5.0) percent between 2004 and 2012. These figures are higher than their counterparts in the benchmark calibration, but still small in absolute terms, given the marked increase in measures of credit over GDP. In relative terms, if trend growth is 2.5 percent, the credit deepening process accounts for 9.4 (13.4) percent of above-trend GDP growth. If trend growth is 3.5 percent, this figure increases to 37.5 (53.1) percent.

Spread A spread of 4 percent per year might be arguably too low for a calibration that targets the Brazilian economy. To assess the sensitivity of our results to the level of spread, we vary separately the parameters γ and η , associated with the financial intermediation technology, to produce different levels of spread. Higher – and perhaps more realistic – levels of spread are associated with smaller macroeconomic effects of the credit deepening process. Similarly, lower levels of spread amplify the macroeconomic effects of credit deepening a bit. Intuitively, spreads are positively associated with intermediation costs, which drain resources from the economy.

Alternative borrowing constraints As we emphasize above, in our baseline specification we assume that impatient households’ credit limit depends on next period’s labor income and on the value of durable goods. In order to inspect the relevance of this assumption, we consider other parametrizations of the borrowing constraint. By imposing that the path of τ_t^{WL} is equal zero, and then calibrating the sequence of τ_t^S to match the trajectory of total (instead of collateralized) credit to households, we eliminate the direct dependence of borrowing on labor income. Alternatively, we also consider a case in which only future labor income matters. To do so, the path of τ_t^S is set equal to zero, whereas τ_t^{WL} is set to match the path of total credit to households. The effects on GDP barely change with these alternative borrowing constraints, although the effects on consumption and investment are a bit affected, but still very modest. We conclude that whether collateral is future labor income or the value of durables does not affect our main findings. However, consumption of durable goods by impatient households is strongly affected by the presence of durable goods as collateral in their borrowing constraint.

Finally, we also run a specification keeping durable goods as collateral, but setting $\lambda = 0$, so that current rather than future income enters the borrowing constraint. We also consider a

parametrization that sets $\lambda = 1$ and $\xi = 0.95$, so that the entire flow of future labor incomes serves as collateral (see Section 3.1.2).²⁴ For each specification, we recalibrate the sequence of credit shocks to match the credit variables observed in the data. Results are largely independent of the specification used.

Flexible prices One may wonder about the relevance of price stickiness for our results. To analyze this issue, we set the parameter that determines the degree of price stickiness, κ_P , equal to zero – thus eliminating price rigidities from the model. Except for tiny differences in the first and last few periods, the trajectories of output, investment, consumption, and inflation overlap almost perfectly with those produced by the baseline calibration.²⁵

Non-smooth transition We also consider a transition between steady-states in which the perfectly foreseen paths of τ_t^{WL} , τ_t^S , and τ_t^K are chosen to fit the trajectories of the credit variables pointwise. In order to guarantee that borrowing constraints always bind during the transition, we decrease both β^e and β^i to 0.93. This non-smooth transition does not change our conclusion that, through the lens of the model, the macroeconomic effects of the credit deepening process observed in Brazil are small.

Finally, in addition to the non-smooth transitions that fit the volumes of credit, we also consider cases in which the path for either γ or η is chosen to fit the path of the spread pointwise (we continue to assume that $\beta^e = \beta^i = 0.93$).²⁶ The conclusion that the macroeconomic effects are modest survives.

Unanticipated shocks The assumption that agents perfectly foresee the intensity of the credit deepening process over such a long horizon might be unrealistic. Hence, as a last robustness exercise, we solve the model under an assumption on the other extreme of the “foresight spectrum”. Namely, we assume that the credit deepening process takes the form of a sequence of unanticipated shocks to the parameters that govern the credit constraints. Reality should arguably be somewhere in between these two extremes assumptions about agents’ foresight. In each period, agents are surprised by the values of τ_t^{WL} , τ_t^S , and τ_t^K , but assume they will remain constant thereafter. Shocks are chosen to fit the trajectories of the credit variables under perfect foresight. In order to guarantee that borrowing constraints always bind during the transition, we need to decrease the values of β^e and β^i to 0.91, so results should not be compared with those under the benchmark calibration (but they can be compared to the results under perfect foresight with $\beta^e = \beta^i = 0.91$ – see Appendix B). At the end of the sample period, the macroeconomic effects of credit deepening are close to those generated under the benchmark calibration. However, during the first few years of the transition, output and consumption are between one and one and a half percent higher than their counterparts

²⁴Recall that $\lambda = 1$ and $\xi \rightarrow 1$ imply that the present value of the entire flow of future incomes is used as collateral.

²⁵Nevertheless, we decided to keep price rigidities in the model in order to study the interactions between the level of credit in the economy and monetary policy (see Appendix D).

²⁶Notice that the benchmark calibration endogenously replicates fairly well the trend of the spread observed in the data. Hence, as robustness check, we consider only the case with non-smooth transition.

under the perfect foresight assumption. Nonetheless, the conclusion that, conditional on the model, the macroeconomic effects of credit deepening are relatively small still holds.²⁷

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 small.

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

Almost goes without saying that this conclusion is conditional on our model. As Justiniano et al. (2015a) argue, results may change in the context of a small open economy, in which the supply of credit is perfectly elastic at a given interest rate. In this case, the macroeconomic effects of credit deepening may be amplified, as the expansion of the demand for credit by impatient households and entrepreneurs does not need to be compensated by higher savings on the part of patient households. In Appendix C, we show that such amplification does not occur in a small open economy version of the model. In particular, the effects on GDP are similar, although the dynamics of consumption and investment change somewhat.

Likewise, models with heterogeneous agents and firms subject to credit frictions may produce different results. Some papers in this literature have found sizable macroeconomic effects stemming from financial frictions (e.g., Buera and Shin, 2013). These frictions may induce misallocation of production factors, and barriers to entry of productive but credit-constrained firms. Hence, as the credit deepening process mitigates financial frictions, a boost in total factor productivity may occur. Of course, these channels are shut down in models with representative agents, such as the one we use. Indeed, our medium-scale dynamic general equilibrium model is not readily manageable to incorporate a meaningful channel that links credit supply and total factor productivity, as in, for example, Buera and Shin (2013). In particular, it is geared towards analyzing the “demand story” of above-trend growth due to a credit-induced consumption boom, which fits common wisdom about what happened in Brazil. This view, however, is not corroborated by our quantitative analysis.

²⁷The credit trajectories under unanticipated shocks are slightly below their counterparts under perfect foresight. Thus, if anything, there is a tiny “bias” against finding higher macroeconomic effects.

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A Figures: Additional results

A.1 Calibrated paths of τ_t^{WL} , τ_t^S , and τ_t^K

Figure 7 plots the trajectories 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 close to their counterparts in the data.

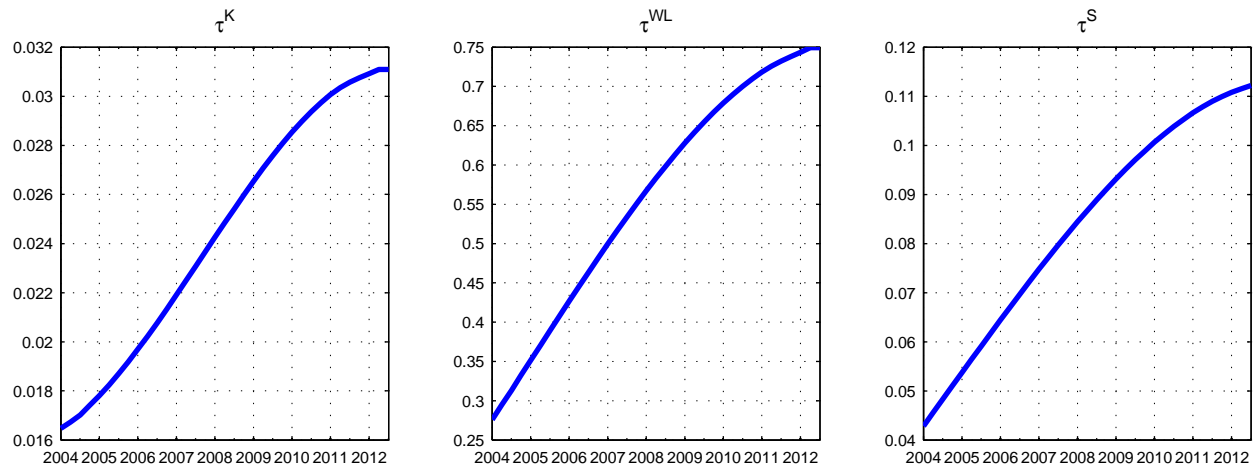


Figure 7: Credit deepening experiment: evolution of τ_t^K , τ_t^{WL} and τ_t^S .

A.2 Labor market outcomes

Figure 8 shows the evolution of labor market outcomes. As in Justiniano et al. (2015a), 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 0.8 percent, whereas those supplied by patient households barely decrease. Moreover, notice that after some point patient households end up earning more, while the impatient ones earn less.

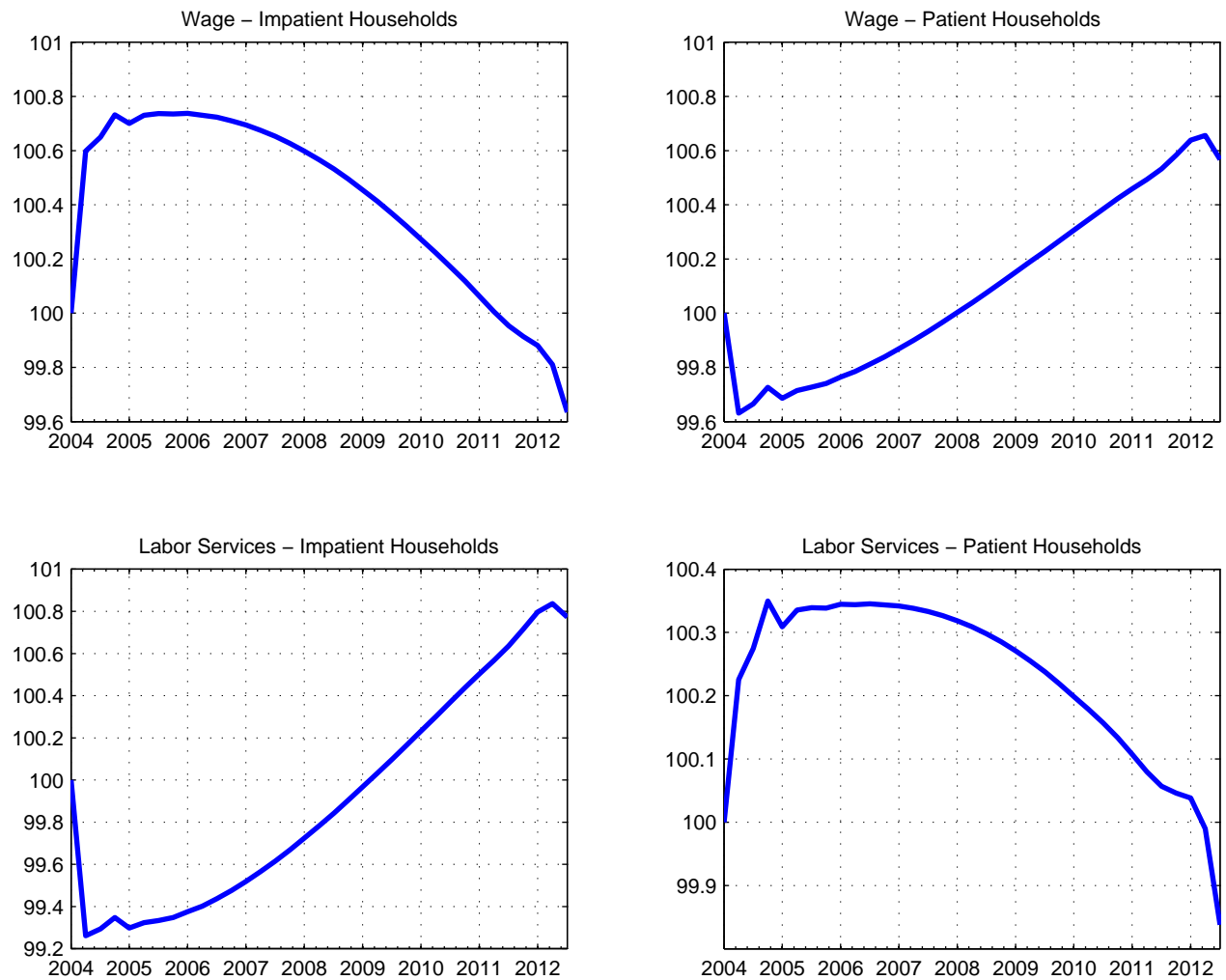


Figure 8: Credit deepening experiment: labor market outcomes.

A.3 Financial market outcomes

Figure 9 shows the evolution of financial market outcomes, i.e. interest rates. After an initial increase of roughly 0.4 percentage point (from the steady state value of 11.8 percent per year), the interest rate that accrues on deposits follows an inverse U-shaped pattern with its peak at 12.6 percent. As the credit deepening process evolves, the interest rate faced by entrepreneurs increases substantially – and so does the spread (see Figure 6, left plot, in the main text). In fact, as entrepreneurs get into debt, the intermediation costs to generate these funds increase, yielding higher interest rates and spreads.

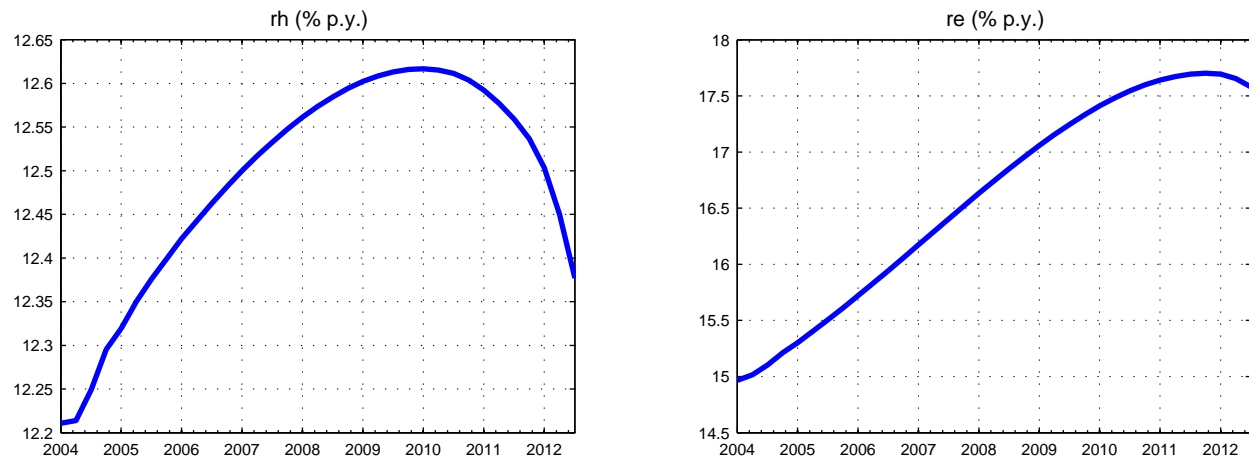


Figure 9: Credit deepening experiment: financial market outcomes.

B Figures: Sensitivity analysis

B.1 Borrower impatience

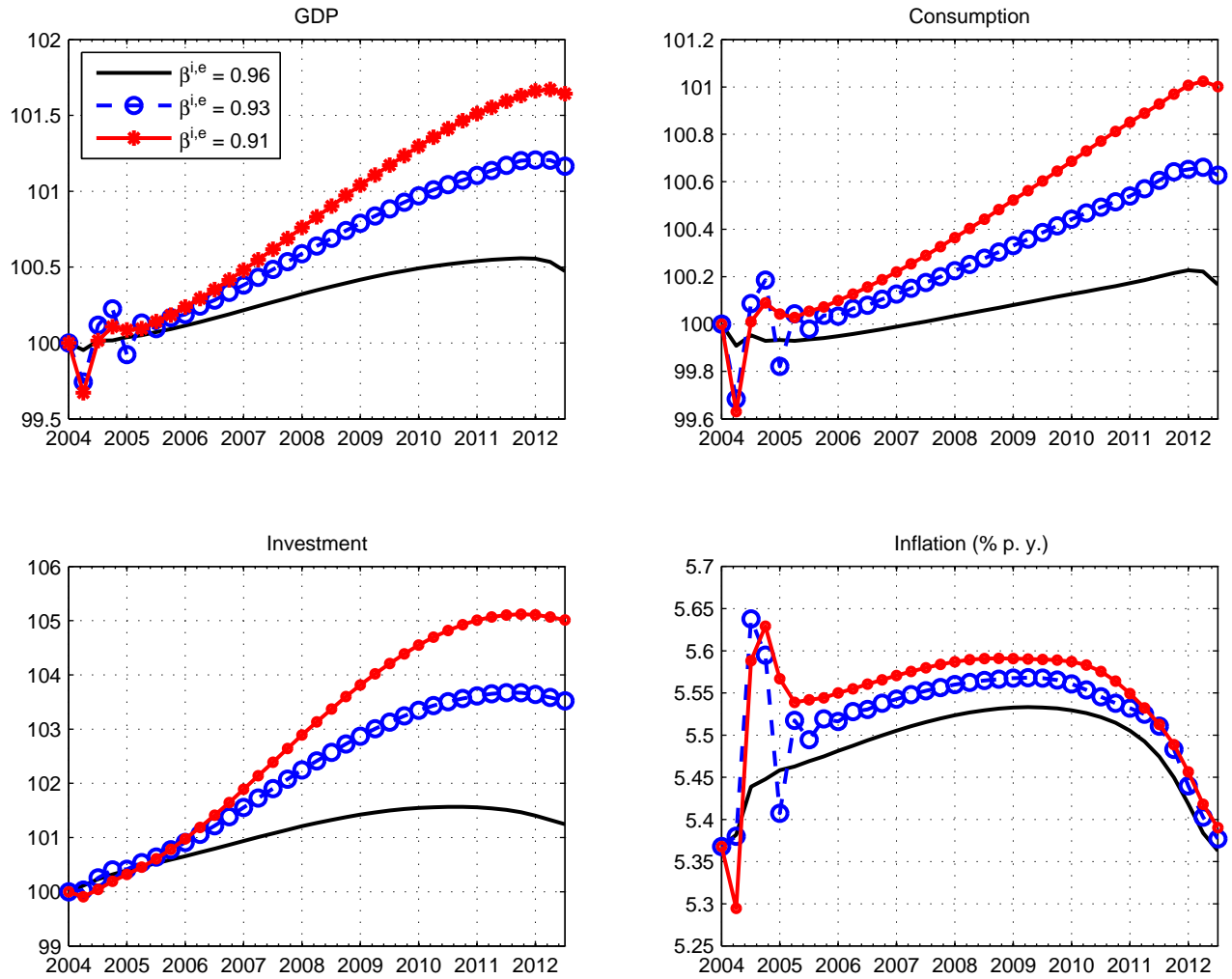


Figure 10: Sensitivity analysis: β^e and β^i .

B.2 Spread

B.2.1 Varying γ

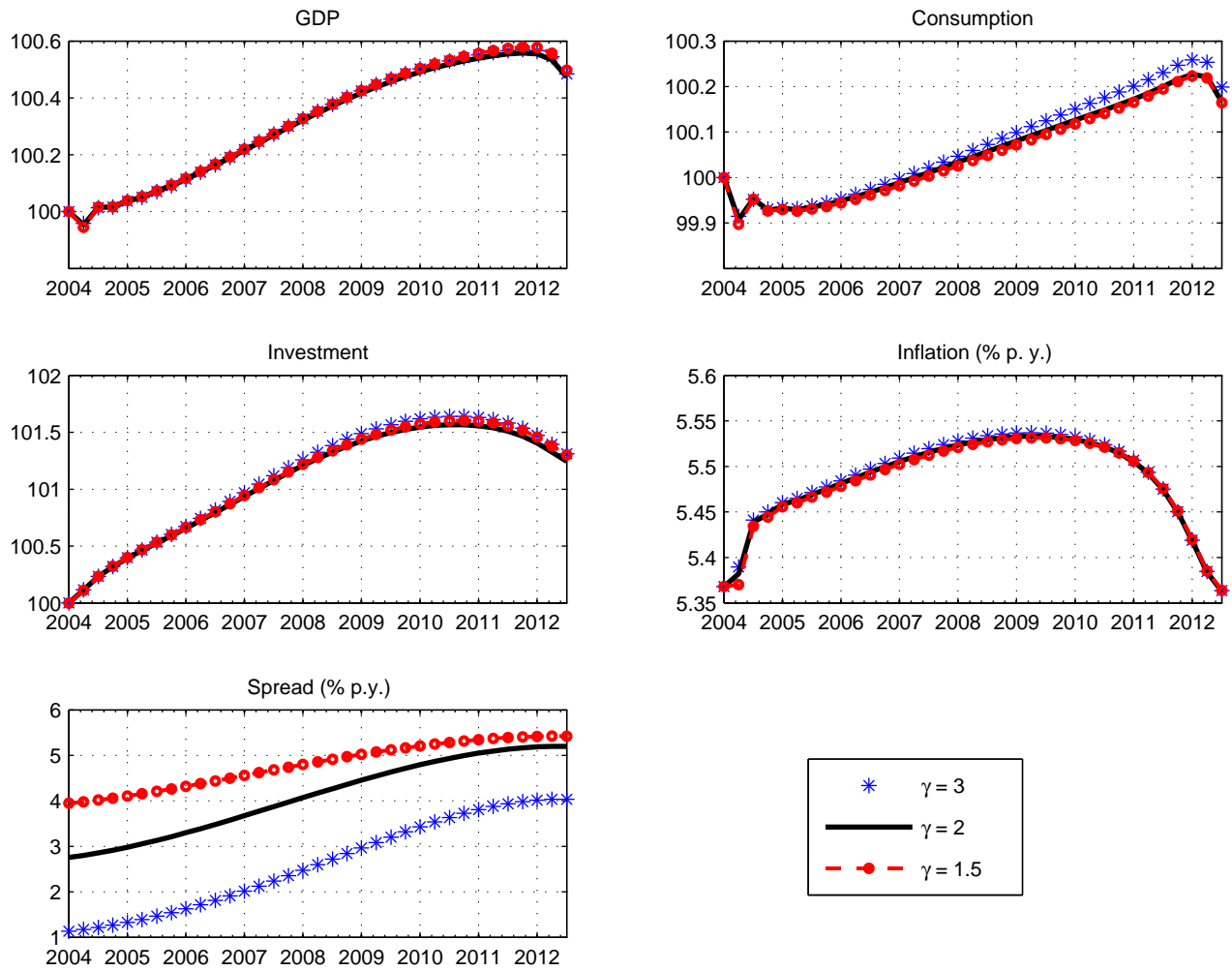


Figure 11: Sensitivity analysis: γ .

B.2.2 Varying η

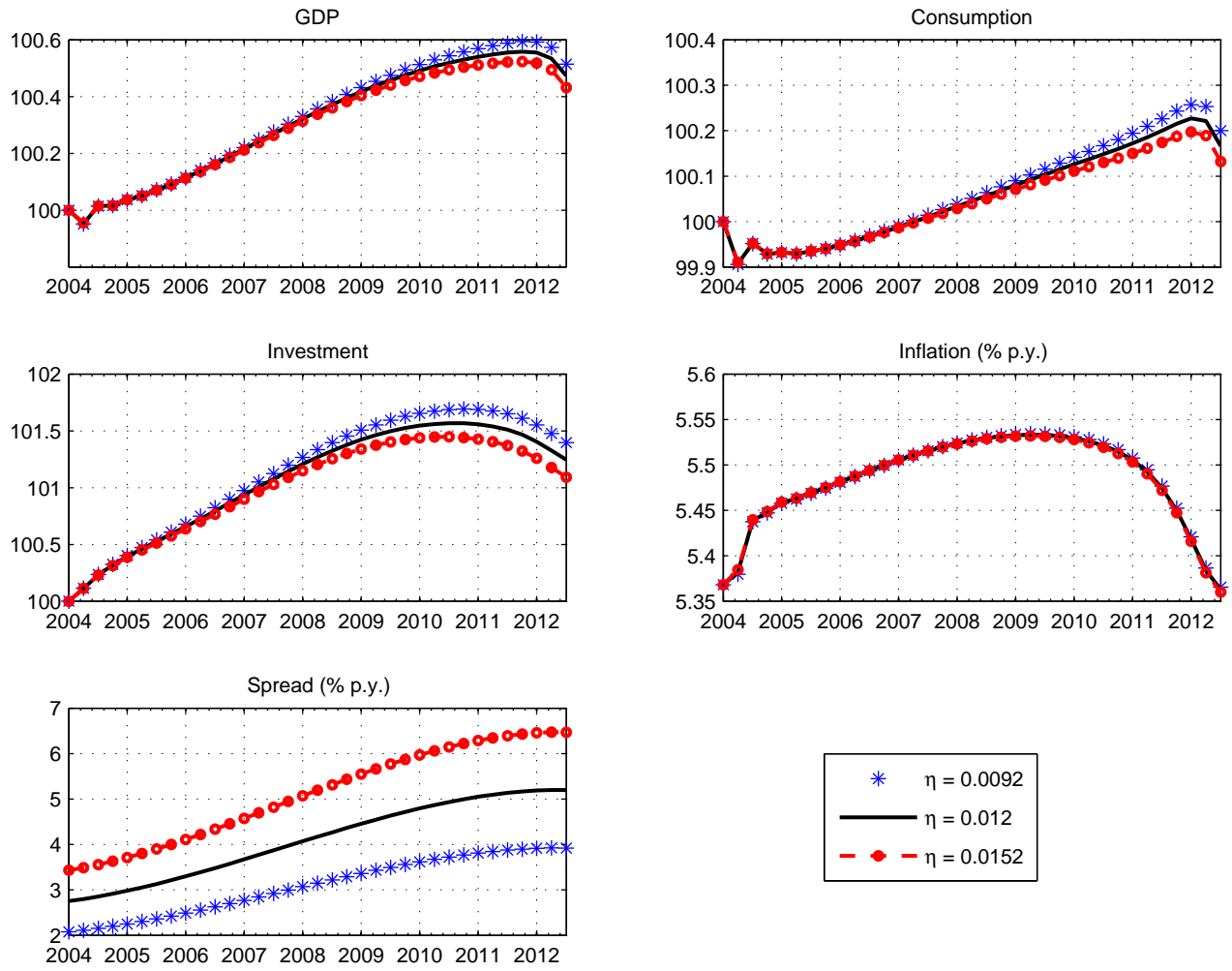


Figure 12: Sensitivity analysis: η .

B.3 Alternative borrowing constraints

B.3.1 Future labor income vs. stock of durables

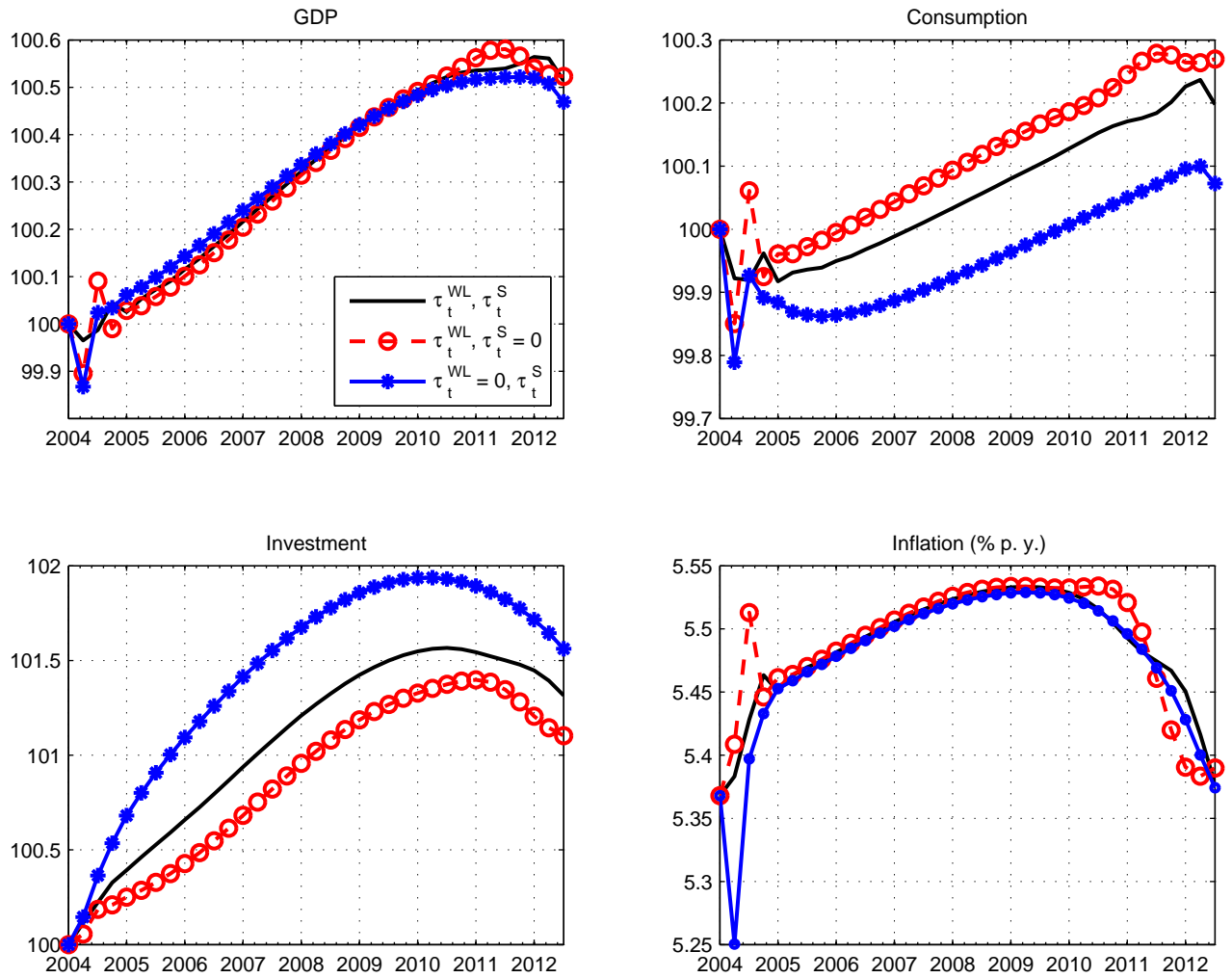


Figure 13: Alternative borrowing constraints: labor income vs. stock of durables.

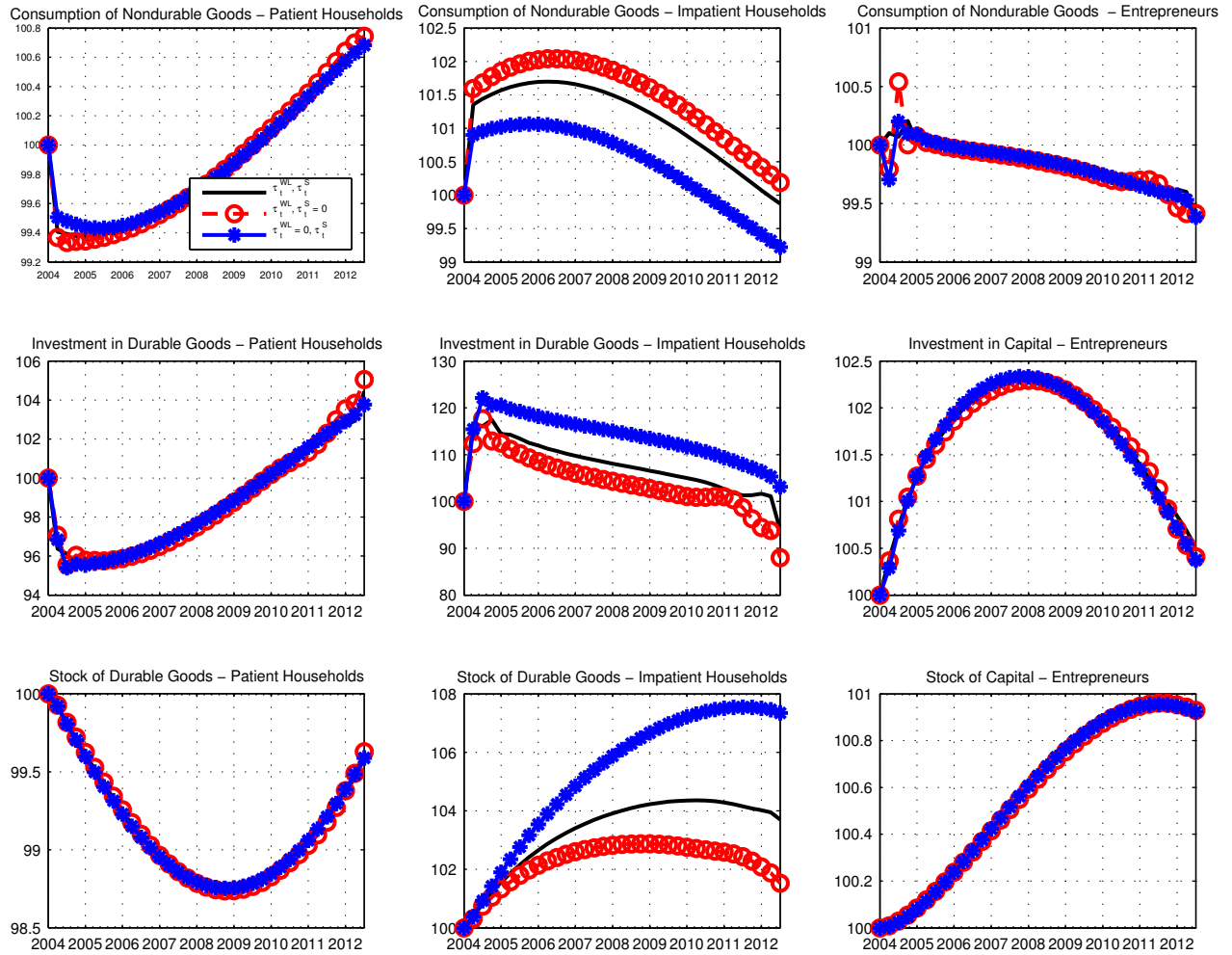


Figure 14: Alternative borrowing constraints: labor income vs. stock of durables.

B.3.2 Current vs. future labor income

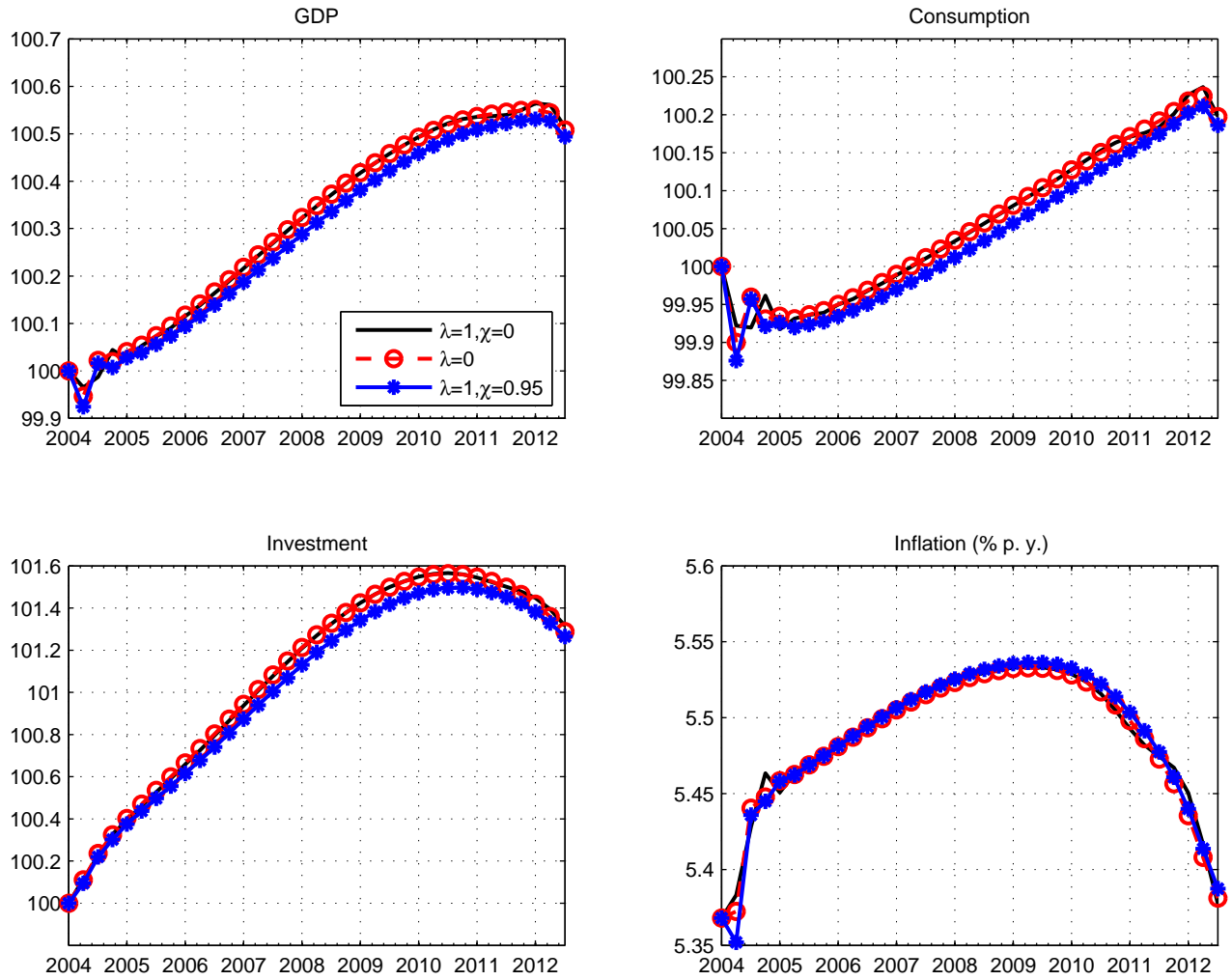


Figure 15: Alternative borrowing constraints: current vs. future labor income.

B.4 Flexible prices

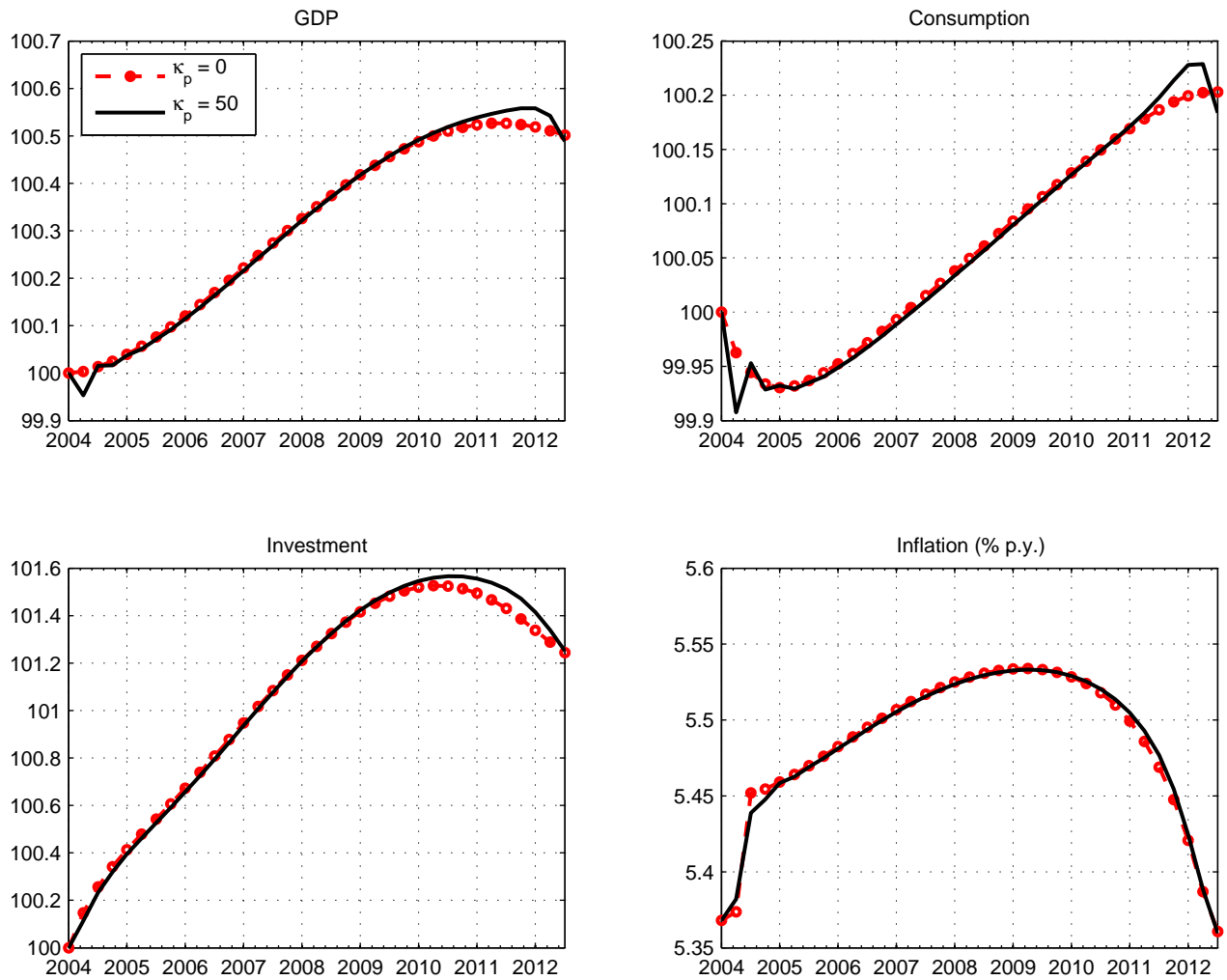


Figure 16: Sensitivity analysis: κ_p .

B.5 Non-smooth transition ($\beta^e = \beta^i = 0.93$)

B.5.1 Credit

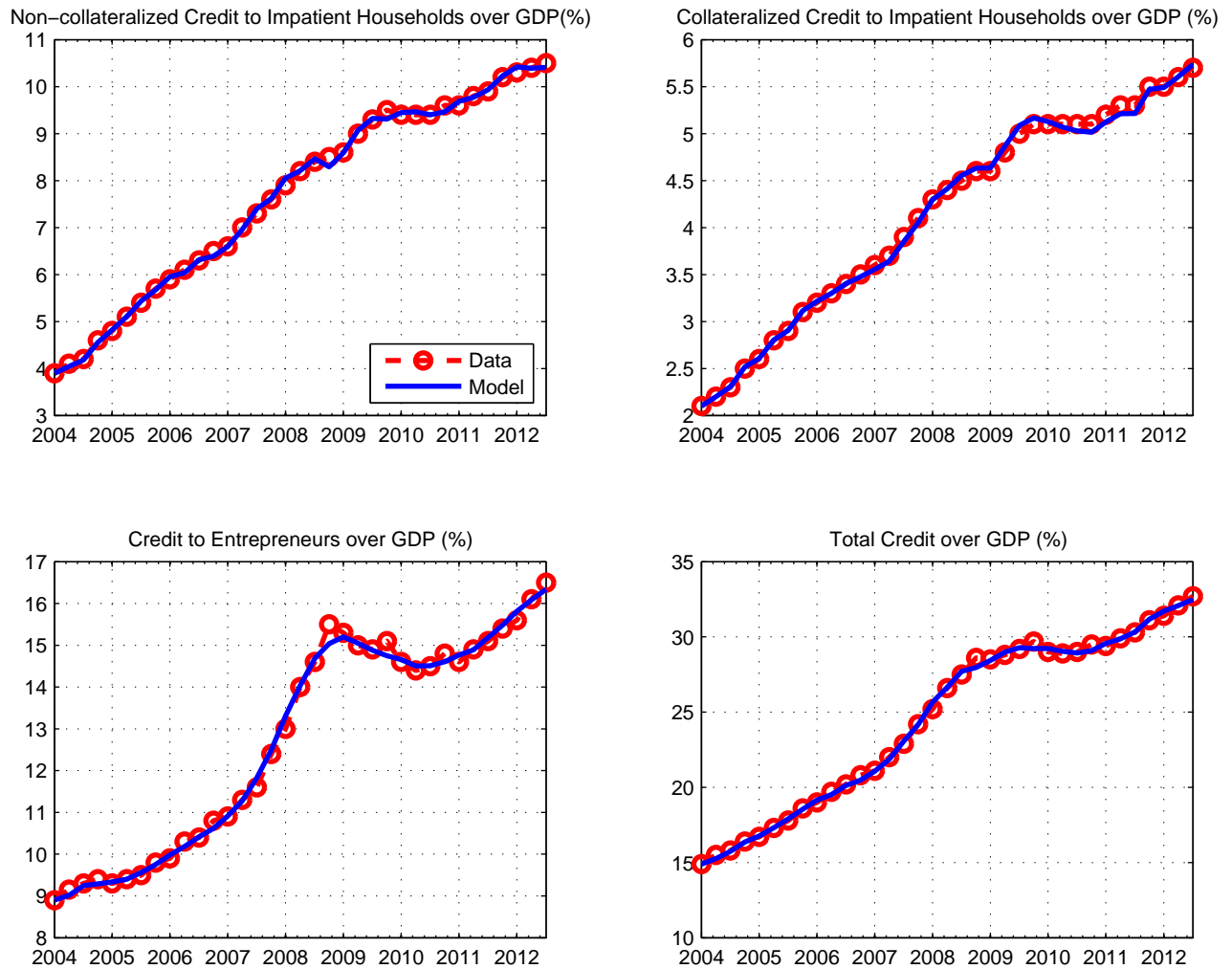


Figure 17: Credit deepening experiment (non-smooth): credit variables (data and model).

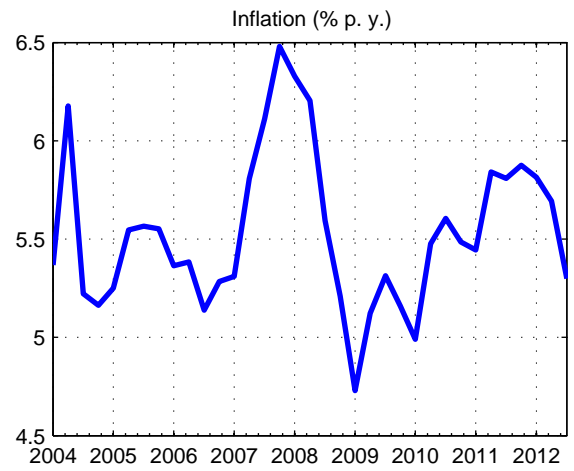
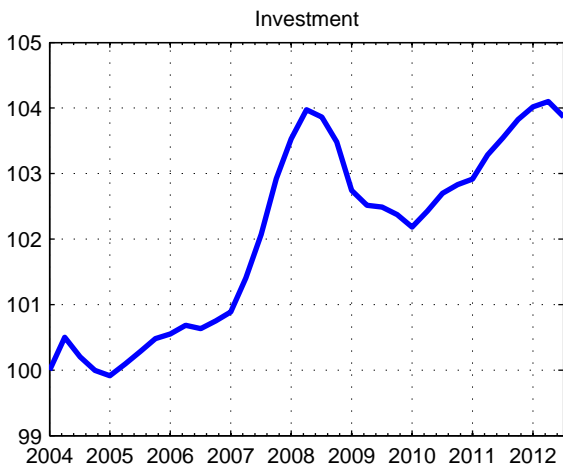
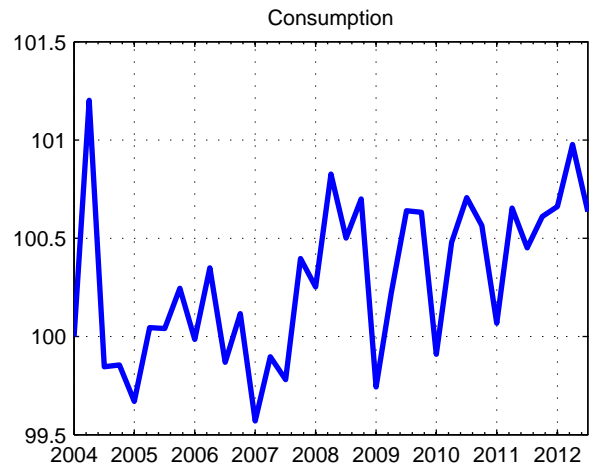
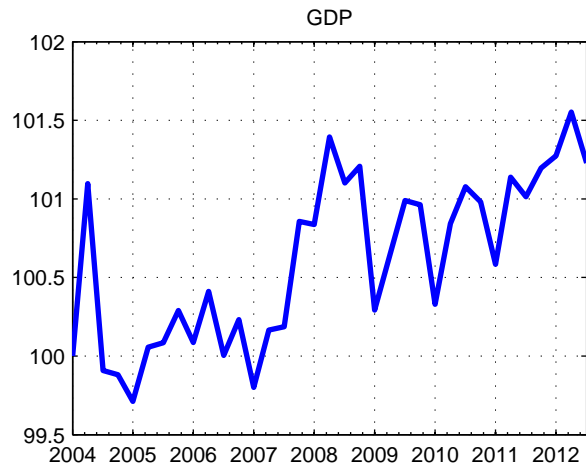


Figure 18: Credit deepening experiment (non-smooth): macro variables (model).

B.5.2 Credit (figure not reported) and spread (varying γ)

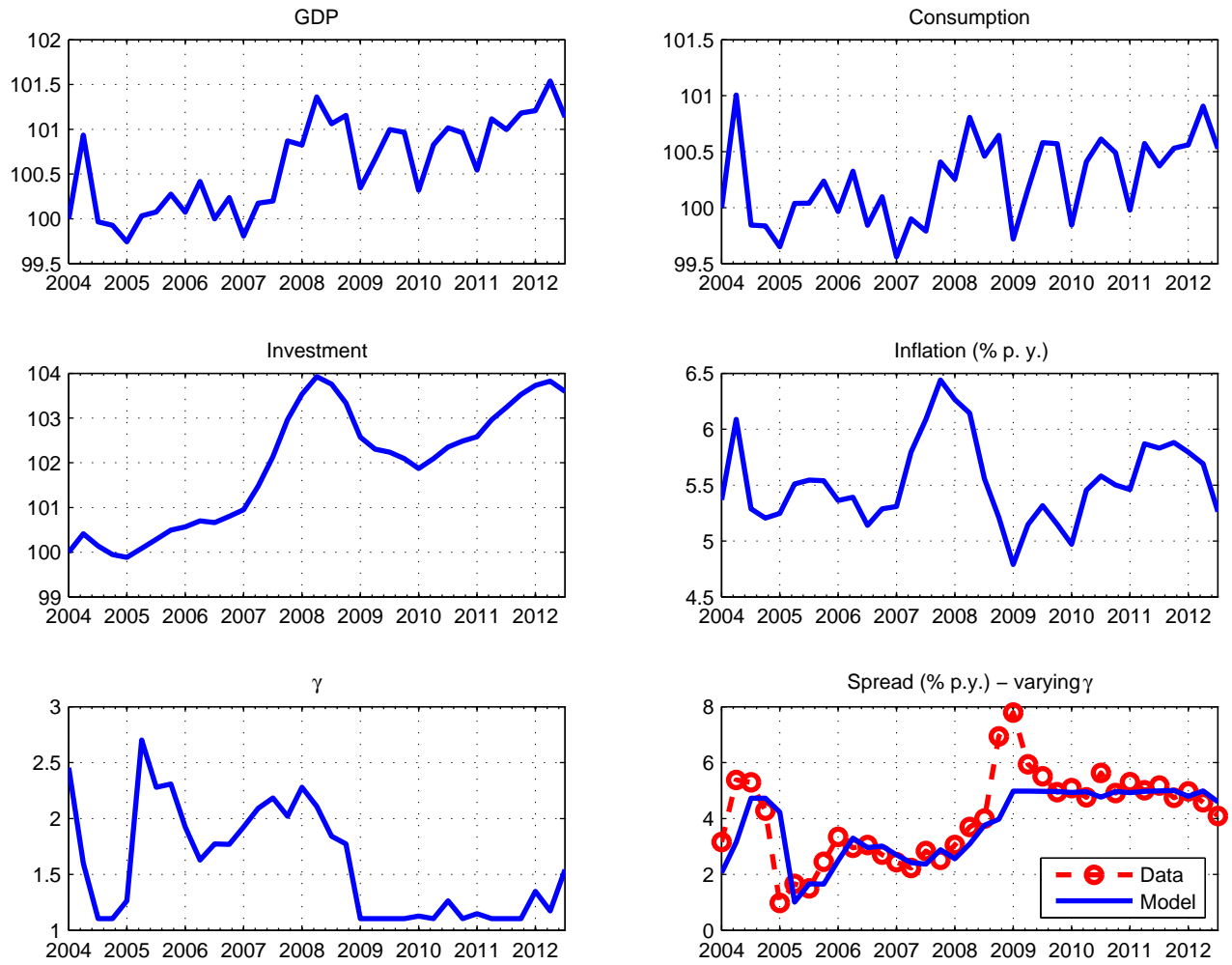


Figure 19: Credit deepening experiment (non-smooth): spread (data and model) and macro variables (model) - varying γ

B.5.3 Credit (figure not reported) and spread (varying η)

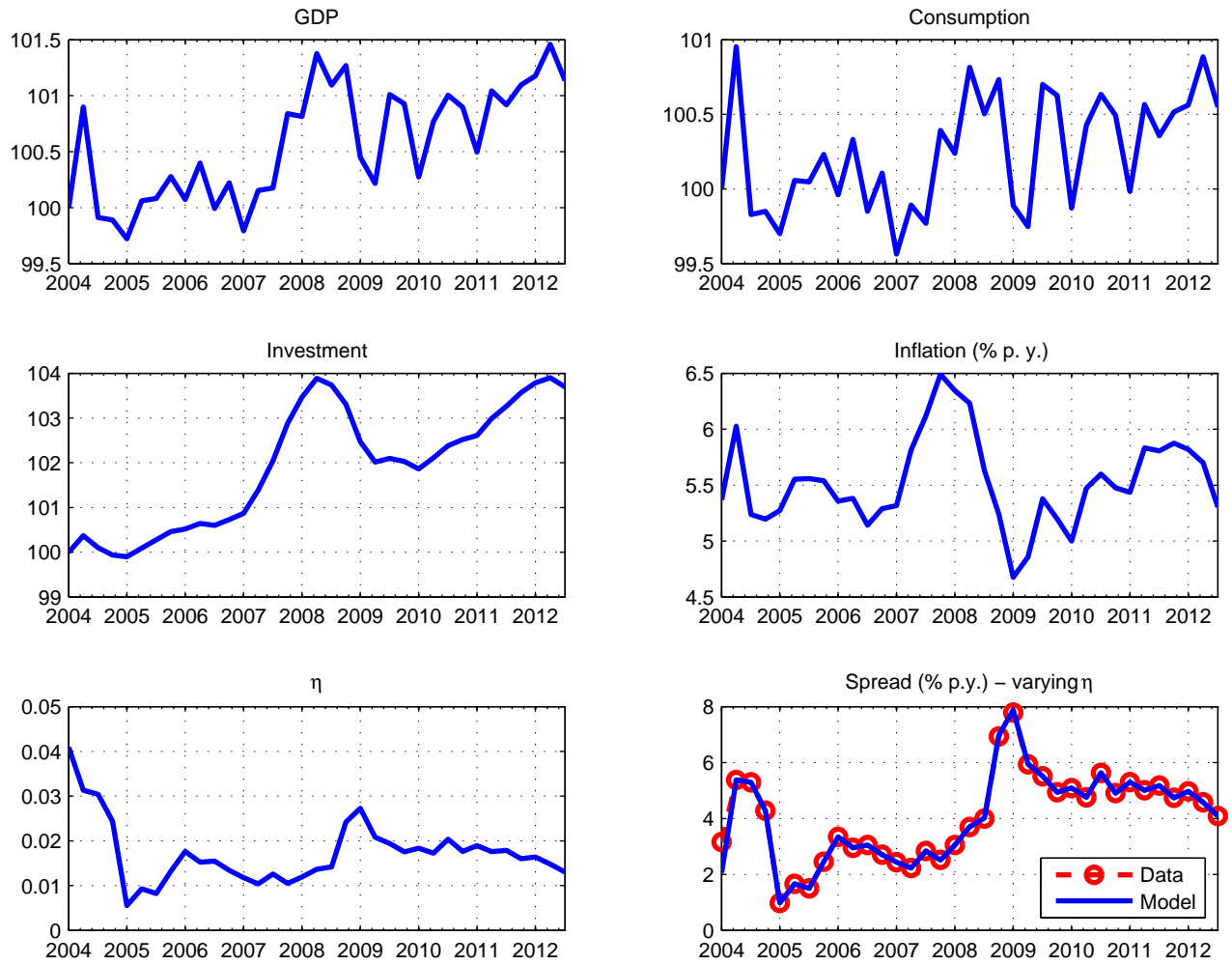


Figure 20: Credit deepening experiment (non-smooth): spread (data and model) and macro variables (model) - varying η

B.6 Unanticipated shocks ($\beta^e = \beta^i = 0.91$)

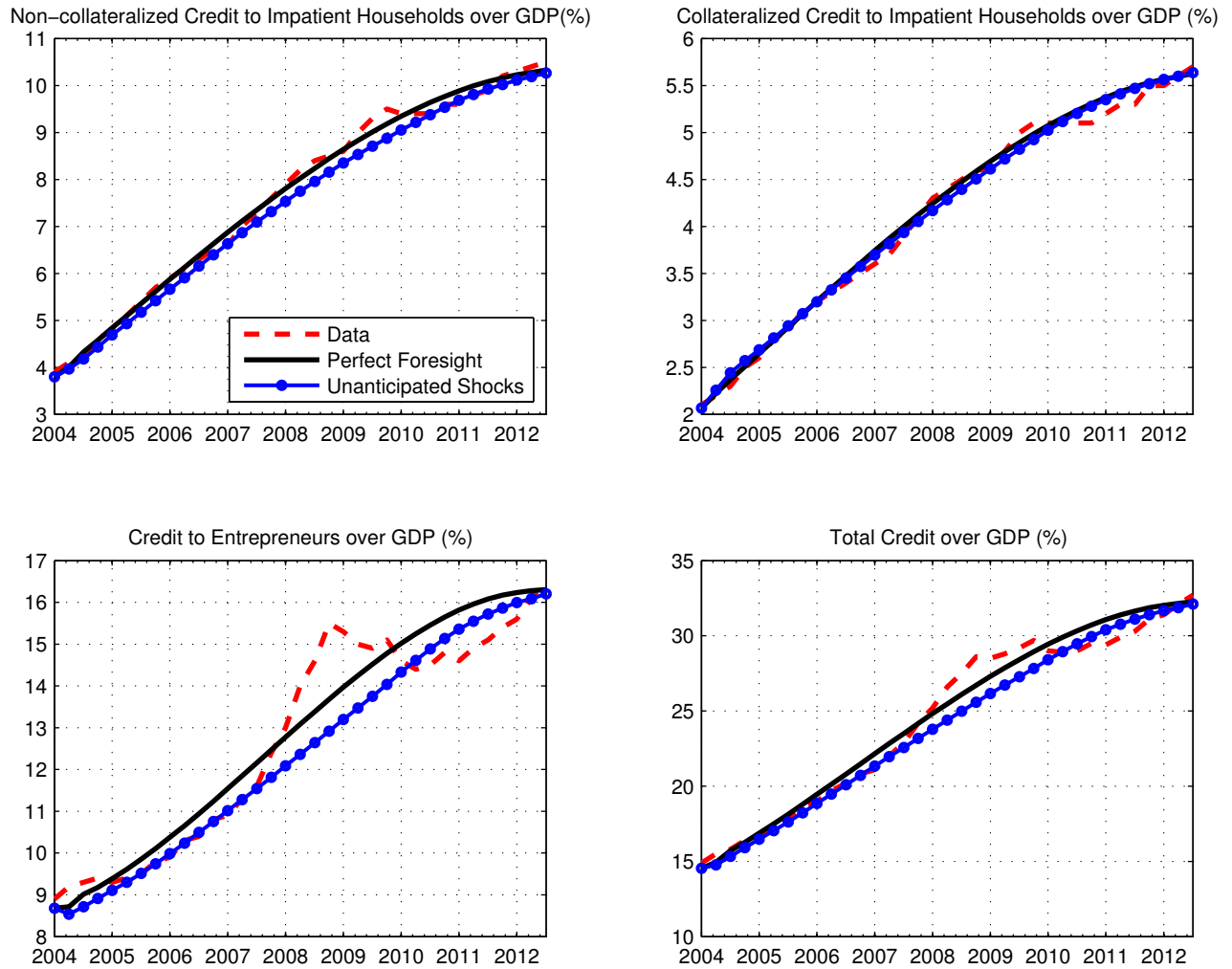


Figure 21: Credit deepening experiment (unanticipated shocks): credit variables (data and model).

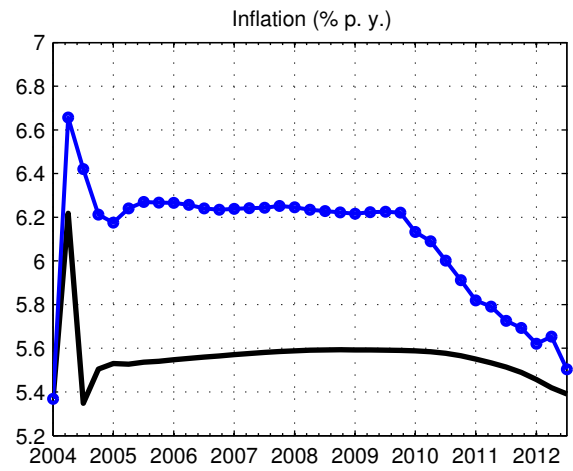
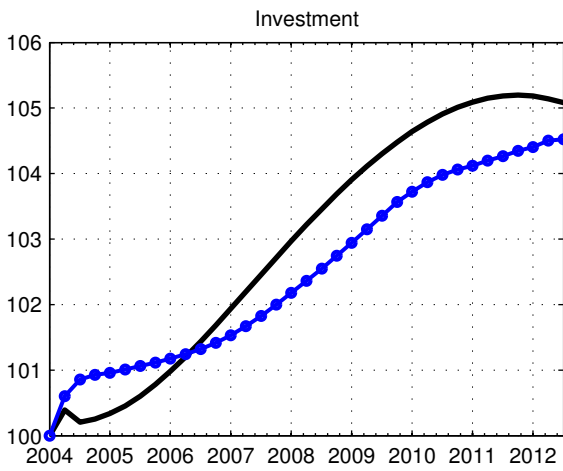
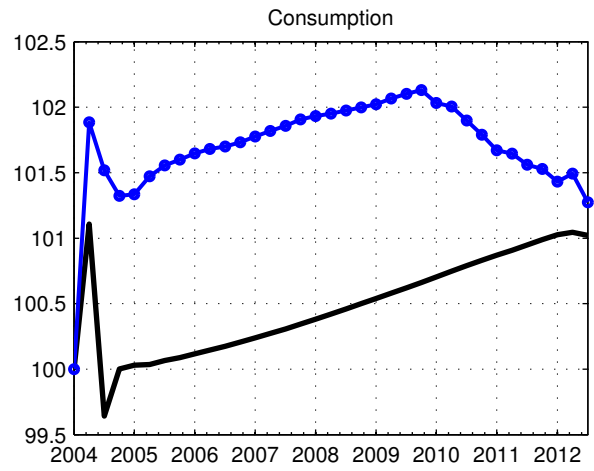
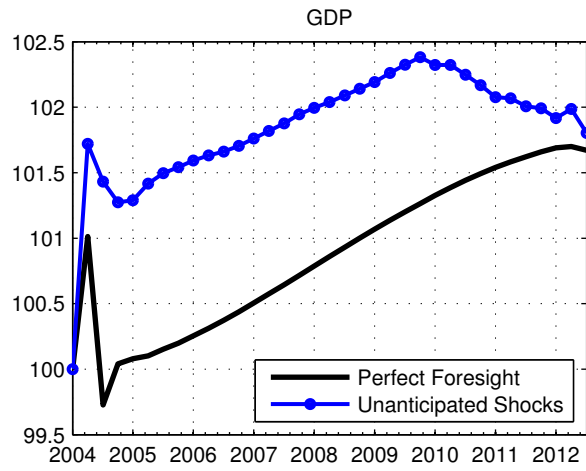


Figure 22: Credit deepening experiment (unanticipated shocks): macro variables (model).

C Small open economy version

Our benchmark specification assumes that Brazil is a closed economy. However, one can conjecture, as Justiniano et al. (2015a), that the macroeconomic effects stemming from a credit expansion may be amplified in small open economies (SOEs). In this case, the demand for credit of firms and impatient agents does not need to be compensated by higher savings and, thus, less consumption by patient agents.

Although the assumption that Brazil is relatively closed to trade is realistic, the financial indices reported by Quinn et al. (2011) as well as the Chinn-Ito index²⁸ suggest that Brazil is not closed to financial flows. Hence, in this appendix, we consider a SOE version of the model in which the interest rate is assumed to be constant, so that capital flows equalize demand and supply in this market, but the wage rate still adjusts to clear the labor market domestically. In particular, we fix the interest rate at its value obtained in the low-credit steady state of the benchmark economy.

In order to scrutinize the aforementioned conjecture, we consider an economy with only impatient households and entrepreneurs that borrow resources from the rest of the world. In this case, there is no “crowding out effect” of domestic lenders consuming less. Now we assume that profits generated by all firms in the economy are transferred to entrepreneurs. For simplicity, we also assume price flexibility. The rest of the model as well as the quantitative strategy remain the same as in the benchmark exercise.²⁹ Again, we solve for the time-varying paths of τ_t^{WL} , τ_t^S , and τ_t^K that generate the smooth paths for non-collateralized credit, collateralized credit to households, and credit to non-financial corporations, shown in Figure 3, that resemble their counterparts in the data.

Figure 23 compares the paths for GDP, consumption and investment in the benchmark model with price flexibility and in the SOE version of the model. It also plots the path of the trade deficit to GDP in the SOE. In addition, Figure 24 shows the evolution of labor market outcomes in the SOE.

²⁸See Chinn and Ito (2006). The updated version of the index is available at http://web.pdx.edu/~ito/Chinn-Ito_website.htm.

²⁹The equations of the SOE version of the model are described in a separate appendix, available upon request.

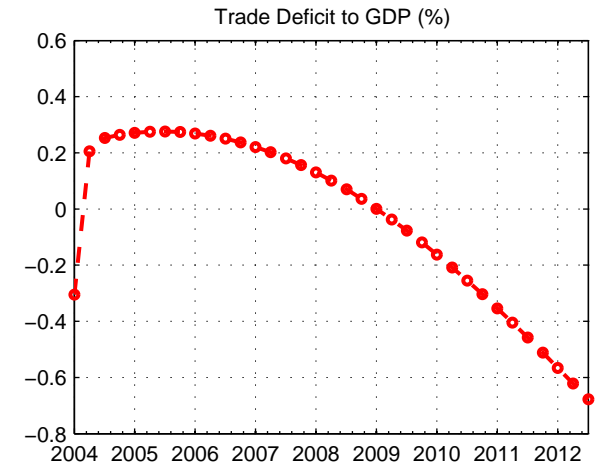
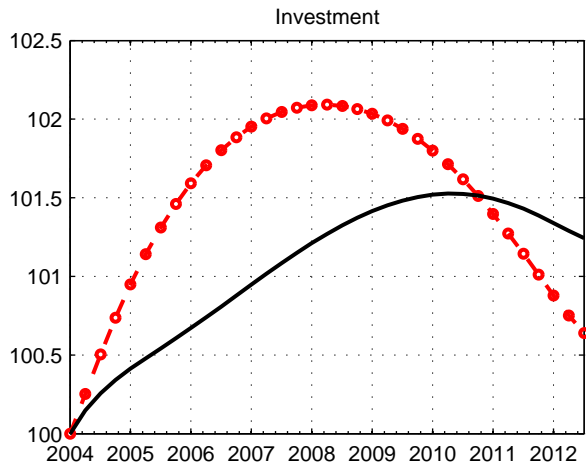
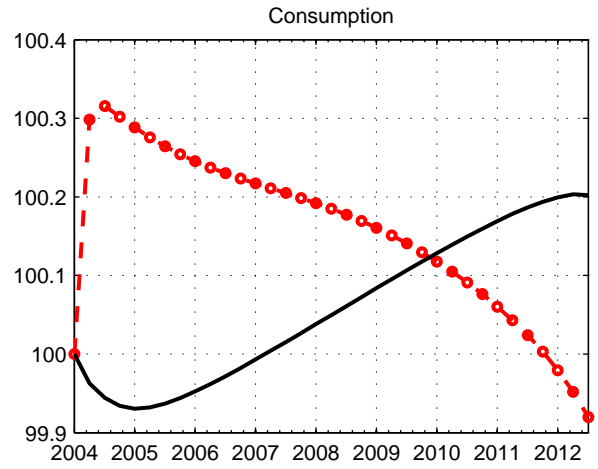
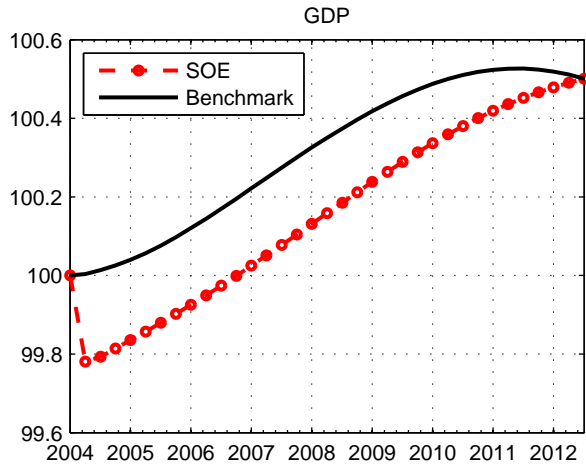


Figure 23: Credit deepening experiment: macro variables (benchmark and SOE).

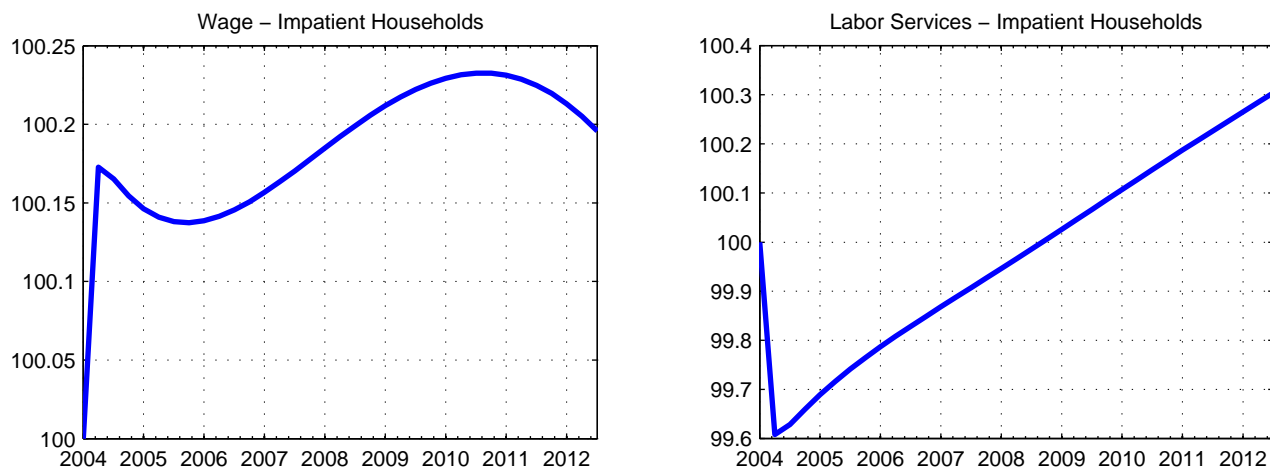


Figure 24: Credit deepening experiment: labor market outcomes (SOE).

Figure 23 shows that the macroeconomic effects of credit deepening are not amplified in the SOE. In the first period, GDP falls and consumption rises. Intuitively, as Figure 24 highlights, the credit deepening process generates an impulse akin to a wealth effect, so that households reduce their labor supply and, thus, the wage rate increases, GDP falls and consumption increases. Hence, the trade deficit must increase to balance the demand and supply of final goods. As the credit deepening process evolves, GDP increases in the SOE as well as in the benchmark economy. The short-to-medium-run effect on GDP is roughly the same in both economies, i.e. 0.5 percent between 2004 and 2012.

In contrast to the closed economy, after an increase of 0.3 percent in a few periods, consumption starts to decline in the SOE. Intuitively, the flow of resources from abroad, due to the credit deepening process, leads households to shift consumption towards the present.³⁰ As this process evolves, the country accumulates foreign debt, and, eventually, next exports have to increase to cover interest payments.

³⁰In a related model, Justiniano et al. (2014) argue that an increase in the willingness of the “rest of the world” to hold U.S. assets generates a flow of resources, so that consumption in the U.S. is shifted towards the present.

D 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.³¹ 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.³²

In the first steady-state, we calibrate $\tau^{WL} = 0.28$ to match the ratio of individual non-collateralized credit to GDP of four 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 2), 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 2). 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 25 and 26 plot the impulse response functions for selected variables (GDP, consumption, investment, household interest rate, and inflation) to the technology and monetary policy shocks, respectively.

³¹For this exercise, we solve an approximate version of the model by log-linearizing the equilibrium conditions. The latter are in a separate appendix, available upon request.

³²Gerali et al. (2010) study how the presence of banks and financial frictions affects the impulse response functions to technology and monetary policy shocks. They find that banks attenuate the effect of a monetary policy shock.

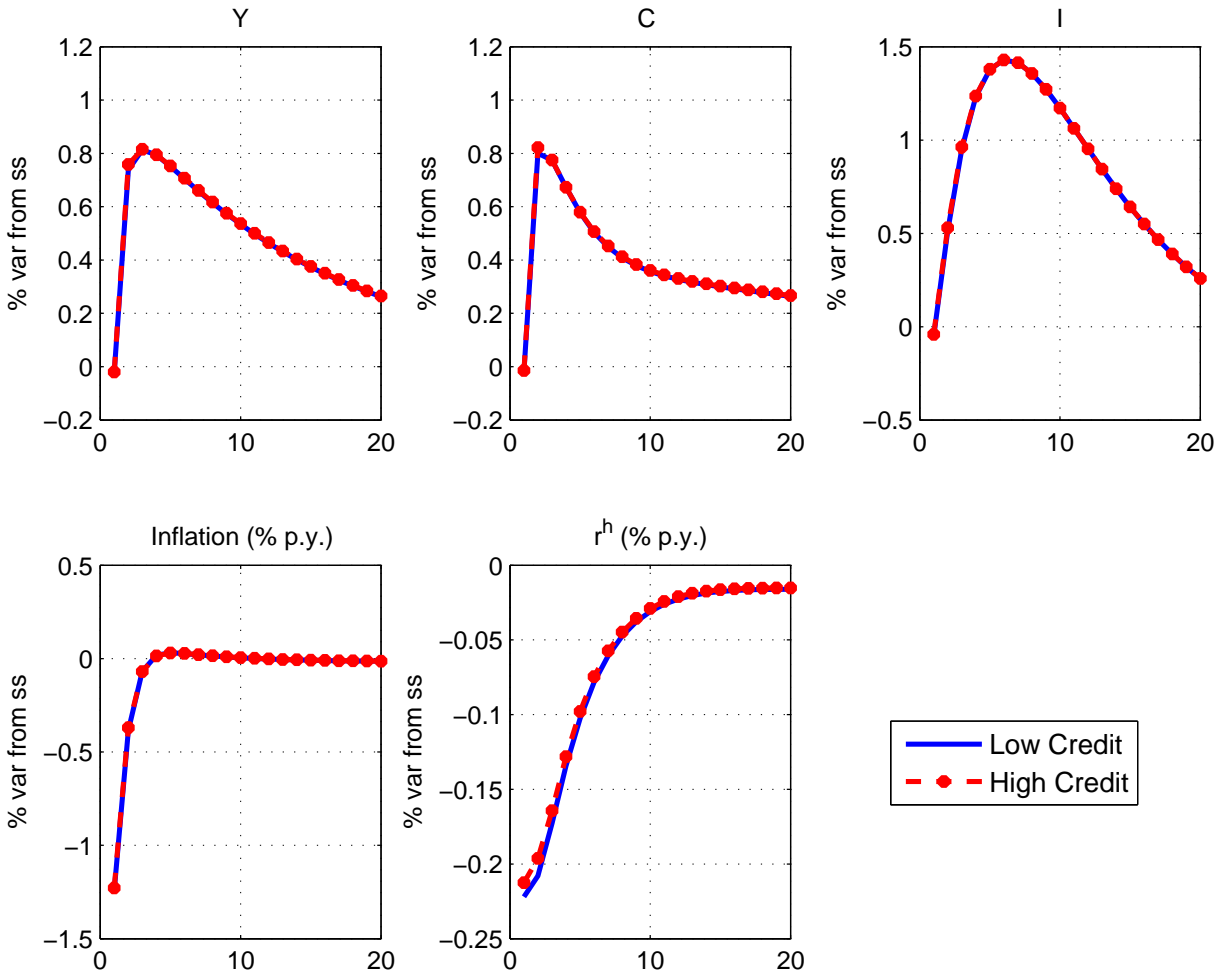


Figure 25: Impulse response functions of selected variables to a technology shock.

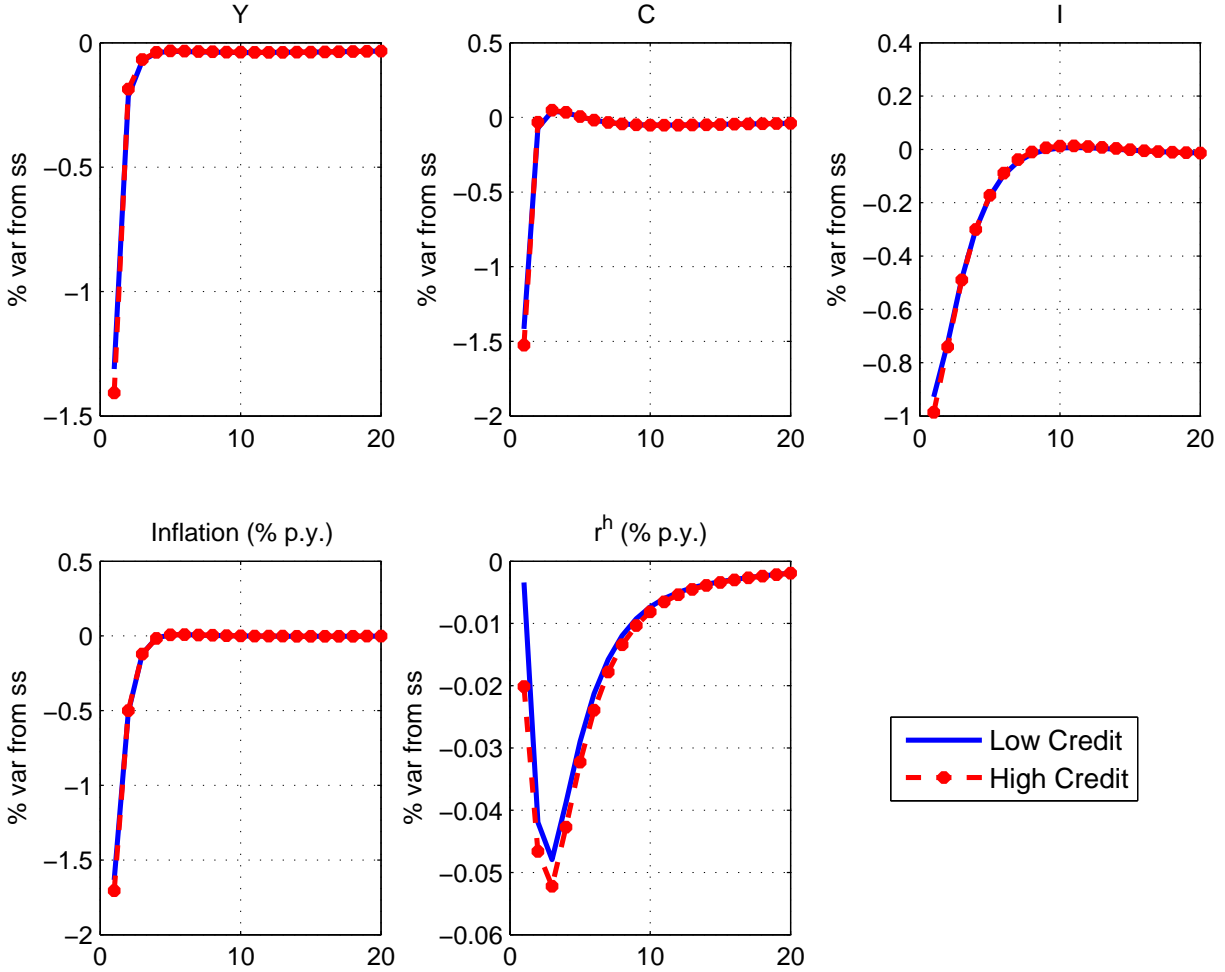


Figure 26: Impulse response functions of selected variables to a monetary policy shock.

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 25). This result is in congruence with previous literature, which argues that credit constraints do not propagate technology shocks.³³ 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 26). In the previous section, we argue that price stickiness does not amplify or mitigate the macroeconomic effects of the credit deepening process. Hence, these two findings suggest that the degree of slackness of the credit constraints and nominal frictions do not interact to generate quantitative meaningful effects.

Finally, this overlapping of the impulse response functions to these keys shocks suggests that business cycle moments across economies, with low and high credit, would barely change.

³³See, for instance, Section IV.4 of Liu et al. (2013) and the references therein.

E Sources for credit and interest rate data³⁴

E.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 nonequity 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>).³⁵

E.2 Nonemarked credit outstanding/GDP

Nonemarked credit outstanding is the nominal balance of such credit operations by the National Financial System. Nonemarked 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: 17461.³⁶

E.2.1 Nonemarked household credit outstanding/GDP

The following types of credit are considered: vehicles financing, other goods financing, mortgages, credit card, personal credit, overdraft and other nonemarked credit instruments that were not classified in previous types of credit.

Source: CBB - Data code: 17483.

E.2.2 Nonemarked 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, exports financing, foreign transfers and other nonemarked credit instruments that were not classified in previous types of credit.

³⁴The remaining data that we use are standard National Account and macroeconomic variables, which can be downloaded from <http://www.ibge.gov.br/english/> and <https://www3.bcb.gov.br/sgspub/localizarseries/localizarSeries.do?method=prepararTelaLocalizarSeries>.

³⁵Definitions of credit variables are taken *ipsis litteris* from the source, whenever available.

³⁶We collected the data from the Portuguese version of the website. Some data were not available in the English version.

Source: CBB - Data code: 17488.

E.3 Spread

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

E.3.1 Brazilian prime rate (% p.y.)

The Brazilian prime rate is calculated as the average of the operations agreed 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.

E.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 the Portuguese acronym) for federal bonds.

Source: CBB - Data code: 4189.

E.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 twelve months (MSAD). MSAD is a measure of aggregate 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.