Economic crisis and the financial system amplification effect[*]

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Abstract

A well informed and cautious financial system can improves the welfare outcome of an economy by driving lenders surplus to borrowers. Nevertheless in a crisis situation the financial system cautious behavior can become a crisis amplifier given that the credit approval conditions are hardly meet, so there could be a credit crunch even in a low interest rates environment. This paper illustrates the previous by developing a general equilibrium model where the collateral credit condition defines the prudential behavior of the financial system. This and some other conditions amplify the magnitude of a negative productivity shock.

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1 Introduction

Recent events in developed economies have called for special attention on the financial markets, reinforcing the idea that the developments in those have marked the economic cycle and that a strong and sustained recovery must be based on a solid financial system. Nevertheless recovery has been slow and highly expansive fiscal and monetary policies have done little to improve this. Credit recovery has become one of the main concerns of the policy makers, as expressed by the chairman of the Federal Reserve (FED) Ben S. Bernanke in his declaration of June 7, 2012: "The depressed housing market has also been an important drag on the recovery. Despite historically low mortgage rates and high levels of affordability, many prospective home buyers cannot obtain mortgages, as lending standards have tightened and the creditworthiness of many potential borrowers has been impaired." The behavior described in Bernanke's declaration has no precedent in the last two decades, as shown in figure 1.

Bernanke's declaration summarizes most of this paper purpose, which is to develop a theoretical model that shows how changes on the collateral constraint, caused by both changes in the collateral's price and the bank's cautious behavior, can strongly diminish the monetary policy effectiveness by breaking the credit channel.

This slump in household's credits has been one of the main reasons why economic recovery has been slower than usual (similar references are found in Miller and Stiglitz (2010), Diamond and Rajan (2009), Mishkin (2009), Taylor (2009) and Brunnermeier (2008)). As shown in figure 2[1], US' unemployment rate has never stayed over 7% for so long in the last two decades. This implies a lower income for households and therefore lower consumption and welfare.

Nevertheless this type of comovements between the credit and economic cycle are far from been new. Aliaga-Díaz and Pía (2010) (see also: Reinhart and Rogoff (2009), Bordo (2008) and Mendoza and Terrones (2008)) have found evidence in line with this by proving a counter cyclical behavior of interest rates. This implies that during crisis the credit is less accessible (due to higher interest rates) reducing investment and worsens recessions.

This common behavior between the credit and economic cycle is closely related to what the literature has referred as "credit crunch" and "financial accelerator". These two terms are often used to explain the effect of the financial system in economic crisis. Particularly, credit crunch refers to a significant reduction in the credit supply, and the financial accelerator has been explained as the amplification of initial shocks due to changes in the credit market.

Bernanke and Lown (1991) mention a set of arguments that could explain the credit crunch in the US 1990 crisis. Among many reasons offered by the authors "overzealous regulation" and the "credit demand and borrowers' balance sheets" fitted quite well to the events in the last six years (even though this two are not chosen by the authors as the main factors for 1990's credit crunch). The first reason refers to a less lax behavior from banks during economic crisis in order to

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[1]GDP cycle is obtained through a Hodrick Prescott filter whit a $\lambda = 14400$.

Figure 1: Household's debt as % of the income and interest rates (monthly).
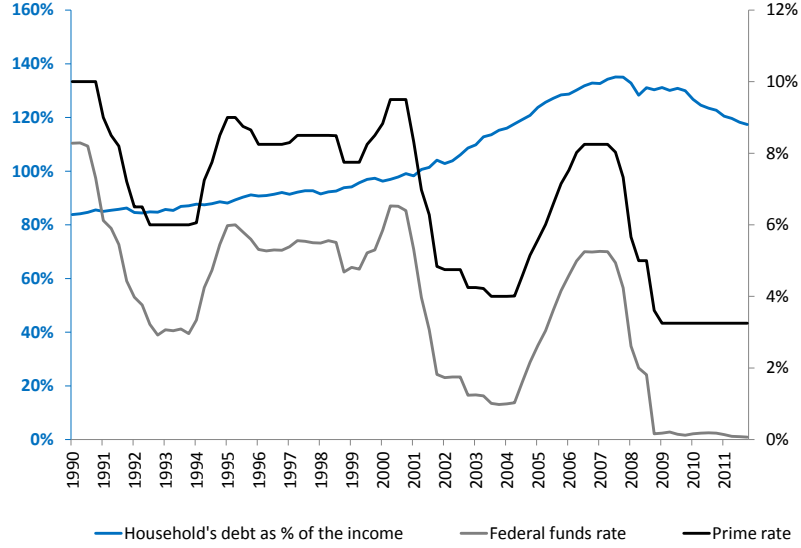
reduce risky credit that could lead to loan losses. This kind of behavior directly reduces credit. The second point argues that during crisis credit demand slows down; one of many reasons for this is the weakening of borrower's balance sheet which is affected by lower prices. This last argument obtains more relevance after the most recent crisis. As shown in figure 3 houses real prices have been reducing constantly since the burst of the subprime crisis.

As shown by Arango et al. (2011) one of the reasons that could induce an economic crisis after a price bubble burst is a protracted underpricing of goods used as collateral, particularly land's prices. This phenomenon will reduce collateral for a long period of time increasing the credit crunch length and deepness.

Using some recent developments of the Dynamic Stochastic General Equilibrium (DSGE) literature on the housing market, this paper develops a DSGE model that explains how financial system's behavior can amplify negative economic shocks in an expansive monetary environment and no mortgage delinquency, by increasing restrictions over credit.

Figure 2: U. S. Unemployment and GDP cycle (monthly).
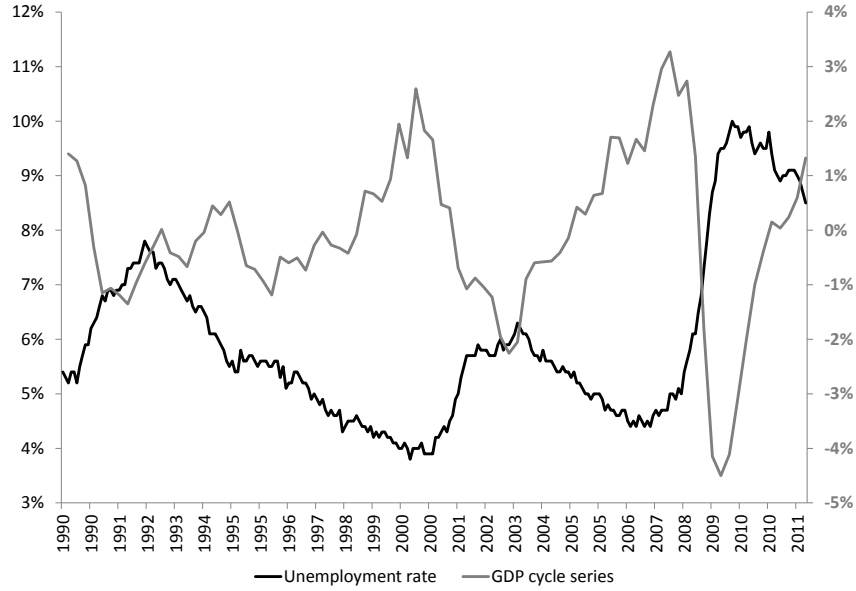
1.1 Credit crunch and financial accelerator

The credit crunch has usually been addressed as a consequence of economic downturns instead of an economic fluctuations sparker. One of the consequences of a financial system is larger fluctuation due to the so called financial accelerator. Bernanke's et al. (1996) seminal work refers to two complementary characteristics of the financial accelerator: the amplification and propagation of initial shocks. The main reason behind these two consequences is given by the worsening of agent's financial conditions. Particularly a flight to quality reduces the access to financing of the most vulnerable agents in the economy restraining their capacity to smooth consumption.

   Bernanke and Gertler (1989) illustrate some of the financial accelerator effects by showing how Real Business Cycles (RBC) fluctuations can reduce cash flows to borrowers and then, through investment, to the rest of the economy, generating a vicious cycle that amplifies the initial shock's effect and prolongs these to the following periods.

   Similar conclusions are reached by Greenwald and Stiglitz (1993) in a model

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Figure 3: Case-Shiller Home Price Indices and Household's debt as % of the income (monthly).
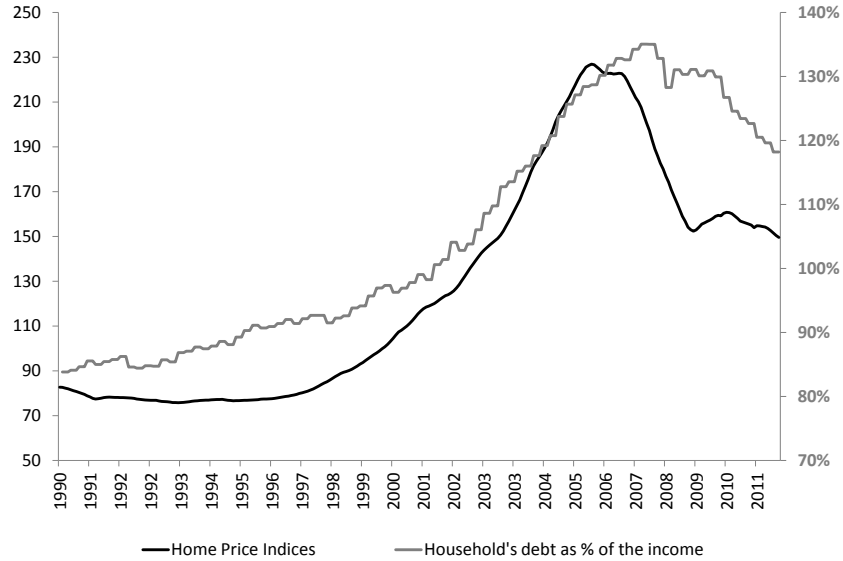
where firms can only operate with debt, causing that a firm whose access to financing is lowered reduces its production and profits, and inducing an income decline to the rest of the economy. Gertler (1992) and Aghion and Bolton (1997), among other authors, find the same effects with different models.

Bernanke et al. (1998) mention as a main reason of the financial accelerator the existence of information asymmetries as well as agency costs and the fact that, under credit market's frictions, the borrowers finance premium depends inversely on its wealth, reinforcing the conclusion that an exogenous reduction of the household's income restrains the access to credit.

In line with Bernanke et al. (1998), Aoki et al. (2004) present a model with frictions in the credit market that includes housing services in consumption. They found that a positive shock in the economy increases demand for houses and therefore their prices. This also improves houseowners' net worth, allowing them to borrow more money, increasing the demand for houses even further.

In another perspective, Kiyotaki and Moore's (1997) seminal paper intro-

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duces a collateral constraint for borrowing, describing a different mechanism of crisis propagation trough credit. In this type of model crisis generates a lowering in the price of any good used as collateral causing a reduction in borrowing capacity and therefore lower spending.

The Kiyotaki and Moore's set up has been widely used in more recent papers as Kocherlakota (2000), Monacelli (2009), Iacoviello (2005), Calza et al. (2009), Brzoza-Brzezina and Makarski (2011) and Arango et al. (2011) among others. This is due to the recent surge in the interest on the relation between credit and the price of goods used as collateral. Most of these papers uses New Keynesian DSGE models that illustrate how financial system can amplify the initial effect of a productivity or monetary policy shock. Many of these models relay on a Calvo pricing set up[2] in order to simulate the effect of durable goods' prices on the collateral constraint.

Most of the literature after Kiyotaki and Moore's paper has taken the collateral constrain as an exogenous term. Brzoza-Brzezina and Makarski (2011) go further on this, presenting a DSGE model that introduces a credit constraint that, in an exogenous way, becomes more restrictive causing a credit crunch.

Other works important to the development of this paper are referenced in the above. Nevertheless the literature on credit-market is vast and the review of the literature presented here is far from been a complete survey. Bernanke et al. (1996) and (1998) can be referenced for further consulting.

1.2   The price bubble

Erroneous pricing is not an idea with which many economists fell comfortable, nevertheless price bubbles are mostly about it. The last US crisis was an example of this, as reported in some journals: "We economists were wrong: Even when traders in an asset market know the value of the asset, bubbles form dependably. Bubbles can arise when some agents buy not on fundamental value, but on price trend or momentum[3]."; "Bubbles don't spring from nowhere. They're usually tied to a development with far-reaching effects: electricity and autos in the 1920s, the Internet in the 1990s, the growth of China and India. At the outset, a surge in the values of related businesses and goods is often justified. But then it detaches from reality[4]". What this section is trying to say is that prices bubbles usually only look like irrational behavior after they burst, in the mean time between the climbing and peak of prices it looks like a sustainable situation. In words of the former chairman of the FOMC, Alan Greenspan: "this vast increase in the market value of asset claims is in part the indirect result of investors accepting lower compensation for risk. Such an increase in market value is too often viewed by market participants as structural and permanent"[5].

The mentioned pricing behavior lead to larger consequences that extended to all the economy; as stated by some analysts, the burst of home price's bubble

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[2]Calvo (1983).

[3]Steven Gjerstad and Vernon L. Smith. April 6, 2009 at The Wall Street Journal.

[4]Justin Lahart, May 16, 2008 at The Wall Street Journal.

[5]As wrote by Paul Krugman, August 29, 2005 at The New York Times.

play a crucial role in the economy's crash: "In the absence of home-price appreciation, many households are finding it difficult to refinance their way out of adjustable-rate mortgages obtained at the height of the housing boom. Larger mortgage payments could exacerbate delinquencies and foreclosures, especially with interest rate resets expected to remain high for the next year[6]."; "Some of this trouble might have been avoided if home prices had continued to climb like they did between 2000 and 2005. As a home appreciates, even borrowers who aren't paying the principal loan amount build up more equity. That in turn would have made it easier for subprime borrowers to refinance into yet another loan with a low interest rate[7]". This two statements reflect the main idea of this paper as it only focus on the burst of the price bubble[8].

1.3   Financial system's cautious behavior

Financial system usually take many cautions as payment affordability and credit score among others. Yet the only one that remains useful after default is the collateral. The sole action of asking for collateral can be seen as caution behavior; however this is usually not enough. Under Kiyotaki and Moore's approach only one percentage of the asset can be used as collateral (usually 75%), this proportion is constant and therefore makes it harder to recreate the financial system tighten behavior. Since all these situation are cautious behavior at different degree, for simplicity of this paper taking collateral at some percentage will be called cautious behavior[9].

My paper presents a model where the collateral constraint, different to previous literature, is endogenous and describes the financial system's decisions, which, along with a "naive pricing" scheme as proposed in Arango et al (2011), generates an amplifying effect like the one described by the financial accelerator literature. But, unlike most of the conventional wisdom, the financial accelerator is not driven by the interest rate. As a consequence this paper's contribution is to simulate a credit crunch in a low interest rates environment so that monetary policy has no significant effect

After this brief introduction four more sections complete this paper: section two present the DSGE model; section three present the parameters calibration; section four shows some simulations results; section five concludes.

2   The model

The economy described in the model is conformed by representative households that consume durable and non durable goods. They obtain their income from several sources that can be divide in three groups: productive factors, benefits
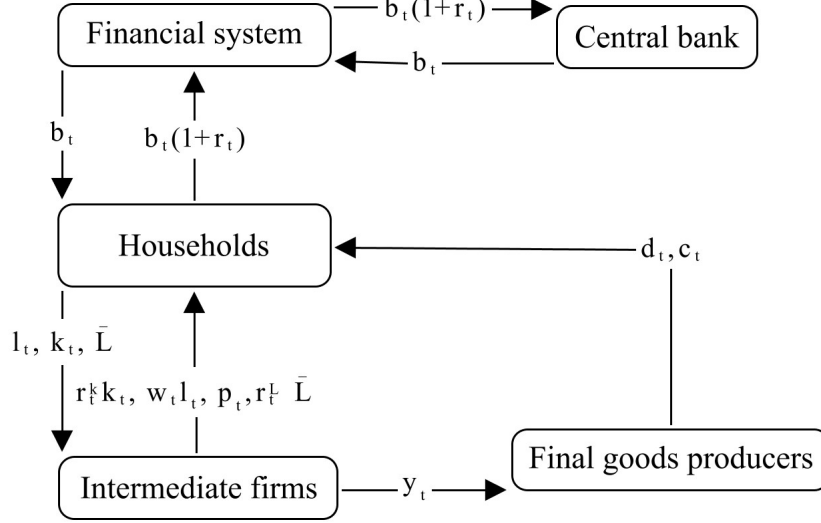
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[6] DiMartino and Duca (2007).

[7] The Associated Press. March 13, 2007 at NBC News.

[8] A description of the boom and consequent burst in a price bubble can be found in Arango et all (2011).

[9] Lower percentages will imply a less lax behavior.

Figure 4: model.

Financial system — $b_t(1+r_t)$ → Central bank

← b_t —

b_t $b_t(1+r_t)$

b_t ← Central bank b_t

Households ← d_t, c_t

$l_t, k_t, \bar{L}$

$r_t^k k_t, w_t l_t, p_t, r_t^L \bar{L}$

Intermediate firms — y_t → Final goods producers

and credits. There are three types of productive factors: labor, capital and land; all of them are used by firms, owned by the households, that produce an intermediate good that is later used by other kind of firms to produce the final goods consumed by the households. The intermediate firms are slightly differentiated and produce benefits that are delivered to the owners.

Credits have to be paid one period after acquired with an interest rate set by the monetary authority; therefore the monetary authority provides all the liquidity needed to sustain the Taylor rule based interest rate. The credit is provided through the financial system that works under perfect competition having no markup on the interest rate. Nevertheless financial system demands a collateral for lending. This collateral constraint is determined by the land's price which is equivalent to the present value of future land's rents. This closes the production and credit circle that is summarized in figure 4.

2.1   Households

A typical household is described by infinitive lifetime utility horizon given by:

$$E_0 \left\{ \sum_{t=0}^{\infty} \beta^t U\left(x_t, n_t\right) \right\} \tag{1}$$

Where n_t is the total hours worked by borrowers and x_t is the consumption index which is a bundle of non durable (c_t) and durable (d_t) consumption, described by:

$$x_t = \left[\left(1 - \alpha_h\right)^{\frac{1}{\nu_c}} \left(c_t\right)^{\frac{\nu_c - 1}{\nu_c}} + \left(\alpha_h\right)^{\frac{1}{\nu_c}} \left(d_t\right)^{\frac{\nu_c - 1}{\nu_c}} \right]^{\frac{\nu_c}{\nu_c - 1}} \tag{2}$$

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Also it will be assumed that utility is a constant relative risk aversion function described by:

$$U\left(x_t, n_t\right) = \frac{\left(x_t\right)^{1-\sigma}}{1-\sigma} - \varphi \frac{l_t^{1+\mu}}{1+\mu} \tag{3}$$

Household's decisions are subject, at any time, to an intertemporal budget constrain that, expressed in units of the non durable good, is:

$$w_t l_t + r_t^k k_t + p_t + b_t + r_t^L \bar{L} + \left(1-\delta_h\right) q_t d_{t-1} \quad + \left(1-\delta_k\right) k_{t-1} \geq$$
$$\left(1+r_t\right) b_{t-1} + c_t + d_t q_t + k_t \tag{4}$$

Where at every period t: w_t is the salary, r_t^k the capital's rent, k_t the capital, p_t intermediate firms benefits, $\bar{L}$ y r_t^L the land and it's rent, b_t the debt acquired every period, r_t the interest rate[10], δ_h and δ_k the durable goods and capital's depreciation rate, q_t durable goods price. Finally π_t^c is the change in the price of the consumption good; given that every variable is expressed in terms of the consumption good, π_t^c is the measure of inflation.

Following Kiyotaki and Moore (1997). Household's borrowing decision is also constrained to it's collateral endowment, this is:

$$b_t\left(1+r_t\right) \leq \chi_t E_t\left(\zeta_t\right) \tag{5}$$

where $E_t\left(\zeta_t\right)$ is the expected value of land and χ_t is the proportion of land's value that can be used as collateral; further explanation on this variable will be given in the following[11].

Given that land is a productive factor it's value is determined by the present value of future productivity:

$$E_t\left(\zeta_t\right) = \sum_{h=0}^{\infty} \beta^h E_t\left(r_{t+h}^L \bar{L}\right) \tag{6}$$

Following closely Arango et al (2011), land's value is set on a naive[12] way, in which lands value depends on the present value of future land's revenue, this is[13]:

$$E_t\left(\zeta_t\right) = \sum_{h=0}^{\infty} E_t\left(\beta^h r_t^L \bar{L}\right) = r_t^L \bar{L} \frac{1}{1-\beta} \tag{7}$$

Equation (7) assumes that transitory productivity shocks are seen by the market as permanent, this is in line with the behavior described in section 1.2. Nevertheless, as the shocks disappears, equation (7) implies that land prices return to its unchanged steady state.

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[10] $1+r_t = \frac{1+i_t}{1+\pi_t^c}$

[11] As in Monacelli (2009), collateral constrain saturates in the proximity of the steady state, making equation (5) an equality.

[12] The naive pricing scheme proposed by the authors supposes that, at any moment, market's land valuation is done assuming that future land's revenues would stay unchanged in the future ($r_t^L = r_{t+1}^L = r_{t+2}^L = ...$) as if the present is the steady state.

[13] Given that $0 < \beta < 1$ expresion $\sum_{h=0}^{\infty} \beta^h$ is equal to $\frac{1}{1-\beta}$.

Households decisions on consumption of both types, labor, capital and borrowing are:

$$\lambda_t = (x_t)^{-\sigma} x_t^{\frac{1}{\nu}} (1 - \alpha) (c_t)^{\frac{-1}{\nu}} \tag{8}$$

$$0 = (x_t)^{-\sigma} x_t^{\frac{1}{\nu}} (\alpha)^{\frac{1}{\nu}} (d_t)^{-\frac{1}{\nu}} + \lambda_{t+1} \beta (1 - \delta_h) q_{t+1} - \lambda_t q_t \tag{9}$$

$$\varphi l_t^{\mu} = \lambda_t w_t \tag{10}$$

$$\lambda_t = \lambda_t r_t^k + \lambda_{t+1} \beta (1 - \delta_k) \tag{11}$$

$$\beta \lambda_{t+1} (1 + r_{t+1}) = \lambda_t + \lambda_t \gamma_t (1 + r_t) \tag{12}$$

Where λ_t is the shadow price of real income that, as shown in equation (8), is equivalent to the marginal utility of no durable consumption.

2.2 Final good producers

Final good producers transform the intermediate good (y_{jt}) in both durable and no durable good $(y_{it} = c_t, \ d_t)$, using the same technology described by the following bounder:

$$\left[\int_0^1 y_{jt}^{\frac{\theta - 1}{\theta}} dj \right]^{\frac{\theta}{\theta - 1}} = y_{it} \qquad \text{for } i = d, \ c \tag{13}$$

Those firms minimize their cost determined by the input price (p_{it}) subject to equation (13). The standard cost minimization implies the following intermediate good demand:

$$y_{jt} = \left(\frac{p_{jt}}{P_t} \right)^{-\theta} y_{it} \tag{14}$$

Where P_t is the aggregated price level given by:

$$P_t = \left[\left((1 - \omega) (p_{jt})^{1-\theta} + (\omega) (P_{t-1})^{1-\theta} \right) \right]^{\frac{1}{1-\theta}} \tag{15}$$

2.3   Intermediate good firms

A typical firm j operates a Cobb-Douglas production function given by:

$$y_{j,t} = z_t k_{j,t}^{1-\alpha-\nu} n_{j,t}^{\alpha} \bar{L}_j^{\nu} \tag{16}$$

Where $z_t = z_{t-1}^{\rho_z} z^{1-\rho_z} e^{\varepsilon_t^z}$ describes the technology process which depends on a normal distributed shock.

Firms minimize their cost subject to their production function, this is:

$$\min_{l_{jt},\, k_{jt}} \quad w_t l_{j,t} + r_t^k k_{j,t} + r_t^L \bar{L}_j - \eta_{jt}\left(y_{j,t} - z_t k_{j,t}^{1-\alpha-\nu} n_{j,t}^{\alpha} \bar{L}_j^{\nu}\right) \tag{17}$$

Where η_{jt} is the intermediate good production's marginal cost.
First order condition attaining capital, land and labor are:

$$r_t^k = \eta_{jt}\left(1-\alpha-\nu\right)\frac{y_{j,t}}{k_{j,t}} \tag{18}$$

$$w_t = \eta_{jt}\alpha\frac{y_{j,t}}{l_{j,t}} \tag{19}$$

$$r_t^L = \eta_{jt}\nu\frac{y_{j,t}}{\bar{L}_j} \tag{20}$$

2.3.1   Intermediate goods pricing

Intermediate goods firms also select their prices following a Calvo pricing restriction. This means that, at any period t, only a proportion $1-\omega$ of the firms can adjust their prices. Price setting is determined by the following profit maximization problem.

$$\max_{p_{jt}} \Pi_t = \sum_{i=0}^{\infty}(\beta\omega)^i\left(\left(\frac{p_{jt}}{P_{t+i}}\right)-\eta_{jt+i}\right)y_{jt+i} \tag{21}$$

The solution to this optimization problem is:

$$\frac{p_{jt}}{P_t} = \frac{\theta}{\theta-1}\left(\frac{\sum_{i=0}^{\infty}(\beta\omega)^i\eta_{jt+i}\left(\frac{P_{t+i}}{P_t}\right)^{\theta}y_{t+i}}{\sum_{i=0}^{\infty}(\beta\omega)^i\left(\frac{P_{t+i}}{P_t}\right)^{\theta-1}y_{t+i}}\right) \tag{22}$$

Equation (22) is the firm's j relative price that, along with (15), summarizes the solution to (21).

2.4   Financial system

Financial system is under perfect competition, which means that no benefit is obtained from its activities. Nevertheless, in order to stay in the market, financial institutions must take measures that allow them to have a safe lending activity. This means that collateral must be enough to cover the debt at any time, situation that is particularly difficult to attain when the collateral prices are in a downward dynamic. From now on the condition that enables a complete collateral coverage of the debt's value will be referred as safe lending condition (SLC). It implies that at any time:

$$(1 + r_t) b_{t-1} \leq \zeta_t \tag{23}$$

As said before, this type of condition is overruled by equation (5) during positive fluctuations, since land's price will be always larger and hence enough to cover the debt and it's cost.

The collateral value can be expressed at any time as a function of it's dynamics:

$$\zeta_t = \kappa_t \overline{\zeta} \tag{24}$$

where

$$\kappa_t \in (0, \infty) \tag{25}$$

As mentioned before, financial system's problem arises when land's value is below debt's total value, this is:

$$\frac{(1 + r_t) b_{t-1}}{\zeta_t} > 1 \tag{26}$$

Using (24), equation (26) can be expressed as:

$$\frac{(1 + r_t) b_{t-1}}{\overline{\zeta}} > \kappa_t \tag{27}$$

The SLC problem is that credit's approval is given one period before it's payment, making it impossible to know the collateral coverage over the debt if defaulted, when credit conditions are established. In this order we have that, if credit is approved in t, SLC is:

$$
\begin{aligned}
(E_t [1 + r_{t+1}]) b_t &\leq E_t [\zeta_{t+1}] \\
&\text{or} \\
(E_t [1 + r_{t+1}]) b_t &\leq E_t [\kappa_{t+1}] \overline{\zeta}
\end{aligned}
\tag{28}
$$

Assuming one more time naive pricing, this is:

$$
\begin{aligned}
(1 + r_t) b_t &\leq \kappa_t \overline{\zeta} \\
\frac{(1 + r_t) b_t}{\zeta_t} &\leq \kappa_t
\end{aligned}
\tag{29}
$$

A similar condition is found in (5), where χ_t can be read as a variable that undervalues current land's price in order to guarantee a complete coverage of debt's in the next period. Following this interpretation SLC can be expressed as a condition on χ_t. Using equation (5) and (29) we have that a sufficient condition for SLC is:

$$\chi_t \leq \kappa_t \tag{30}$$

or

$$\chi_t \leq \frac{\zeta_t}{\bar{\zeta}} \tag{31}$$

Following the later and using κ_t as χ_t's argument, χ_t must fit the following conditions

$$\chi_t = \begin{cases} 1. & f(\kappa_t) \in (0,1) \ \forall \kappa_t \in (0,\infty) \\[2mm] 2. & f(\kappa_t) = 0 \iff \kappa_t = 0 \\[2mm] 3. & f(\kappa_t) \leq \kappa_t \ \forall \kappa_t \in (0,\infty) \end{cases} \tag{32}$$

First condition constrains equation (5) to the literature standards of χ_t between 0 and 1 given that κ_t can only take positive values; second condition keeps credit to zero when there is no value in the collateral and third condition allows for equation (31) to be met.

The specific equation with these conditions is the following:

$$\chi(\kappa_t) = \left(\frac{e^{\kappa_t - \vartheta}}{1 + e^{\kappa_t - \vartheta}} - \Phi \right) (1 - \Phi)^{-1} \tag{33}$$

Where ϑ and Φ are chosen to fit conditions (32) as shown in figure 5.

Figure 5: mapping of $\chi\left(\kappa_t\right)$.
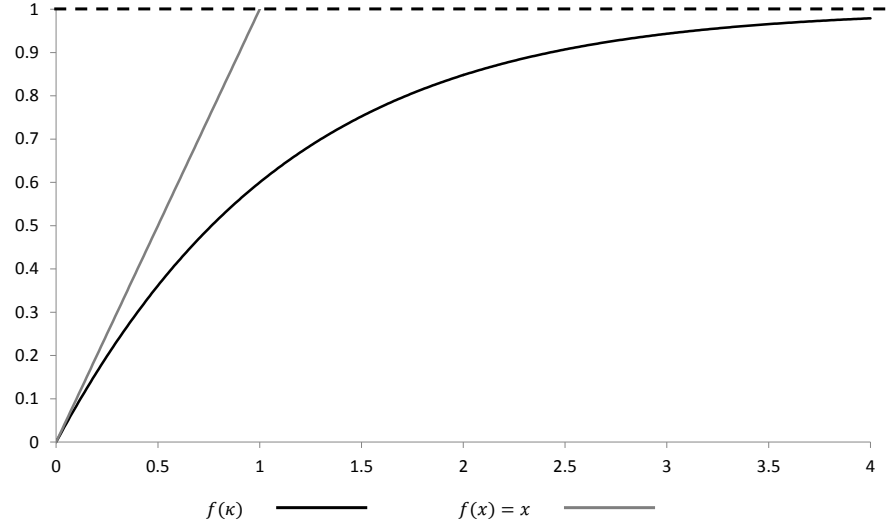
2.5   Monetary policy

Monetary policy follows a standard Taylor rule determined by the consumption goods inflation, described by:

$$r_t \;\; = \;\; \bar{r}\left(\frac{\pi_t^c}{\bar{\pi}}\right)^{\varphi}\left(\frac{y_{t-n}}{\bar{y}}\right)^{(1-\varphi)} \tag{34}$$

Where φ determines the weight of inflation in the dual objective interest rate rule.

3   Calibration

Calibration of the model is done following some literature standards. Most of the works used for this are built to reply some developed economies, mainly the US economy. This paper is intended to illustrate the transmission mechanism

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through which the financial system can amplify negative economic shocks in a low interest rates environment. So as prediction power is not an issue a non controversial calibration, like the one presented in this section, serves well this paper's purpose.

Among some works Faia and Monacelli (2007) and Monacelli (2009) are closely follow in choosing the parameters value. Some other papers are mentioned in Table 1.

Households discount factor β is set equal to 0.99 which means that the discount rate is 0.03 in a quarterly basis. Labor and land's share in the production function are are in that order $\alpha = 0.33$ and $\nu = 0.16$. Capital's an durable good's depreciation factor (δ_k and δ_h) are both equal to 0.025.

Elasticity of substitution among productive sectors is given by $\theta = 6$. Elasticity of substitution between durable and non durable goods (ν_c) is set to 1.4. Durable goods' share in the consumption bounder is $\alpha_h = 0.27$. The chance of price adjustment $\omega = 0.75$, implies that price adjustment occurs every 4 quarters [14]. Consumption and labor weights' in the utility function are given by $\sigma = 1$ and $\mu = 1$. Finally it is assumed that only 75% of the land can be used as collateral ($\chi = 0.25$)

As mentioned before ϑ and Φ are chosen to fit conditions (32), this is $\vartheta = 1.93$ and $\Phi = 0.87$. All other parameters that are taken from the literature are summaraised in Table 1.

4   Results

This section presents the model's results under two different conditions: fixed and variable χ_t. The first case describes a collateral constrain very similar to the one in Kiyotaki and Moore, where the proportion of land's value that can be used as collateral is always constant (I will refer to this case as fixed). In this case $\chi_t = \overline{\chi}$, using (5) this is:

$$b_t (1 + r_t) \leq \overline{\chi} E_t (\zeta_t)$$

The second case is the one described in (5) where a downward trend on land's value increases financial system's awareness and so reduces the credit slackness, as described by equation(33), reducing households' access to new credits at any interest rate (I will refer to this case as variable).

Figures 6 and 7 show the response of different variables to a shock in technology given by a 1% decrease in ε_t^z in period $t = 0$.

Figure 6 shows that a 1% negative shock in technology cause an even larger reduction in production due to the so call financial accelerator, as reflected in the borrowing's dynamics (figure 7).

From the demands point of view, the negative shock reduces land's productivity causing an even larger reduction in its value due to the naive pricing assumption. This strongly restrains credit extending the reduction effects to

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[14] $\frac{1}{1-\omega} = 4$

Table 1: Calibration

Parameter	Values	References
β	0.99	Monacelli (2009), Krusell and Smith (1998), Faia and Monacelli (2007) and Gali (2008)
δ	0.025	Monacelli (2009), Campbell and Hercowitz (2006) and Faia and Monacelli (2007)
θ	6	Monacelli (2009) and Faia and Monacelli (2007)
α_h	0.27	Monacelli (2009) and Carlstom and Fruest (2006)
ν	0.16	Kocherlakota (2000)
α	1/3	Faia and Monacelli (2007) and Campbell and Hercowitz (2006)
ω	0.75	Faia and Monacelli (2007) and Monacelli (2009)
σ	1.5	Smets and Wouters (2003)
μ	1	Gali (2008) and Walsh (2010)
χ	0.75	Monacelli (2009)
φ	0.5	Taylor (1993)

durable consumption and capital investment. Particularly capital show a very pronounced decrease highly linked to the durable goods dynamics that, opposite to the non durable goods, shows an increase after the production shock. Both capital and non durable goods are instrument that allow households to transfer wealth from one period to the other. Nevertheless, different to the capital behavior, durable goods profitability is never affected by the technology shock, making that households substitute capital with durable goods. From the supply point of view the negative ε_t^z shock reduces all productive factors rent, shrinking the household's supply of all of them, specially of capital as said before. This clearly reduces production and ergo consumption and investment.

As mentioned before, figures 6 and 7 show the effects whit a fixed $\overline{\chi}$ and varible χ_t described in equation (33). Both figures show that SLC induces and even deeper fluctuation, particularly on the credits dynamics. However production decrease during the first period, is only 1.075 times bigger that under variable χ_t, this difference diminishes during the following periods. The fact that this situation is common to all the variables, allows concluding that most of the financial accelerator effect simulated by the model is explained by the collateral value and no so much by the financial system's cautious behavior. A similar remark is found in Bernanke et al (1991), where they find no evidence that financial system's cautious behavior, which they address as "overzealous regulation" has a significant impact on lending. On the other hand "borrowers' balance sheets", strongly determined by collateral's value, is found to be a valid answer to the weakening of lending activity.

Unlike conventional wisdom, in both cases depicted in figures 6 and 7, the production, credit and other variables, slowdown despites of the low interest rates. The main reason for the credit and economy's slowdown is found in the limited access to lending at a low interest rate like ones set by the monetary authority [15]. So it is the shortage on warranties offered by the borrowers that explains most of the credit's slump.

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[15]A low interest rate rules out a flight to quality or any shortage of financial system's liquidity.

Figure 6: Impulse response to a 1 % decrease in ε_t^z under naive expectations
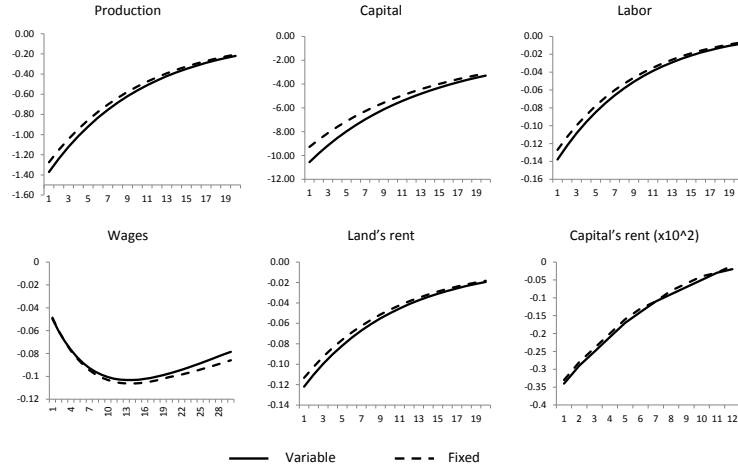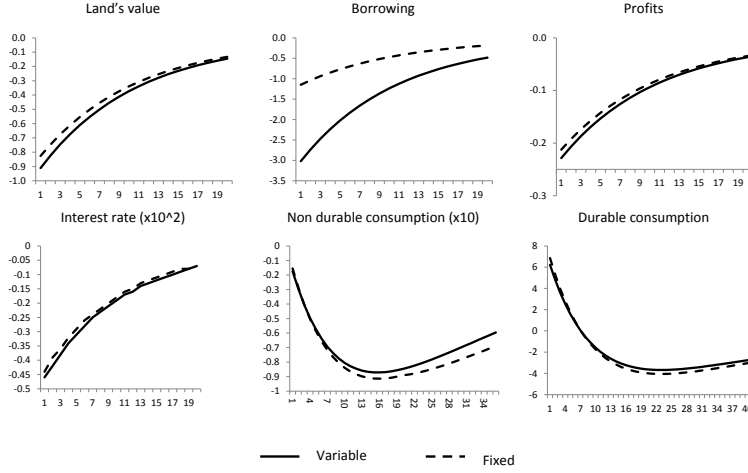
Figure 7: Impulse response to a 1 % decrease in ε_t^z under naive expectations

4.1 Alternative monetary policy

Simulations in figure 8 and 9 show the effect of an interest rate rule different to (34). This alternative rule uses a bounder of land's prices and the price index of consumption goods, this is:
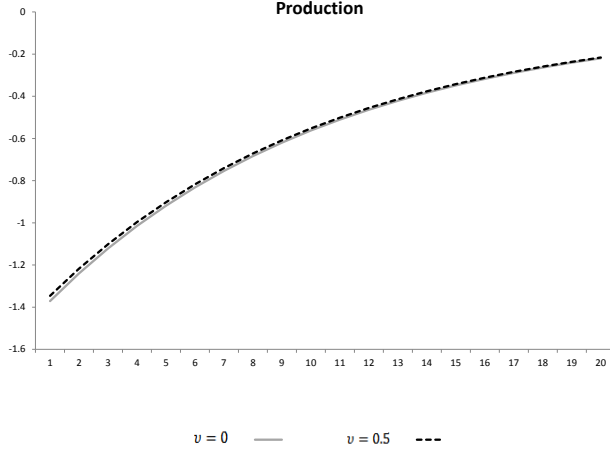
$$i_t = \bar{i}\left((1-\upsilon)\frac{\pi_t^c}{\bar{\pi}} + \upsilon\frac{\zeta_t}{\bar{\zeta}}\right)^{\varphi}\left(\frac{y_t}{\bar{y}}\right)^{1-\varphi} \tag{35}$$

where υ is the weight of land's value in the prices index factor.

As shown in figures 6 and 7, land's value is one of the variables that has the strongest reaction after the initial shock. Using (35) causes a greater decrease in interest rates for higher values of υ. A more expansive monetary policy should reduces the economy's slump, but, as shown in figures 8 and 9, a more restrictive credit constrain, explained by the collateral value and the financial system behavior[16], can stop the monetary policy expansion's effects. Figures 8 and 9 map respectively the impulse response of product and interest for different values of υ. Figures 10 and 11 shows that higher values of υ increase the monetary authority reaction to the production shock, through lower interest rates. This effect is hard to acknowledge in figures 8 and 9, which unveils some monetary policy impotence during economic crisis. This is a consequence of the

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[16]Simulations are done using (5).

Figure 8: Product response with $\upsilon = 0$ and $\upsilon = 0.5$, to a 1 % decrease in ε^z_t under naive expectations

strong reaction on the collateral that prevents the credit recovery despite the low interest rates.

4.2 Alternative land's valuation scheme

Pricing as proposed in equation (7) creates a very strong reaction after a productivity shock, allowing to simulate the dynamics of a price bubble's burst, as shown in Figures 6 to 11 for the land's value. Even if the results are quite compelling it is interesting to try a different way to determine the land's value in order to prove the exercises robustness .

An alternative pricing scheme must be based on a different expectations formation model; one alternative is having adaptive expectations. Following Nerlove and Bessler (2001) one can suppose that at every time t the expected land's revenue is the steady state value plus a portion of the deviation from the steady state observed in the last period, this is:

$$E_t\left(r^L_{t+1}\right) = \bar{r}^L + \Omega\left(r^L_t - \bar{r}^L\right) \text{ for } 0 < \Omega < 1 \tag{36}$$

Iterating and replacing (36) in (6), follows that:

$$E_t\left(\zeta_t\right) = \bar{L}\left[\bar{r}^L\left(\frac{\beta}{1-\beta}\right) + r^L_t + \left(r^L_t - \bar{r}^L\right)\left(\frac{\beta\Omega}{1-\beta\Omega}\right)\right] \tag{37}$$

20

Figure 9: Product response with different values of v, to a 1 % decrease in ε_t^z under naive expectations
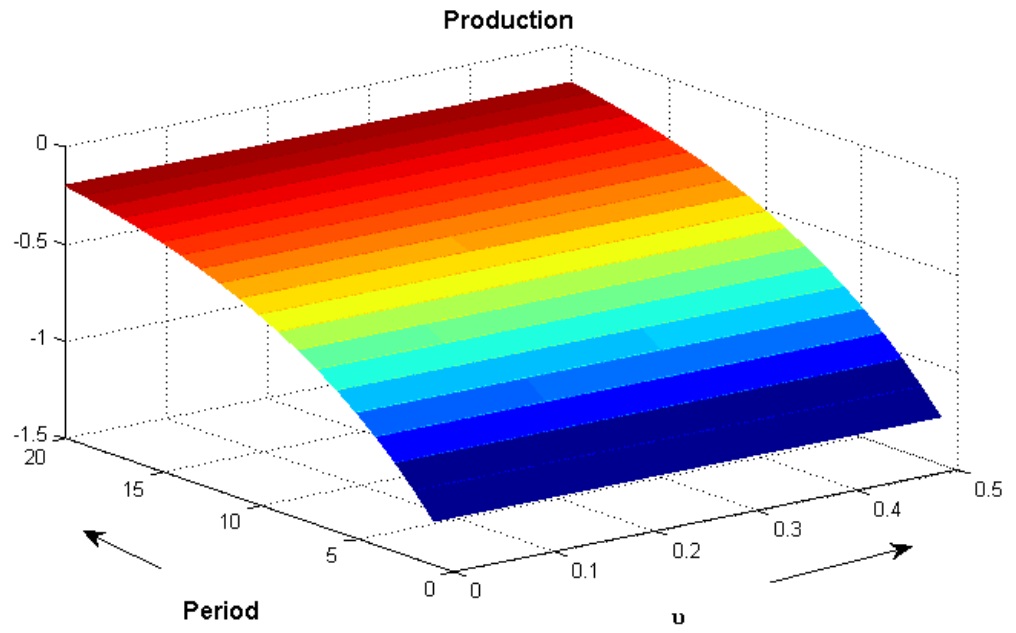
Figure 10: Interest rate (as in (35)) response with $v = 0$ and $v = 0.5$, to a 1 % decrease in ε_t^z under naive expectations
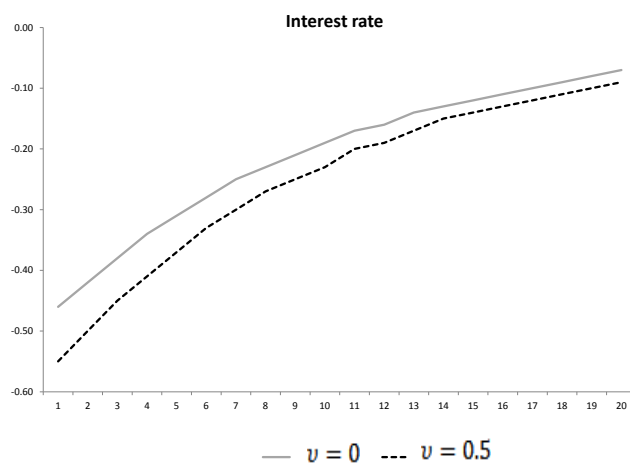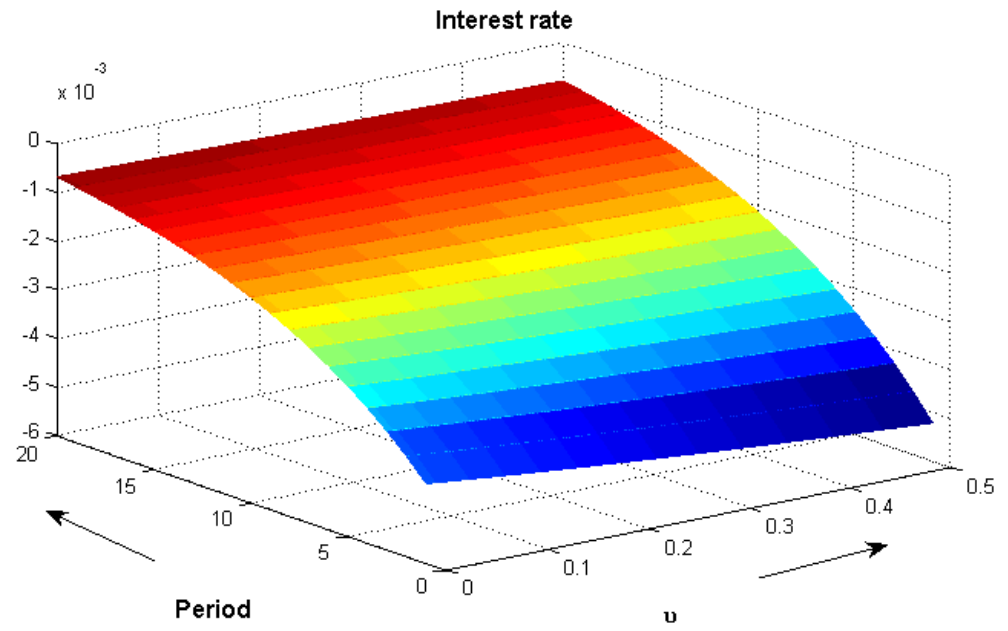

22

Figure 11: Interest rate (as in (35)) response with different values of v, to a 1 % decrease in ε_t^z under naive expectations

As the reader can notice, equation (7) and (37) are similar in the fact that both depend on the present productivity of land; the difference is that (37) assumes that only a fraction of the present productivity is incorporated in the land's price. It also can be demonstrated that these equations are equivalent in steady state[17].

Results for this alternative expectations formation model are quite similar to the naive pricing scheme, as shown in Figures 12 and 13[18]. Nevertheless the price bubble burst depicted in Figure 13 is not as strong as the one in figure 7; this as a consequence of higher transitory information asymmetries in the naive expectations compared to the one with adaptive expectations.

Pricing schemes purposed in equations (7) and (37) are a result of non rational expectations. Given that under rational expectation there is by definition non wrong pricing, there is no place for a bubble burst. This is why a wrong pricing scheme, like the one in equations (7) and (37), is needed in order to illustrate a bubble's burst.

Figure 12: Impulse response to a 1 % decrease in ε_t^z under adaptive expectations
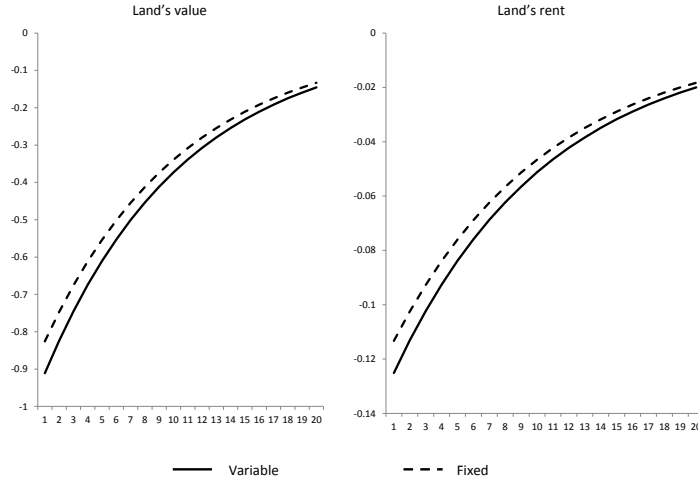

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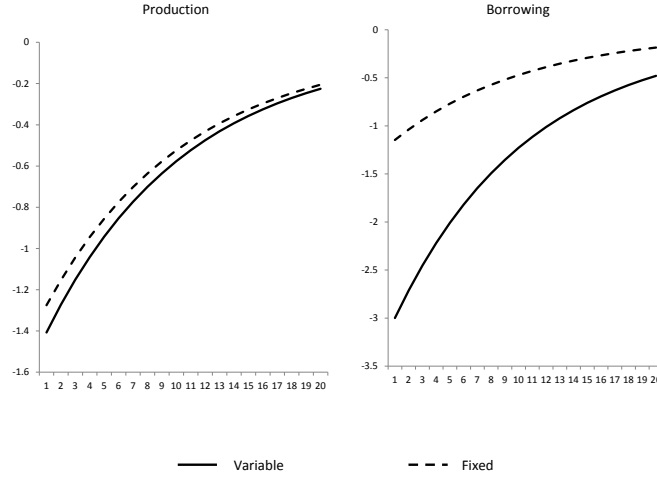
[17] In steady state:
Equation (7) is: $\sum_{h=0}^{\infty} \beta^h r_t^L \bar{L} = r_t^L \bar{L} + \beta r_t^L \bar{L} + \beta^2 r_t^L \bar{L} + ... = r_t^L \bar{L} \frac{1}{1-\beta}$.
Equation (37) is: $\bar{L} \left[\bar{r}^L \left(\frac{\beta}{1-\beta} \right) + r_t^L \right] = r_t^L \bar{L} + \beta r_t^L \bar{L} + \beta^2 r_t^L \bar{L} + ...$
[18] All the other variables have a very similar behavior to the one in figures 6 and 7.

Figure 13: Impulse response to a 1 % decrease in ε_t^z under adaptive expectations

5 Conclusions

The model depicts an amplifying effect of credit over the rest of the economy, which is vastly described by the financial accelerator literature. Nevertheless, unlike most of the literature, credit's dynamic is determined by the collateral meaning that collateral value and financial system's slackness, when taking guaranties for credit approvals, can determine credit's dynamic, playing a more important role the first factor than the second.

Under this circumstance traditional monetary policy proves highly inefficient in increasing economic activity, keeping the economy in a sort of "liquidity trap" induced by the low access to credit. As collateral determines the credit's value, asset's price used for this restriction deserve special attention of economic authorities in order to have a higher control on the credit cycle and its power to influence the economic cycle.

The simulations shows that the collaterals value can become a strong barrier to expansive monetary policy given that credit approvals need two conditions: asking for it and being worthy. Low interest rates can make it for the first condition but not for the second. For that reason lowering interest rates in order to improve credit and thus house price might not be enough.

This kind of situation showed that the burst of a price bubble on assets used as collateral have larger consequences that lets say the .com bubble. It is also harder to deal with given that monetary policy effectiveness diminishes.

This makes that the idea of "buying houses and burn them in order to reduce supply" does not look so unappealing, notwithstanding it is steel unviable. Some central banks have tried buying unusual assets (for instance the Bank of Japan has started to intervene in the stock market and the FEDS' QE programs have also lead to unusual balance sheets); nevertheless these actions have been quite futile given that those assets are not used as collateral.

Intervention of monetary authorities in the real estate market can be more distortionary than useful, that's why the attention must be in avoiding price bubbles, at least on asset that usually are used as collateral. In those cases the Greenspan's philosophy of not doing anything and then cleaning the mess[19] might not be the best idea.

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