Consumption habits and interest rate rigidity

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Abstract:
In this paper we provide a micro model of loans where the lender is a monopolistic bank and the borrower is a competitive consumer with consumption habits who may default on part of his debt. In this setting, we prove that the loan demand curve is kinked and therefore it is possible to find interest rate rigidity in equilibrium as well as asymmetric response of loans to interest rate variations.

Keywords: Interest rate rigidity, kinked loan demand, consumption habits.

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1. Introduction

One of the main concerns in applied and theoretical economics is the absence or slow response of some economic variables to shocks in fundamentals or in economic policy instruments. New Keynesian models suppose that agents have delays in some decisions and that they generate rigidity or sticky prices. In that vein, some works evaluate the impact of monetary policies on inflation and growth, supposing that some firms do not update prices after shocks in costs or other relevant variables (Calvo (1983), Rotemberg and Woodford (1997, 1998)). An alternative to sticky prices, provided by Mankiw and Reis (2001) and Keen (2007), is the assumption of sticky information, which is caused by costs in collecting new information or in re-executing optimization processes.

Industrial Organization theory provides another explanation for price rigidity: the stickiness in prices results from collusive behavior among firms. Empirical and econometric analyses were performed to conclude that market concentration is responsible for that phenomenon (Mills (1927), Means (1935), Carlton (1986, 1989)). On the theoretical side, the most popular theory to explain rigidity is the “kinked demand” (Sweezy (1939) and Hall and Hitch (1939)); however, Scherer (1980) and Tirole (1988) highlight some important shortcomings of that theory. Implicit or explicit collusions are also included as a theoretical explanation for rigidity (Athey, Bagwell and Sanchirico (2004)).

In credit markets, empirical studies report not only rigidity in the interest rates but also asymmetric response of them with respect to costs variations or shocks in interest rates of funds. Hannan and Berger (1991) argue that the deposit rate rigidity is a result of either the market concentration or the size of the consumer base. Using a multinomial logit model they analyze the asymmetric response of interest rate in relation to increases or decreases in the security-rate. Neumark and Sharpe (1992) use panel data to show that banking concentration is responsible for the asymmetric adjustment of the deposit rates. Scholnick (1996) examined the difference between the upward and downward rigidity of the retail interest rate using cointegration and error correction methodology.

In Brazil it is quite interesting the presence of the rigidity of the market interest rate. In Figure 1 we show the values of the SELIC interest rate (which is the reference interest rate for the Government debt) versus the interest rate paid by consumers from 1994 to 2009 (given in monthly percentages).

We can observe that for a SELIC greater than 2.5% the consumer interest rate remains almost unaltered, thus changes in the interest rate paid by the Government when it is greater than 2.5% per month does not affect the market interest rate paid by the consumers.
The purpose of this paper is to provide a theoretical framework where interest rate rigidity arises due to the existence of consumption habits of the borrowers. More precisely, shocks in the marginal costs of the bank affect neither the market interest rate nor the amount of loans taking by the borrowers. To obtain this, we consider a partial equilibrium model, where the borrowers may default in part on their debts and they do this indeed, in order to preserve the consumption in a previous period (consumption habit formation). As a consequence, they accept to pay higher interest rates even though the marginal cost of the bank might be reduced. Furthermore, the response of the loan demand is asymmetric to increases or decreases of the market interest rate. Therefore, not only the banking industry concentration may provoke the rigidity, but also the demand side, when individuals want to preserve the status quo in their consumptions.

Consumption habits and their consequences have been extensively studied in economics. Dynan (2000) used panel data to test the presence of consumption habits and asserts that the same may explain the excess of smoothness in the aggregate consumption. Fuhrer (2000) also tests and rejects the hypothesis of no habit formation in consumption in a monetary-policy model. Carroll, Overland and Weil (2000) analyzed the effect of consumption habit formation on saving and growth.

The paper is divided in the following way. In Section 2 we present our theoretical framework. Section 3 is devoted to presenting the results: the asymmetric response of the loan demand and the rigidity of the interest rate. Section 4 presents the conclusions and the proofs are shown in the Appendix.

2. The Model

We will consider a loan market model where the borrowers are represented by a single agent and the lender by a monopolistic bank. In this sense, borrowers are interest-rate-takers in the loan market and lenders have market power to decide the interest rate. There are two periods \( t = 0, 1 \) and in \( t = 0 \) the borrower demands loans \( (m) \) and consumption \( (c_0) \). In \( t = 1 \), the same agent delivers (part of) the debt and
also consumes \((c_1)\). In case the borrower does not fulfill his entire obligation, he will suffer a penalty in his utility function. The interest rate on loans are given by \(r > 0\).

All these elements are included in the classic models with possibility of default (Dubey, Geanakoplos and Shubik (2005)). In this work we include an additional term representing the consumption habits of the borrower. If in the second period, the consumption is greater or equal to that of the first period, the agent does not suffer any loss in his utility. Otherwise, he will have a disutility proportional to the consumption decrease. Namely, the payoff of the borrower with consumption plan \((c_0, c_1) \in R^2_+\), loan demand \(m \geq 0\) and delivery decision \(D \in [0,(1+r)m]\) is given by:

\[
V(c_0, c_1, m, D) = U(c_0, c_1) - \lambda [(1+r)m - D] - \gamma \max\{c_0 - c_1, 0\}
\]

The parameters \(\lambda > 0\) and \(\gamma > 0\) in (1) represent the intensity of the penalty for defaulting and the disutility for the decrease in the first period consumption due to the consumption habits, respectively. We will suppose the following assumption:

**Hypothesis (H):** The utility function of consumption is a separable function \(U(c_0, c_1) = u(c_0) + \delta u(c_1)\); where \(u: R_+ \rightarrow R\) is twice differentiable, \(u' > 0\), \(u'' < 0\) and satisfies \(u'(0) = +\infty\), \(u'(+\infty) = 0\).

Finally, the budget constrain for the representative agent is defined by the following inequalities:

\[
\begin{align*}
p_0 c_0 &\leq p_0 w_0 + m \\
p_1 c_1 + D &\leq p_1 w_1 \\
0 &\leq D \leq (1+r)m
\end{align*}
\]

In this way, the borrower problem is defined as the maximization of the payoff function (1) subject to the restrictions (2), (3) and (4). The demand for loans is the \(m^* = m(r)\) component of the solution of that problem.

In this economy, the lender side is modeled by a monopolistic bank which decides the value of the interest rate \(r > 0\) to be fixed for private loans, given the loan demand curve \(m = m(r)\). The assumption of a monopoly in the loan market may be seen as a simplification of a collusive behavior of an oligopoly in that sector. Thus, if \(c(m)\) is the cost of the monopolist, its problem is to choose the interest rate for loans in order to maximize \(R(m) - c(m) = (1+r)m(r) - c(m(r))\).

### 3. Asymmetry of the Loan Demand and Rigidity of the Interest Rate

In this section we will prove the asymmetry of the loan demand response to changes in the interest rate (a kinked demand curve for loans). As a consequence, the marginal revenue of the monopolist will present a discontinuity provoking rigidity in the interest rate with respect to marginal costs changes. In the literature
the discontinuity of the marginal revenue (and therefore the rigidity of prices) is found as a consequence of some kind of oligopolistic competition among firms (Sweezy (1939) and Hall and Hitch (1939)). In our case, the kinked demand results from the endeavor of borrowers to maintain the status quo in their consumptions.

The following proposition states the existence of (at most) two kinks in the demand for loans.

**Proposition 1. (Asymmetry of the response to interest rate changes)** Under hypothesis (H) the loan demand curve \( m = m(r) \) is strictly decreasing and there exist two values of the interest rate

\[
\begin{align*}
    r_1 &= \frac{p_1}{\partial \rho_0} - \frac{\gamma}{\lambda \rho_0} \left(1 + \frac{1}{\delta}\right) - 1, \\
    r_2 &= \frac{p_1}{\partial \rho_0} - 1
\end{align*}
\]

where the demand for loans is kinked. In other words

\[
\lim_{r \to r_i} m'(r) \neq \lim_{r \to r_i} m'(r); \quad i = 1, 2
\]

The proposition above implies the shape shown in Figure 2 for the loan demand. Note that \( r_1 < r_2 \), and if we have in addition that \( \delta = (1 + \rho)^{-1} \), \( p_1 / p_0 = 1 + \pi \) (\( \rho > 0 \) is the intertemporal discount rate and \( \pi > 0 \) is the inflation rate) then \( r_2 > 0 \). Therefore, if \( r_1 > 0 \) then we will have two kinks in the demand curve for loans; otherwise there will be just one. In each kink it is easy to verify the asymmetric response of demands for loans with respect to interest rate changes.

It is also worth noting that the difference \( r_2 - r_1 = \gamma / (\lambda \rho_0) \) depends on the intensity of the consumption habits. Furthermore, from the proof of proposition 1, we can conclude that \( \gamma = 0 \) implies the non-existence of any kink in the loan demand curve.

![Figure 1: Demand for loans under consumption habits and the asymmetric response to interest rate changes](image)

If we suppose that the marginal cost of the monopolistic bank is a constant (\( MC = c \)) then we will have the following result.

**Proposition 2. (Rigidity of the interest rate)** Under hypothesis (H) and the assumption of constant marginal costs of the monopolist bank (\( MC = c \)), there exist two open intervals \( I_1 \) and \( I_2 \) such that: a) for all \( c \in I_2 \), the equilibrium interest rate...
is \( r_2 \), b) for all \( c \in I_1 \), \( r_1 \) is a relative minimum of the profit and the equilibrium interest rate is located around that minimum.

Proposition 2 asserts that any change in the marginal cost that leaves it in the interval \( I_2 \) will not have effect on the equilibrium interest rate which will remain in \( r_2 \) (and as a consequence, the loan demand will remain equal to \( m_2 \)). Figure 3 shows the shape of the marginal revenue and one possible position of the marginal cost where we obtain the rigidity.

If in addition, the monopolistic bank finances the Government debt too; we can obtain an important conclusion from the rigidity of the market interest rate with respect to changes in the interest rate paid by the Government. Let \( r_f > 0 \) the interest rate on the Government loans (risk-free interest rate). If \( M \) is the total amount of resources available to the bank to lend either to the borrowers or to the Government, the problem of the lender results:

\[
\text{Max}_{m \geq 0} (1 + r(m)m + (1 + r_f)(M - m) - cm = \text{Max}_{m \geq 0} (1 + r(m)m - (c + 1 + r_f)m),}
\]

Therefore, any change in \( r_f \) that leaves \( c + 1 + r_f \) in the interval \( I_2 \) affects neither the equilibrium interest rate nor the amount of loans, which remain in \( r_2 \) and \( m_2 \) respectively.

4. Conclusions

In this paper we provided an explanation of the asymmetry of the loan demand response to changes in the interest rate. The kinked demand for loans that provokes that effect is a result of the borrowers' willingness to maintain the status quo in their former consumptions. As a consequence, the marginal revenue of the monopolistic bank presents a discontinuity, generating rigidity of both the interest rate and loans with respect to changes in its marginal cost. This kind of consumption habit was not used to explain phenomena of asymmetry and rigidity in the literature, so it may compete with (or complement) the theories of sticky prices based on concentration or collusion of firms in specific markets.
From the monetary-policy point of view, the rigidity of the interest rate is a market imperfection that policy makers must take into consideration. This is because, as we noted in the final comments of the Section 3, it is possible that the monetary-policy instrument (the interest rate paid by the Government on its loans), might not be effective if it falls into the region of interest rate rigidity.

REFERENCES


APPENDIX

**Proof of Proposition 1.** The borrower problem is to maximize (1) restricted to the budget set:

\[ B(p_0, p_1, r) = \{ (c_0, c_1, m, D) \in \mathbb{R}^4 \mid (2), (3) \text{ and } (4) \text{ are satisfied and } m \leq v_i \} . \]

We are imposing bounded short-sales in order to guarantee finite solutions. Let \( m^* = m(r) \) be the loan demand, which is (upper hemi-) continuous in \( r > 0 \). The behavior of that solution will be described from a comparative static analysis, so interior solutions \( m^* > 0 \) and \( 0 < D^* < (1+r)m^* \) will be supposed. Since the payoff function depends on the signal of \( c_0 - c_1 = -\Delta w + (m/p_0) + (D/p_1) \) (where \( \Delta w = w_i - w_o \)), we will separate the analysis into three cases.

**Case I** \( \frac{m}{p_0} + \frac{D}{p_1} > \Delta w \)

In this case, the first order conditions are given by:

\[
\begin{align*}
\frac{m}{p_0} + \frac{D}{p_1} &= \Delta w \\
\frac{m}{p_0} &= \lambda p_0 (1+r) + \gamma \\
\frac{D}{p_1} &= \frac{\lambda}{\delta} p_1 - \frac{\gamma}{\delta}
\end{align*}
\]

From (A1) and (A2) we can find \( m(r) = p_0 \left[ (u')^{-1}(\lambda p_0 (1+r) + \gamma) - w_o \right] \) and \( D(r) = p_1 \left[ w_i - (u')^{-1}(\delta^{-1}(\lambda p_1 - \gamma)) \right] \). Whenever necessary, we will denote the demand for loans in this case by \( m'(r) \).

In order to compatibilize with \( \frac{m^*}{p_0} + \frac{D(r)}{p_1} > \Delta w \), we must have:

\[
(u')^{-1}(\lambda p_0 (1+r) + \gamma) > (u')^{-1}(\delta^{-1}(\lambda p_1 - \gamma))
\]

\[ \Rightarrow r < \frac{p_1}{\delta \frac{\lambda}{p_0}} - \frac{\gamma}{\delta} \left( 1 + \frac{1}{\delta} \right)^{-1} = r_i \]

**Case II** \( \frac{m}{p_0} + \frac{D}{p_1} < \Delta w \)

The first order conditions are:
\[ u'(w_0 + \frac{m}{p_0}) = \lambda p_0 (1 + r) \quad (A3) \]
\[ u'(w_1 - \frac{D}{p_1}) = \frac{\lambda}{\delta} p_1 \quad (A4) \]

From equations (A3) and (A4), the loan demand and delivery decisions are
\[ m(r) = p_0 [u'(1 + r)]^{-1} \left( \lambda p_0 (1 + r) - w_0 \right) \] and
\[ D(r) = p_1 \left[ w_1 - (u')^{-1} \left( \delta^{-1} \lambda p_1 \right) \right] \] respectively. In this case, the loan demand is denoted by \( m''(r) \).

As in case I, the restriction \( \frac{m(r)}{p_0} + \frac{D(r)}{p_1} < \Delta w \) implies the following demand for the interest rate:
\[ r > \frac{p_1}{\delta p_0} - 1 = r_2 \]

(Case III) \( \frac{m}{p_0} + \frac{D}{p_1} = \Delta w \)

Since a solution exists for all \( r > 0 \), this case will correspond to the domain \( r \in (r_1, r_2) \). The first order condition is:
\[ \frac{u'(w_0 + \frac{m}{p_0})}{p_0} + \delta \frac{u'(w_1 - \frac{D}{p_1})}{p_1} = \lambda \left[ (1 + r) + \frac{P_1}{P_0} \right] \]

\[ \Rightarrow u' \left( w_0 + \frac{m}{p_0} \right) = (1 + \delta)^{-1} \lambda \left[ (1 + r) p_0 + p_1 \right] \quad (A5) \]

From (A5) we obtain \( m(r) = p_0 \left[ u'(1 + \delta)^{-1} \lambda p_0 (1 + r) + (1 + \delta)^{-1} \lambda p_1 \right] - w_0 \) and the restriction of this case implies \( D(r) = p_1 \Delta w - (p_1 / p_0) m(r) \). As done formerly, we denote the demand for loans here by \( m'''(r) \). From (A1), (A3) and (A5) one can verify that the function \( m = m(r) \) is a strictly decreasing function. Furthermore, the following limit exists,
\[ \lim_{r \to r_i} m(r) = m_i = m(r_i); \quad i = 1, 2 \]

To prove the non-differentiability of \( m(r) \) in \( r_i \), we use equations (A1), (A3) and (A5) to calculate the derivatives in each interval, namely:

if \( r < r_1 \), then (A1) implies:
\[ \frac{dm}{dr}(r) = \frac{\lambda p_0^2}{u''(c_0)}; \]

if \( r > r_2 \), then (A2) implies:
\[ \frac{dm}{dr}(r) = \frac{\lambda p_0^2}{u''(c_0)}; \]

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if \( r \in (r_1, r_2) \), then (A3) implies: 
\[
\frac{dm^\text{III}}{dr}(r) = \frac{(1 + \delta)^{-1} \lambda p_0^2}{u''(c_0)} ,
\]
where \( c_0 = w_0 + m(r)/p_0 \). Therefore, we can conclude that,
\[
\lim_{r \to r_1^+} m'(r) < \lim_{r \to r_2^-} m'(r) \quad \text{and} \quad \lim_{r \to r_2^+} m'(r) > \lim_{r \to r_1^-} m'(r)
\]

**Proof of Proposition 2.** The monopolistic bank revenue is \( R(m) = (1 + r(m))m \), where \( r = r(m) \) is the (inverse) demand for loans. \( m^* > 0 \) is a solution for the monopolistic bank if and only if \( MR(m) \geq MC(m) = c \) for all \( m < m^* \) and \( MR(m) \leq MC(m) = c \) for all \( m > m^* \), where \( MR \) and \( MC \) are the marginal revenue and the marginal cost of the monopolist respectively.

The marginal revenue has two discontinuities. In \( m_2 \) we have
\[
MR_-(m_2) = r_-'(m_2)m_2 + 1 + r_2 = \frac{m_2}{m_-'(r_2)} + 1 + r_2 = \frac{u''(w_0 + m_2/p_0)}{\lambda p_0^2} m_2 + 1 + r_2
\]
\[
MR_+(m_2) = r_+'(m_2)m_2 + 1 + r_2 = \frac{m_2}{m_+'(r_2)} + 1 + r_2 = \frac{(1 + \delta)u''(w_0 + m_2/p_0)}{\lambda p_0^2} m_2 + 1 + r_2
\]

So, if \( c \) belongs to the interval \( I_2 = (MR_-(m_2), MR_+(m_2)) \), then the equilibrium interest rate is \( m^* = m_2 \). In \( m_1 \) the behavior is qualitatively different. If we calculate de marginal revenue in that point we will have,
\[
MR_-(m_1) = r_-'(m_1)m_1 + 1 + r_1 = \frac{m_1}{m_-'(r_1)} + 1 + r_1 = \frac{(1 + \delta)u''(w_0 + m_1/p_0)}{\lambda p_0^2} m_1 + 1 + r_1
\]
\[
MR_+(m_1) = r_+'(m_1)m_1 + 1 + r_1 = \frac{m_1}{m_+'(r_1)} + 1 + r_1 = \frac{u''(w_0 + m_1/p_0)}{\lambda p_0^2} m_1 + 1 + r_1
\]

Therefore \( MR_-(m_1) < MR_+(m_1) \), thus, if \( c \in I_1 = (MR_-(m_1), MR_+(m_1)) \), then \( m^* = m_1 \) becomes a relative minimum with two relative maximums around it. \( \square \)