Collateralized assets prices and monetary policy

Mauricio Arango†

September 4, 2013

Abstract

A well informed and cautious financial system can improve the welfare outcome of an economy by making lenders surplus to borrowers. Nevertheless, in a crisis situation the behavior of the financial system can become a crisis amplifier given that credit approval conditions are rarely met. Therefore, a credit crunch may occur even in a low interest rates environment. This paper illustrates the aforementioned point by developing a general equilibrium model where the collateral credit condition defines the prudential behavior of the financial system. This and various other conditions amplify the magnitude of a negative productivity shock.

*I am thankful to Carlos Esteban Posada, Eduardo Morón, Luis Eduardo Arango and Carlos Andres Giraldo for useful comments.

†Fondo Latino Americano de Reservas (FLAR).
1 Introduction

Recent events in developed economies have caused special attention to be paid to the financial markets. Such events reinforce the idea that the developments in these countries have had a considerable impact on 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 on 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 the purpose of this paper, which is to develop a theoretical model that shows how changes in collateral constraints, caused by both changes in the price of collateral and the cautious behavior of the banks, can strongly diminish monetary policy effectiveness by breaking the credit channel.

This slump in household credit 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, the US unemployment rate has never remained over 7% for very long in the last two decades. This implies a lower income for households and therefore lower consumption and welfare.

Nevertheless, this type of comovement between the credit and economic cycle is far from 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 the counter cyclical behavior of interest rates. This implies that during crisis credit is less accessible (due to higher interest rates), reducing investment and worsening the recession.

The connection between credit and the economic cycle is closely related to what is referred to in the literature as the “credit crunch” and “financial accelerator”. These two terms are often used to explain the effect of the financial system in economic crisis. The credit crunch refers to a significant reduction in 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 the many reasons offered by the authors, "overzealous regulation" and "credit demand and borrowers’ balance sheets" fit quite well into the events of the last six years (even though the aforementioned are not chosen by the authors as the main factors for the 1990s

\[ \lambda = 14400. \]
credit crunch). The former reason refers to a less lax behavior from banks during economic crisis in order to 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 borrowers’ balance sheets which is affected by lower prices. The latter argument becomes more relevant after the most recent crisis. As shown in figure 3, real house prices have been constantly decreasing since the outbreak of the subprime crisis.

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

Using some recent developments from the Dynamic Stochastic General Equilibrium (DSGE) literature on the housing market, this paper develops a DSGE model that explains how a financial system’s collateral constrain can amplify
negative economic shocks in an expansive monetary environment, reducing monetary policy effectiveness.

1.1 Credit crunch and financial accelerator

A credit crunch has usually been thought of as a consequence of economic downturns instead of a cause of economic fluctuations. One of the consequences of a financial system is the presence of larger fluctuations due to the financial accelerator. The seminal work of Bernanke et al. (1996) refers to two complementary characteristics of the financial accelerator: the amplification of initial shocks and its propagation. The main reason behind these two consequences is given by the worsening of the financial conditions of the agent. In particular, a flight to quality reduces access to the 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 Cycle (RBC) fluctuations can reduce cash flow to borrowers, and later through investment, to the rest of the economy.
This generates a vicious cycle that amplifies the effect of the initial shock and prolongs it to the following periods.

Similar conclusions were reached by Greenwald and Stiglitz (1993) using a model where companies can only operate with debt. They found that a company whose access to financing is reduced suffers a decrease in its production and profits, which in turn induces a decline in income to the rest of the economy. Gertler (1992) and Aghion and Bolton (1997), among other authors, found the same effects with different models.

Bernanke et al. (1998) mention information asymmetries as one of the main reasons for the financial accelerator. They also cite agency costs and the fact that, under credit market frictions, borrowers’ finance premiums depend inversely on their wealth, reinforcing the conclusion that an exogenous reduction of household income restrains 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 as part of consump-
tion. They found that a positive shock in the economy increases the demand for houses and therefore house prices rise. This in turn improves homeowners’ net worth, allowing them to borrow more money, increasing the demand for houses even further.

Considering a different perspective, Kiyotaki and Moore’s (1997) seminal paper introduces a collateral constraint for borrowing, describing a different mechanism of crisis propagation through credit. In this type of model, crisis generates a decrease in the price of any goods used as collateral, causing a reduction in borrowing capacity and therefore lower spending.

The Kiyotaki and Moore’s setup has been widely used in more recent papers, such 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 interest on the relationship between credit and the price of goods used as collateral. Most of these papers use New Keynesian DSGE models that illustrate how the financial system can amplify the initial effect of a productivity or monetary policy shock. Many of these models rely on a Calvo pricing setup\(^2\) in order to simulate the effect of the price of durable goods on collateral constraint.

Most of the literature after Kiyotaki and Moore’s paper has taken collateral constraint 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 and in turn causes a credit crunch.

Other studies important to the development of this paper are referenced below. Nevertheless, literature on the credit-market is vast and the literature review presented here is far from being a complete survey. Bernanke et al. (1996) and (1998) can be referenced for further consultation.

1.2 The price bubble

Erroneous pricing is not an idea with which many economists feel comfortable. Nevertheless, price bubbles are mostly related to this term. The last US crisis was an example of erroneous pricing, as reported in various 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 a price bubble usually only looks like irrational behavior after it bursts. In the meantime, as prices rise and peak, it looks like a sustainable situation. In the words of the former chairman of the FOMC, Alan

\(^2\)Calvo (1983).  
\(^3\)Steven Gjerstad and Vernon L. Smith. April 6, 2009 at The Wall Street Journal.  
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 pricing behavior mentioned above leads to larger consequences that extended to the economy as a whole. As stated by some analysts, the bursting of the house price bubble plays a crucial role when the economy crashes: “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.”; “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.” These two statements reflect the main idea of this paper, which focuses on the bursting of the price bubble.8

1.3 Financial system’s cautious behavior

A financial system will often take many precautions, such as the analysis of payment affordability and a credit score among others. Yet the only precaution that remains useful after default is collateral. Although the sole action of asking for collateral can be seen as cautious behavior. Under Kiyotaki and Moore’s approach, only one percent of the asset can be used as collateral (usually 75%). This proportion is constant and therefore makes it harder to make the financial system tighten its behavior. Since all these situations are examples of cautious behavior to one degree or another, in this paper for simplicity, collateral taken at a certain percentage will be called cautious behavior.9

This paper presents a model where the collateral constraint, unlike in previous literature, is endogenous and describes the financial system’s decisions. This, along with a “naïve pricing” scheme as proposed in Arango et al (2011), generates an amplifying effect like the one described by the financial accelerator literature. However, unlike most 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 presents the DSGE model; section three presents the parameter calibration; section four presents the results and section five concludes.

---

5 As wrote by Paul Krugman, August 29, 2005 at The New York Times.
6 DiMartino and Duca (2007).
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.
section four shows the simulation results; and section five draws conclusions.

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 divided into three groups: productive factors, benefits and credits. There are three types of productive factors: labor, capital and land. All three are used by companies and owned by households. They produce intermediate goods that are later used by companies to produce the final goods consumed by the households. The intermediate companies are slightly differentiated and produce benefits that are delivered to the owners.

Credits have to be paid within a certain time after they are acquired, with an interest rate set by the monetary authority. In this way, the monetary authority provides all the liquidity needed to sustain a Taylor rule based interest rate. Credit is provided through a financial system that works under perfect competition, having no markup on the interest rate. Nevertheless, the financial system demands a collateral for lending. This collateral constraint is determined by land price, which is equivalent to the present value of the future rent of the land. This closes the production and credit circle that is summarized in figure 4.
2.1 Households

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

\[ E_0 \left\{ \sum_{t=0}^{\infty} \beta^t U \left( x_t, n_t \right) \right\} \]  

(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:

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

(2)

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

\[ U \left( x_t, n_t \right) = \frac{(x_t)^{1-\sigma} - \varphi t^{1+\mu}}{1 - \sigma} \]  

(3)

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

\[ w_t k_t + \rho_t k_t + p_t + b_t + r_t L_t + (1 - \delta_h) q_t d_{t-1} + (1 - \delta_k) k_{t-1} \geq \]  

\[ (1 + r_t) b_{t-1} + c_t + d_t q_t + k_t \]  

(4)

Where at every period \( t \): \( w_t \) is the salary, \( r_t \) the capital’s rent, \( k_t \) the capital, \( p_t \) intermediate firms benefits, \( L_t \) the land and it’s rent, \( b_t \) the debt acquired every period, \( r_t \) the interest rate\(^{10} \), \( \delta_h \) and \( \delta_k \) the durable goods and capital’s depreciation rate, \( q_t \) durable goods price. Finally \( \pi_t^\pi \) is the change in the price of the consumption good; given that every variable is expressed in terms of the consumption good, \( \pi_t^\pi \) is the measure of inflation.

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

\[ b_t (1 + r_t) \leq \chi_t E_t \left( \zeta_t \right) \]  

(5)

where \( E_t \left( \zeta_t \right) \) is the expected value of land and \( \chi_t \) 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:

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

(6)

\(^{10} \)\( 1 + r_t = \frac{1 + \pi_t}{1 + \pi_c} \)

\(^{11} \)As in Monacelli (2009), collateral constrain saturates in the proximity of the steady state, making equation (5) an equality.
Following closely Arango et al (2011), land’s value is set on a naive way, in which land’s value depends on the present value of future land’s revenue, this is:

\[ E_t(\zeta_t) = \sum_{h=0}^{\infty} E_t(\beta^h r^h L) = r_t^L \frac{1}{1-\beta} \]  

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.

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

\[ \lambda_t = (x_t)^{-\sigma} x_t^{1/\sigma} (1-\alpha) (c_t)^{-1/\sigma} \]  

\[ 0 = (x_t)^{-\sigma} x_t^{1/\sigma} (\alpha)^{1/\sigma} (d_t)^{-1/\sigma} + \lambda_{t+1} \beta (1-\delta_k) q_{t+1} - \lambda_{t} q_{t} \]  

\[ \varphi_l^u = \lambda_t w_t \]

\[ \lambda_t = \lambda_t r_t^k + \lambda_{t+1} \beta (1-\delta_k) \]

\[ \beta \lambda_{t+1} (1+r_{t+1}) = \lambda_t + \lambda_t \gamma (1+r_t) \]  

Where \( \lambda_t \) 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:

\[ \left[ \int_0^1 y_{jt}^{\frac{1}{\gamma_i}} dj \right]^{\frac{\gamma}{\gamma_i}} = y_{it} \quad \text{for } i = d, c \]  

\(^{12}\)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 \( 0 < \beta < 1 \) expression \( \sum_{h=0}^{\infty} \beta^h \) is equal to \( \frac{1}{1-\beta} \).
Those rms minimize their cost determined by the input price \( p_{it} \) subject to equation (13). The standard cost minimization implies the following intermediate good demand:

\[
y_{jt} = \left( \frac{p_{jt}}{P_t} \right)^{-\theta} y_{it}
\]

(14)

Where \( P_t \) is the aggregated price level given by:

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

(15)

### 2.3 Intermediate good firms

A typical rm \( j \) operates a Cobb-Douglas production function given by:

\[
y_{j,t} = z_{t} k_{j,t}^{\alpha} \bar{L}_j^{\nu} \]

(16)

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

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

\[
\min_{l_{j,t}, k_{j,t}} w_t l_{j,t} + r^k_t k_{j,t} + r^L_t \bar{L}_j - \eta_{jt} (y_{j,t} - z_{t} k_{j,t}^{1-\alpha - \nu} \bar{L}_j^{\nu})
\]

(17)

Where \( \eta_{jt} \) is the intermediate good production’s marginal cost.

First order condition attaining capital, land and labor are:

\[
r^k_t = \eta_{jt} (1 - \alpha - \nu) \frac{y_{jt}}{k_{j,t}}
\]

(18)

\[
w_t = \eta_{jt} \frac{y_{jt}}{l_{j,t}}
\]

(19)

\[
r^L_t = \eta_{jt} \frac{y_{jt}}{L_j}
\]

(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.

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

(21)

The solution to this optimization problem is:
\[
\frac{p_{jt}}{P_t} = \frac{\theta}{\theta - 1} \left( \frac{\sum_{i=0}^{\infty} (\beta \omega)^i \eta_{jt+i} \left( \frac{P_{t+i}}{P_t} \right)^{\theta} y_{t+i}}{\sum_{i=0}^{\infty} (\beta \omega)^i \left( \frac{P_{t+i}}{P_t} \right)^{\theta-1} y_{t+i}} \right)
\]  

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:

\[
(1 + r_t) b_{t-1} \leq \zeta_t
\]  

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:

\[
\zeta_t = \kappa_t \zeta
\]  

where

\[
\kappa_t \in (0, \infty)
\]

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

\[
\frac{(1 + r_t) b_{t-1}}{\zeta_t} > 1
\]  

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

\[
\frac{(1 + r_t) b_{t-1}}{\zeta} > \kappa_t
\]  

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:
\[(E_t [1 + r_{t+1}]) b_t \leq E_t [\zeta_{t+1}]\]
\[(E_t [1 + r_{t+1}]) b_t \leq E_t [\kappa_{t+1}] \zeta\]  

Assuming one more time naive pricing, this is:
\[(1 + r_t) b_t \leq \kappa_t \zeta\]
\[\frac{(1 + r_t) b_t}{\zeta} \leq \kappa_t\]  

A similar condition is found in (5), where \(\chi_t\) 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 \(\chi_t\). Using equation (5) and (29) we have that a sufficient condition for SLC is:
\[\chi_t \leq \kappa_t\]  
\[\chi_t \leq \frac{\zeta_t}{\zeta}\]  

Following the later and using \(\kappa_t\) as \(\chi_t\)’s argument, \(\chi_t\) must fit the following conditions
\[
\chi_t = \begin{cases} 
1. & f (\kappa_t) \in (0, 1) \ \forall \kappa_t \in (0, \infty) \\
2. & f (\kappa_t) = 0 \iff \kappa_t = 0 \\
3. & f (\kappa_t) \leq \kappa_t \ \forall \kappa_t \in (0, \infty) 
\end{cases}
\]

First condition constrains equation (5) to the literature standards of \(\chi_t\) between 0 and 1 given that \(\kappa_t\) 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 (30) to be met.

The specific equation with these conditions is the following:
\[
\chi (\kappa_t) = \left( \frac{e^{\kappa_t - \vartheta}}{1 + e^{\kappa_t - \vartheta} - \Phi} \right) (1 - \Phi)^{-1}
\]

Where \(\vartheta\) and \(\Phi\) are chosen to fit conditions (32) as shown in figure 5.
2.5 Monetary policy

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

\[ r_t = \bar{\bar{r}} \left( \frac{\pi_t}{\bar{\pi}} \right)^\varphi \left( \frac{y_t - \bar{y}}{\bar{y}} \right)^{(1-\varphi)} \]  

(34)

Where \( \varphi \) 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
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 $\beta$ 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 in that order $\alpha = 0.33$ and $\nu = 0.16$. Capital’s an durable good’s depreciation factor ($\delta_k$ and $\delta_h$) are both equal to 0.025.

Elasticity of substitution among productive sectors is given by $\vartheta = 6$. Elasticity of substitution between durable and non durable goods ($\nu_c$) 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 \footnote{$\frac{1}{1-\omega} = 4$}. 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 $\vartheta$ and $\Phi$ 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 summarized in Table 1.

4 Results

This section presents the model’s results under two different conditions: fixed and variable $\chi_t$. 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 $\chi_t = \bar{\chi}$, using (5) this is:

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

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 $\varepsilon^a_t$ 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
<table>
<thead>
<tr>
<th>Parameter</th>
<th>Values</th>
<th>References</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\beta$</td>
<td>0.99</td>
<td>Monacelli (2009), Krusell and Smith (1998), Faia and Monacelli (2007) and Gali (2008)</td>
</tr>
<tr>
<td>$\delta$</td>
<td>0.025</td>
<td>Monacelli (2009), Campbell and Hercowitz (2000) and Faia and Monacelli (2007)</td>
</tr>
<tr>
<td>$\theta$</td>
<td>6</td>
<td>Monacelli (2009) and Faia and Monacelli (2007)</td>
</tr>
<tr>
<td>$\alpha_h$</td>
<td>0.27</td>
<td>Monacelli (2009) and Carlstrom and Fuster (2006)</td>
</tr>
<tr>
<td>$\nu$</td>
<td>0.16</td>
<td>Kochelevskii (2000)</td>
</tr>
<tr>
<td>$\omega$</td>
<td>0.75</td>
<td>Faia and Monacelli (2007) and Campbell and Hercowitz (2006)</td>
</tr>
<tr>
<td>$\sigma$</td>
<td>1.5</td>
<td>Faia and Monacelli (2007) and Monacelli (2009)</td>
</tr>
<tr>
<td>$\mu$</td>
<td>1</td>
<td>Gali (2008) and Walsh (2010)</td>
</tr>
<tr>
<td>$\chi$</td>
<td>0.75</td>
<td>Monacelli (2009)</td>
</tr>
<tr>
<td>$\phi$</td>
<td>0.5</td>
<td>Taylor (1983)</td>
</tr>
</tbody>
</table>
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 $\varepsilon_t$ 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 $\chi$ and variable $\chi_t$ 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 $\chi_t$, 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 despiets 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.

$^{15}$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 $\varepsilon_t^z$ under naive expectations

![Diagram of production, capital, and labor responses](image1)

Figure 7: Impulse response to a 1% decrease in $\varepsilon_t^z$ under naive expectations

![Diagram of land's value, borrowing, profits, interest rate, non-durable, and durable consumption responses](image2)
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:

\[ i_t = \bar{i} \left( 1 - \nu \right) \frac{\pi_t}{\pi} + \nu \left( \frac{\zeta_t}{\zeta} \right)^\varphi \left( \frac{y_t}{\bar{y}} \right)^{1-\varphi} \]

(35)

where \( \nu \) 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 \( \nu \). 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 \( \nu \). Figures 10 and 11 shows that higher values of \( \nu \) 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 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 exercise 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:

\[ E_t (r_{t+1}^L) = \pi^L + \Omega (r_t^L - \pi^L) \quad \text{for } 0 < \Omega < 1 \]

(36)

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

\[ E_t (\zeta_t) = L \left[ \pi^L \left( \frac{\beta}{1-\beta} \right) + r_t^L + (r_t^L - \pi^L) \left( \frac{\beta \Omega}{1-\beta \Omega} \right) \right] \]

(37)

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)

\(^{16}\) Simulations are done using (5).
Figure 8: Product response with $v = 0$ and $v = 0.5$, to a 1% decrease in $\varepsilon_i^*$ under naive expectations.
Figure 9: Product response with different values of $u$, to a 1% decrease in $\varepsilon_t$ under naive expectations.
Figure 10: Interest rate (as in (35)) response with $v = 0$ and $v = 0.5$, to a 1% decrease in $\varepsilon_t$ under naive expectations.
Figure 11: Interest rate (as in (35)) response with different values of \( \nu \), to a 1% decrease in \( \varepsilon_t \) under naive expectations

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.

\(^{17}\)In steady state:
Equation (7) is: \( \sum_{h=0}^{\infty} \beta^h r_t^L L = r_t^L L + \beta r_t^L L + \beta^2 r_t^L L + ... = r_t^L L \frac{1}{1-\beta} \).
Equation (37) is: \( L \left[ \frac{r_t^L}{r_t^L} - r_t^L \right] = r_t^L L + \beta r_t^L L + \beta^2 r_t^L L + ... \)

\(^{18}\)All the other variables have a very similar behavior to the one in figures 6 and 7.
Figure 12: Impulse response to a 1% decrease in $\varepsilon^*_t$ 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 guarantees 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 still 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 might not be the best idea.

References


---

19 Greenspan (2007).


