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HOUSEHOLD CREDIT AND THE MONETARY TRANSMISSION MECHANISM

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Abstract

This paper evaluates the importance of household credit in the transmission of monetary policy and in explaining the positive correlation between money and credit services over the business cycle. It does so in the context of a general equilibrium framework of cash and household credit with two distinguishing features. There is an explicit financial sector with firms specializing in the production of credit services. Second, the financial sector also contains financial intermediaries who provide interest bearing accounts for households and loanable funds to credit producers. It is shown that monetary injections in this set-up can generate a liquidity effect which positively influences the availability of household credit services and real activity. Furthermore, the model predicts that monetary injections actually lower the real cost of consumption, thus resolving a difficulty with recent liquidity effect models. The potential quantitative importance of this monetary transmission mechanism is analyzed.

JEL Classification: E51, E43

Keywords: Money and credit, financial intermediation liquidity effect

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I. Introduction

The monetary transmission mechanism has received much recent theoretical and empirical attention in the macroeconomic literature. While many empirical studies find that (i) there is a negative contemporaneous correlation between monetary shocks and nominal interest rates and (ii) money and financial services tend to be positively correlated over the business cycle,[1] capturing both of these features in a general equilibrium framework has eluded conventional business cycle approaches.[2] This observation has spurred a growing literature advocating the credit market as an important mechanism for the transmission of monetary policy [see Bernanke (1992)]. In particular, the recent liquidity effect approaches of Lucas (1990) and Fuerst (1992) represents a promising class of models embodying this credit view. Liquidity effect models highlight the role of financial intermediaries in receiving cash injections from the monetary authority and channeling loans from households to firms. Fuerst (1992) demonstrates that in such a model with portfolio rigidities positive monetary innovations can generate a liquidity effect and increase real activity through increasing the availability of loanable funds to business firms.

This paper evaluates the role of household credit markets in the transmission of monetary policy. By doing so, it seeks to address two important deficiencies in the liquidity effect literature. First, as noted by Christiano (1991) and Fuerst (1993), the basic liquidity effect model

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[1] Examples include King and Plosser (1984), Bernanke and Blinder (1992), and Christiano and Eichenbaum (1992).

[2] For example, cash-in-advance models [Stockman (1981) and Cooley and Hansen (1989)] predict that positive shocks to the money growth rate generates a pure inflation tax effect which raises nominal rates and depresses real output. Introducing credit goods in these models [as in Lucas and Stokey (1987)] explains the money-credit correlation through this inflation tax effect. The "reverse-causation" real business cycle approach of King and Plosser (1984) captures the relationship between inside money and credit but provides no role for policy generated monetary shocks.

has counterfactual quantitative implications. In particular, the liquidity effect may be too small to dominate the anticipated inflation effect of a serially correlated monetary shock. Secondly, even when it dominates, consumption falls in the period of the shock.[3] A link between monetary policy and the availability of household credit services provides a natural mechanism by which monetary shocks reduce the real cost of consumption. As a result, without imposing additional restrictions on the timing of household decisions, observations (i) and (ii) can be reconciled with a positive contemporaneous correlation between monetary shocks and consumption.

Second, this paper provides some theoretical support to recent empirical studies suggesting that consumer credit is an important link between monetary policy and real activity. While most of the literature on the credit channel has focused on business borrowing, there is also considerable evidence indicating that monetary policy has important effects on household financing of consumption and investment goods as well. For example, Boldin (1995) uncovers a positive correlation between mortgage financing costs and the federal funds rate; Wilcox (1989) determines that nominal interest rates are equally important in explaining both durable and nondurable consumption; and Duca (1995) finds a significant positive relationship between the availability of consumer installment loans by banks and various indicators of monetary policy.[4]

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[3] Intuitively, this feature stems from the assumption that consumption is a pure cash good and responds negatively to the inflation tax effect of a monetary injection. Christiano and Eichenbaum (1995) assumes that investment decisions cannot change in the period of the shock to correct this problem. See Fuerst (1993) for a survey of the recent "liquidity effect" literature.

[4]Some authors have argued that an exception to these observations is the credit card market where interest rates tend to be sticky and above competitive rates [Ausubel (1991) and Mester (1994)]. This market may not be representative of the overall household loan market. First, the high degree of heterogeneity among borrowers creates an adverse selection problem for credit card providers. Secondly, credit card debt consists of less than ten percent of the total liabilities of the household sector [see Park (1993), Duca (1995)].

The paper constructs a general equilibrium framework of cash and household credit with two central features. First, similar to Aiyagari and Eckstein (1994), the model incorporates an explicit financial sector with firms which specializes in the production and selling of credit services to households. Purchasing these credit services permits households to finance part of their current purchases of consumption or capital goods with current income (instead of requiring "cash-in-advance"). One of the advantages of this approach is that it does not require an a priori distinction between "cash goods" and "credit goods" in household preferences -- this distinction is made in the transactions technology.

Second, the banking sector consists of both a financial intermediary and producers of credit services. The financial intermediary provides interest bearing accounts where households deposit a portion of their cash holdings at the beginning of the period. Producers of credit services must borrow these deposits to finance household credit purchases within the period. Adopting the modeling strategy of Lucas (1990) and Fuerst (1992), monetary injections occur asymmetrically through the financial sector and credit producing firms. This realistic feature of the model is obtained by assuming that household saving decisions must be made prior to the current realization of the monetary shock.

The results of the paper may be summarized by the following. A monetary shock that exhibits positive serial correlation has two opposing equilibrium effects. The anticipated inflation effect leads households to substitute out of cash and into credit transactions, hence increasing the demand for credit services. This increases the nominal interest rate and the relative price of credit services to goods. As a result, overall work effort falls while there is a reallocation of labor towards the financial sector. These results are consistent with empirical findings which show that the relative size of the banking sector expands during hyperinflations and shrinks after monetary stabilization.[5] Because cash injections are received by credit producers, monetary injections also create a liquidity effect which drive down nominal interest rates. In response, the relative price of credit services to goods falls and credit producers spend the extra cash on expanding credit services to households. Employment in both sectors respond positively to the liquidity effect, the fraction of goods purchased with cash falls while total consumption rises. Finally, the quantitative experiments find that there does exist plausible parameterizations of the model where this liquidity effect can dominate the anticipated inflation effect.

The paper proceeds as follows. Section II will set-up the general model and characterize the efficiency and equilibrium conditions. To analyze the liquidity and anticipated inflation effects in this model, Section III analytically solves a special case of our general framework where capital is inelastically supplied. Section IV then investigates some qualitative and quantitative predictions of the general model. Finally, Section V concludes with a brief summary.

[5] See Aiyagari and Eckstein (1994) for documentation of this observations.

II. A Model of Household Credit

The economy is populated with infinitely lived identical households with preferences over consumption c_t and leisure. The expected lifetime utility of the representative household is given by

$$E_0 \sum_{t=0}^{\infty} \beta^t \{u(c_t) + V(1-n_t)\}, \tag{1}$$

where n_t is work effort at time t, c_t is consumption purchases at time t, $0 < \beta < 1$ is the time discount factor, and u and v, the utility obtained from consumption and leisure, respectively, are given by $u(c) = \ln(c)$ and $V(1-n) = A(1-n)$ with $A > 0$.[6] Households purchase both consumption and investment goods I_t in the commodity market and has the option of using cash or credit when purchasing either good. Similar to the definition given by Lucas and Stokey (1987), a cash transaction must be financed with cash-in-advance while a credit transaction may be financed with end-of-current-period income. Let g_{1t} and g_{2t} denote household purchases of cash and credit goods, respectively. The household's total purchases of goods must thus satisfy the following resource constraint:

$$g_{1t} + g_{2t} = c_t + I_t = c_t + k_{t+1} - (1-\delta)k_t, \tag{2}$$

where k_t is the household's stock of capital and $\delta \in (0,1)$ is the capital depreciation rate.

In addition to households, the economy is also populated by many producers of two types. Firms in the goods producing sector (Sector 1) employ labor n_{1t} and k_{1t} to produce output Y_t

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[6] The logarithmic form of preferences with separable leisure is standard in the business cycle literature. However, it should be clear that the qualitative effects are not sensitive to more general "balanced growth" preferences of the type suggested by King, Plosser, and Rebelo (1987).

according to a Cobb-Douglas production technology $Y_t = F(k_{1t},n_{1t}) = k_{1t}^{\alpha}n_{1t}^{1-\alpha}$, where $\alpha \in (0,1)$. Credit producers in the financial sector (Sector 2) employ labor n_{2t} and capital k_{2t} to produce a flow of credit services q_t according to technology $q_t = Q(k_{2t},n_{2t}) = \phi k_{2t}^{\gamma}n_{2t}^{1-\gamma}$, where $\phi > 0$ and $\gamma \in (0,1)$. Since it is likely that employment is more intensive and variable than physical capital in the provision of credit services over the business cycle, capital is supplied inelastically to the financial sector so that $k_{2t} = k_2$. The purchase of a unit of credit services permits households to finance a unit of a good with credit: $g_{2t} = q_t$. Finally, the financial sector also consists of financial intermediaries who accept cash deposits from households, receives monetary injections from the central bank, and provides loans to credit producers. These credit producers use the borrowed funds to finance household credit purchases within the period. The money supply process is given by

$$M_{t+1}^{s} = M_t^{s} + X_t = (1+x_t)M_t^{s}, \tag{3}$$

where M_t^s is the beginning-of-period t nominal money supply per household, X_t is the monetary injection, and x_t is the money growth rate between periods t and t+1.

To keep the flow of funds tractable in this model we adopt the "family" methodology of Lucas (1990) and Fuerst (1992). That is, each representative family consists of a worker/shopper pair, a goods producing firm, a credit producing firm, and a financial intermediary. By lumping all sectors of the economy together, monetary injections which occur through the financial sector will be asymmetric within the family. However, since at the end of the period the family reunites and pools their cash receipts, these monetary injections will be symmetric across families. Given this structure, the timing of events within period t will proceed as follows. The family begins the period with capital stock k_t and nominal cash holdings M_t and deposits D_t

dollars into the financial intermediary. The family then separates. The state of nature $s_t \in S$ is revealed in the form of a monetary injection to the financial intermediary, X_t, where S is the compact continuous support of the stochastic money growth rate. The financial intermediary now has available $D_t + X_t$ dollars to loan out. The nominal interest rate financial intermediaries charge for loans and pay on deposits is given by R_t. The worker travels to the labor market and supplies a total of n_t hours of work effort in the goods and financial sector and receives a nominal wage payment W_t. Goods and credit services are then produced with n_{1t}, k_{1t}, k_2, and n_{2t}.

The shopper first travels to the financial sector to rent out the capital stock k_t to goods and credit producers at a rental price of r_t and to purchase a given amount of credit services q_t at price P_{qt}. It is assumed that households may finance these credit services with end-of-period income. The shopper then travels to the goods market to buy consumption and capital goods at price P_{gt} where g_{1t} is financed with cash and $g_{2t} = q_t$ with credit services. Credit producers are obligated to finance household purchases of g_{2t} in the goods market and a fraction $\sigma < 1$ of that quantity must be in the form of cash. To obtain that cash, credit producers borrow an amount B_t from the financial intermediary. This leads to the following cash-in-advance constraints for shoppers and credit producers, respectively:

$$P_{gt}g_{1t} \leq M_t - D_t \tag{4}$$

$$\sigma P_{gt}Q(k_2,n_{2t}) \leq B_t \tag{5}$$

At the end of the period the family reunites to enjoy the consumption of goods. All credit loans (between households, credit producers, goods producers, and the financial intermediary) are repaid and households receive rental income generated by the capital stock. The family pools its cash receipts and enters period t+1. Figure 1 of the paper provides a flow diagram of the activities within and at the end of the period. The end-of-period t cash holdings of the family must thus satisfy the following budget constraint:

$$M_{t+1} = [M_t + D_tR_t + r_tP_{gt}k_t + W_tn_t - P_{gt}(g_{1t} + q_t) - P_{qt}q_t] + X_t(1 + R_t) \\ +[P_{gt}F(k_{1t},n_{1t}) - W_tn_{1t} - r_tP_{gt}k_{1t}] + [P_{qt}Q(k_2,n_{2t}) - W_tn_{2t} - r_tP_{gt}k_2 - B_tR_t]. \tag{6}$$

The first term in brackets represents the cash receipts of the worker/shopper, the second is the cash holdings of the financial intermediary, the third is the profits of the goods producing firm, and fourth is the profits of the credit producer, net of loan repayments to the financial intermediary. The family's optimization problem thus consists of choosing a sequence $\{g_{1t}, q_t, n_t, k_{t+1}, D_t, n_{1t}, n_{2t}, k_{1t}, B_t\}$ maximizing (1) subject to (2), (4), (5), and (6).

In a stationary equilibrium all nominal variables will be growing at the same rate as the nominal money supply. Thus, it will be convenient to introduce a stationary transformation by scaling all nominal variables by the beginning-of-period money supply M_t^s. Denote $m = M_t/M_t^s$, $d_t = D_t/M_t^s$, $b_t = B_t/M_t^s$, $w_t = W_t/M_t^s$, $p_{gt} = P_{gt}/M_t^s$, and $p_{qt} = P_{qt}/M_t^s$. Let the transition density for the state variable be expressed as $\Phi(s_t,ds_{t+1}) = \text{Prob}(s_{t+1} = s_i \mid s_t = s_j)$ for all $s_i,s_j \in S$. Denoting primes (′) as next period's variables, the household's dynamic programming problem can be expressed as

$$J(m,k,s) = \max_d \int \max_{g_1,q,k',n,b,n_1,n_2,k_1} \{u(c) + V(1-n) + \beta J(m',k',s')\}\Phi(s,ds') \tag{7}$$

subject to

$$g_1 + \phi q = c + k' - (1-\delta)k, \tag{8}$$

$$p_g g_1 \leq m - d, \tag{9}$$

$$\sigma p_g Q(k_2,n_2) \leq b, \tag{10}$$

$$m' = \frac{m + dR + rp_g k + wn - p_g(g_1+q) - p_q q + x(1+R) + p_g F(k_1,n_1) - wn_1 - rp_g k_1 + p_q Q(k_2,n_2) - wn_2 - rp_g k_2 - bR}{1+x}. \tag{11}$$

The market-clearing conditions for goods, credit services, labor, capital, financial intermediary loans, and money are given by $g_1 + q = F(k_1,n_1)$, $q = Q(k_2,n_2)$, $n = n_1 + n_2$, $k = k_1 + k_2$, $b = d + x$, and $m = m' = 1$. Letting λ_1 and λ_2 denote the Lagrange multipliers associated with cash constraints (9) and (10), the household's first order conditions for g_1, q, k′, d, n, b, n_1, n_2, k_1 evaluated at the market-clearing conditions, is given by

$$u'[c(k,s,s')] = p_g(s,s')\left\{\beta\frac{J_m(k',s')}{1+x(s')} + \lambda_1(k,s,s')\right\}, \tag{12}$$

$$u'[c(k,s,s')] = \beta\frac{J_m(k',s')}{1+x(s')}[p_g(k,s,s') + p_q(k,s,s')], \tag{13}$$

$$u'[c(k,s,s')] = \beta J_k(k',s') \tag{14}$$

$$\int \beta R(k,s,s')\frac{J_m(k',s')}{1+x(s')}\Phi(s,ds') = \int \lambda_1(k,s,s')\Phi(s,ds'), \tag{15}$$

$$p_g(k,s,s')\omega(k,s,s')\beta\frac{J_m(k',s')}{1+x(s')} = V'[1-n(k,s,s')], \tag{16}$$

$$\beta\frac{J_m(k',s')}{1+x(s')}R(k,s,s') = \lambda_2(k,s,s'), \tag{17}$$

$$F_n(k_1,n_1) = \omega(k,s,s') \tag{18}$$

$$\{p_q(k,s,s')Q_n(k_2,n_2) - \omega(k,s,s')p_g(k,s,s')\}\beta\frac{J_m(k',s')}{1+x(s')} = p_g(k,s,s')\lambda_2(k,s,s')\sigma Q_n(k_2,n_2), \tag{19}$$

$$F_k(k_1,n_1) = r(k,s,s'). \tag{20}$$

where $\omega(s,s') \equiv w(s,s')/p_g(s,s')$ is the real wage rate. The envelope conditions are given by

$$J_m(k,s) = \int\left\{\beta\frac{J_m(k',s')}{1+x(s')} + \lambda_1(k,s,s')\right\}. \tag{21}$$

$$J_k(k,s) = \int\left\{u'[c(k,s,s')](1-\delta) + r(k,s,s')p_g(k,s,s')\beta\frac{J_m(k',s')}{1+x(s')}\right\}\Phi(s,ds'). \tag{22}$$

Equations (21) and (12) give

$$J_m(k,s) = \int\frac{u'[c(k,s,s')]}{p_g(k,s,s')}\Phi(s,ds'). \tag{23}$$

Equation (23) states that the marginal value of cash to the family is simply the marginal value of next period's consumption it will generate. The intuition behind these first order conditions are straightforward. For example, (13) equates the marginal benefits of an additional unit of credit services, which is the additional utility from the consumption of credit goods, with the marginal costs of purchasing both credit services and the goods that it will buy. Equation (19) equates the marginal value of cash obtained from employing an additional unit of labor in the credit producing sector to the marginal cost of financing a portion σ of the additional credit services provided to households with cash borrowed from financial intermediaries.

The crucial feature of the model which will produce a liquidity effect component to the nominal interest rate is contained in (15) and (17). Substituting (17) into (15) yields $\int\lambda_1\,\Phi(s,ds') = \int\lambda_2\,\Phi(s,ds')$. This implies that the family equates the expected or average marginal value of cash across the goods and credit markets. However, as in Fuerst (1992), unexpected changes in the economy's state of nature may cause cash to be more valuable in one market and the nominal rate will be non-Fisherian. For example, if asymmetric monetary injections cause the marginal value of cash in the goods market to be high relative to the financial market, then holding the anticipated inflation effect constant, an unexpected monetary shock will lower R and create a liquidity effect.

The conditions defining an equilibrium in this economy can be simplified by collapsing the system of equations to be strictly functions of k, n_1, and d. Substitute (17) into (19) and use (18) to obtain

$$\frac{p_q}{p_g} = \frac{F_n(k_1,n_1)}{Q_n(k_2,n_2)} + \sigma R. \tag{24}$$

All else being equal, a high relative price of credit services to goods causes a reallocation of labor demand away from the industrial sector and towards credit producing firms. Also, quite naturally, there will be a positive relationship between nominal rates and the relative price of credit services. We will return to the precise nature of this relationship below. Also, from (13) $\beta J_m(k',s')/(1+x) = u'(c)/\{p_g+p_q\}$. Substituting this into (16) gives an expression for the relative price of credit services:

$$\frac{p_q}{p_g} = \left[\frac{u'(c)F_n(k_1,n_1)}{A} - 1\right] \tag{25}$$

Substituting (25) into (24) gives us an expression for the nominal interest rate:

$$R = \frac{1}{\sigma}\left\{\left[\frac{u'(c)F_n(k_1,n_1)}{A} - 1\right] - \frac{F_n(k_1,n_1)}{Q_n(k_2,n_2)}\right\} \tag{26}$$

Substituting (22) into (14) and using $\beta J_m(k',s')/(1+x) = A/p_g F_n$ from (16) gives us an efficiency condition for $k'(k,s,s')$,

$$u'(c) = \beta \int \left\{ u'(c')(1-\delta) + \frac{F_k(k_1',n_1')A}{F_n(k_1',n_1')} \right\} \Phi(s',ds''), \tag{27}$$

(12) and (15) obtains an efficiency condition for the choice of d(k,s):

$$\int [1+R] \frac{A}{p_g F_n(k_1,n_1)} \Phi(s,ds') = \int \frac{u'(c)}{p_g} \Phi(s,ds'), \tag{28}$$

and equations (23) and (16) provides an efficiency condition for $n(k,s,s')$:

$$\frac{\beta}{1+x} \int \frac{u'(c')}{p_g'} \Phi(s',ds'') = \frac{A}{p_g F_n(k_1,n_1)}. \tag{29}$$

From (9) and (10) $p_g = (1-d)/g_1 = (d+x)/\sigma Q(k_2,n_2)$. Using the goods market-clearing condition, substitute out g_1 and simplify to get

$$Q(k_2,n_2) = \left\{ \frac{d+x}{\sigma(1-d)+d+x} \right\} F(k_1,n_1). \tag{30}$$

Notice that equation (30) expresses the quantity of credit goods purchased g_2 as a share of total output. All else being equal, this share is increasing in x and d. It also implicitly defines n_2 as a function of k, n_1, and d. From the goods market-clearing condition, (8), and (9), $g_1 = F(k_1,n_1) - g_2$, $p_g = (1-d)/g_1$, and $c = F(k_1,n_1) - k' + (1-\delta)k$ are functions of k, n_1, and d as well. With these and (26), a *stationary competitive equilibrium* can be defined as policy functions for $\{k'(k,s,s'),n_1(k,s,s'),d(k,s)\}$ satisfying (27), (28), and (29).

This also derives an "average" relationship between the price of a credit good relative to the price of a cash good. The price of purchasing one unit of a good on credit is given by p_g + p_q, since one unit of credit services can purchase one credit good, and thus the relative price of a credit good is $1 + p_q/p_g = u'(c)F_n(k_1,n_1)/A$ by (25). However, notice that on average, or if d is chosen after observing s′, (28) implies that $1+R = u'(c)F_n(k_1,n_1)/A$. Therefore, the steady state relative price of credit to cash goods is simply the gross nominal interest rate 1+R. Intuitively, this is simply saying that the household, at the optimum, equalizes the marginal cost of using cash and credit services in transactions. However, as shall be seen below, unanticipated shocks could cause the relative price of credit goods to deviate from the nominal rate.

Before analyzing the stochastic properties of this general model, it will be useful to first consider a simplified version of the model where the capital stock is exogenously fixed. This will permit us to analytically separate out the anticipated inflation and liquidity effect from a monetary injection and analyze the channel by which it influences the household credit market and real activity in each sector.

III. The Model with Fixed Capital Stock

In order to analytically analyze the anticipated inflation and liquidity effects from monetary growth this section simplifies the general model above by assuming an inelastically fixed level of aggregate capital $k_{1t} = k_{2t} = 1$ and setting $\delta = 0$. Thus, g_1 and $g_2 = q$ now denotes the consumption of cash and credit goods, respectively, and $c = g_1 + q$. The relevant first-order conditions for this problem are (12) - (13) and (15) - (19).

A. Some Steady State Properties

The effects of steady anticipated money growth can be clearly seen by analyzing the steady state of the model. Given that s = s′ and using the efficiency conditions from the previous section, the steady state nominal interest rate and employment in the goods and credit sectors is given by

$$1 + \frac{p_q}{p_g} = 1 + R = \frac{1 + x}{\beta}, \quad n_1 = \frac{\beta(1 - \alpha)}{A(1+x)},$$

$$n_2 = \left\{ \frac{(1 - \alpha)}{\gamma n_1^{-\alpha}[\frac{(1 - \alpha)}{A} - (1+\sigma R)n_1]} \right\}^{-\frac{1}{1-\gamma}}.$$

With these expressions the following steady state properties are immediate:

Proposition 1:

(i) $\partial R/\partial x > 0$, $\partial n_1/\partial x < 0$, $\partial n_2/\partial x > 0$, and $\partial n/\partial x < 0$.

(ii) $\partial q/\partial x > 0$, $\partial (g_1+g_2)/\partial x < 0$, $\partial g_2/\partial x > 0$.

(iii) As $\sigma \to 1$, n_2, q, and $g_2 \to 0$. A necessary condition for existence of a steady state equilibrium with credit transactions is $\sigma < 1$.

Proposition 1 (i) and (ii) captures the inflation tax effect of money growth. Similar to standard cash-in-advance models, the inflation tax causes individuals to substitute away from activities involving cash and into credit transactions. This increase in the demand for credit services drives up the nominal rate and the relative price of credit services. Thus, there is a reallocation of labor away from goods production to the production of credit services and the total fraction of goods purchased with credit rises. Since leisure can be viewed as a costless credit good as well, there is a reduction in the overall equilibrium work effort. As a result, consumption and the production of goods will be strictly decreasing in the money growth rate.

Proposition 1 (iii) says that in the limiting case where credit producers must finance all of the household's credit purchases with cash ($\sigma = 1$), the model degenerates to a pure cash in advance economy where all household transactions involve cash and the credit producing sector vanishes. Intuitively, σ can be viewed as a technological or institutional parameter which measures how more efficiently credit producers can carry out transactions relative to households. Since the cost of borrowing to credit producers is directly proportional to this parameter, their profit maximizing choice of employment decreases with σ. Also, since the steady state relative price of credit services is exactly the nominal interest rate, it will never be optimal to hire labor and supply credit services if credit producers are equally cash constrained as households in the goods market. We will discuss further intuition behind σ in an institutional context in the quantitative exercises of Section IV.

B. Some Properties of the Stochastic Equilibrium

To analytically extract the liquidity effect of monetary shocks from the anticipated inflation effects, let the stochastic process governing the money growth rate be i.i.d. Thus, the transition density may be written as $\Phi(s,ds') = \Phi(ds')$. The cash-constraints in (9) and (10) gives $p_g[g_1 + \phi q] = \{d(1-\sigma) + \sigma + x\}/\sigma$. Substituting this into (23) gives

$$J_m(s) = \int \left\{ \frac{\sigma}{d(1-\sigma) + \sigma + x} \right\} \Phi(ds') = J_m. \tag{31}$$

Notice that since $d \in (0,1)$ is chosen before the current state s' is realized, it can be treated as a constant in the decision rules of the other variables within the period. Equation (31) states that this feature, combined with the i.i.d. nature of the monetary shock, implies that the marginal value of an extra dollar for the family entering the current period will be constant. This result will prove extremely useful in establishing the following proposition regarding the effect of an unanticipated monetary shock.

Proposition 2. A positive innovation to the money growth rate

(i) increases the fraction of total household consumption purchased with credit,

(ii) increases employment and output in the goods producing and credit services sectors,

(iii) decreases the relative price of credit services to consumption goods.

Proof. From equation (10) $p_g = (d+x)/\sigma Q(n_2)$. Substituting this and (18) into equation (16) and rearranging gives

$$\beta\left\{\frac{d+x}{1+x}\right\}J_m = \frac{A\sigma Q(n_2)}{F_n(n_1)}.$$

Substituting (30) into the above expression yields one equation which can be solved for n_1 as a function of d, J_m, and x:

$$n_1 = J_m\frac{\alpha\beta}{A\sigma}\left\{\frac{\sigma + x + d(1-\sigma)}{1+x}\right\}. \tag{32}$$

Since $\sigma + d(1-\sigma) < 1$, it is immediate that employment and output in the goods producing sector will be strictly increasing in the monetary shock. With this, the stochastic behavior of n_2 can be easily characterized by substituting (32) into (30) and solving for $Q(n_2)$:

$$Q(n_2) = \frac{d+x}{\sigma + x + d(1-\sigma)}\left\{J_m\frac{\alpha\beta}{A\sigma}\left(\frac{\sigma + x + d(1-\sigma)}{1+x}\right)\right\}^{\alpha}. \tag{33}$$

Thus, employment and output in the credit producing sector increases with the size of the monetary shock as well. These results imply that aggregate consumption and household work effort will respond positively to the monetary innovation. Equation (26) implies that this leads to a negative relationship between a positive money shock and the relative price of credit services. ■

The intuition behind these results can be given by the following observations. Since the household saving decision (d) must be made prior the realization of the current monetary shock, monetary injections of cash enter the economy asymmetrically through the financial sector and credit producing firms. This creates a liquidity premium for producers of credit services who must finance a portion of household purchases of credit goods with cash. As a result, credit producing firms increase their demand for labor and expand the supply of credit services to households. This drives the relative price of credit services as well as the nominal interest rate down. Credit services are valuable to households because it permits them to circumvent the inflation tax effects of holding cash between periods (given a positive steady state money growth rate). Households respond to this increased availability of credit services by increasing work effort, the fraction of consumption financed with credit, and total consumption. As a result, employment and output in both sectors respond positively to the current monetary injection.

IV. Quantitative Properties of the General Model

The previous section separated out both the pure anticipated inflation and liquidity effect of a monetary injection in the household credit model. Since money growth rates consistent with U.S. time series exhibit positive serial correlation both of these effects will be present. This section investigates the cyclical properties of our general model and evaluates at some quantitative level the importance of household credit markets in generating a dominant liquidity effect. The model is solved using a linear-quadratic (L-Q) approximation technique that involves linearizing Euler equations (27), (28), and (29) with a Taylor-series approximation about the steady state. A method of undetermined coefficients is then used to solve for decision rules which are linear in the model's state variables. The money growth rate in the model will be assumed to follow a stationary AR(1) process:

$$x_{t+1} = (1 - \rho)x^* + \rho x_t + \epsilon_{t+1}, \qquad \textbf{(34)}$$

where x^* is the steady state value for x_t, $\rho < 1$, and ε_t is a white noise disturbance with zero mean and constant variance.

Consistent with previous real business cycle studies [e.g., Cooley and Hansen (1989)] we set $\alpha = 0.36$, $\beta = 0.99$, and $\delta = 0.025$. The value of $A = 2.55$ is chosen to give a steady state hours worked of 1/3. Aiyagari and Eckstein (1994) uses estimates of the production function for credit services which finds $\gamma = 0.35$. The money supply process parameters are set as $x^* = 0.016$ and $\rho = 0.32$ based on Christiano (1991).[7] However, it is not immediately obvious how to select an appropriate values for σ. Recall that σ measures the fraction of household credit purchases that credit producers must finance with cash. Since in equilibrium $\sigma = (d+x)/p_g g_2$, one possible empirical counterpart to this is the ratio of the quantity of cash deposited into the financial sector to bank loans. Thus, a rough estimate for σ may be inferred by looking at the ratio of total reserves to demand deposits. This gives us a benchmark value of $\sigma = 0.15$ and a starting point

[7]This figure, used as the benchmark parameters for Christiano (1990) and Fuerst (1993), is based upon estimated money growth models for the post-1970 sub-sample

about which to conduct our sensitivity analysis.[8] Finally ϕ and k_2 are set to 41.6 and 0.12, respectively, so that the steady state value of $p_qQ/(p_gY+p_qQ)$ is 0.89%, the approximate value added share of the U.S. household banking sector.[9]

Impulse response plots to a one time, one percent positive monetary shock for the cash-in-advance (CIA) case, where d is chosen after x_t is observed, as well as our household credit (HC) model are presented in Figures 2A through 2I. The shock occurs in period 10 and the vertical axis for real variables measures percent deviations from steady state. Figure 2B shows that employment in the credit producing sector increases for both models. This is since the anticipated inflation effect increases household credit demand while the liquidity effect works to increase the availability of household credit. Hence, the equilibrium quantity of credit services in Figure 2D increases for both models.

However, the models have exactly the opposite predictions for the cyclical behavior of employment in the goods producing sector, aggregate employment, consumption, investment, and the nominal interest rate. Although money and credit services are positively related in CIA they are also countercyclical. The anticipated inflation effect in CIA depresses employment and real activity in the goods producing sector and raises the nominal interest rate. To the contrary, the benchmark HC model displays a dominant liquidity effect where the nominal interest rate in Figure 2G falls in the period of the shock. The expansion of household credit services increases

[8] Source: *Federal Reserve Bulletin*, 1995. Alternative measures include the ratio of reserves to consumer loans and reserves to transactions deposits (10 percent and 7.5 percent in 1996, respectively). Thus, $\sigma = 0.15$ seems like a reasonable and "conservative" choice.

[9]The value added share of the banking sector [excluding insurance agents and services] is 2.7% of GDP [see Diaz-Gimenez et.al. (1992)]. Actual household financial activity accounts for roughly 1/3 of this measure.

hours worked in both sectors as well as aggregate employment and investment and this leads to a short-term boom in the industrial sector (Figures 2A, 2B, 2C, and 2F). Furthermore, consumption in Figure 2E now rises in the period of the shock as well. Unlike the typical liquidity effect model, the monetary injection is actually able to mitigate the inflation tax effect by lowering the real cost of consumption through the availability of credit services.

Finally, Figures 2H and 2I compare the responses of the nominal rate (R_t) and relative price of credit services (PR_t) across CIA and HC models. Since the monetary shock is anticipated when portfolio decisions are made, CIA predicts that both coincide and rise in the period of the shock. Interestingly enough, while both falls in HC, the volatility of the nominal rate exceeds that of the relative price of credit services. Intuitively, the monetary shock unexpectedly increases the marginal value of cash in the goods market relative to the financial market, making the opportunity cost of using cash, or the nominal rate, lower than that of using credit services at the margin. This feature of the model may also help to explain the observation, by some, that the cost of consumer borrowing tends to be "sticky" and less volatile than the nominal interest rate.

To test the sensitivity of the size of the liquidity effect in the HC model to changes in the fraction of household credit purchases which credit producers must finance with cash, alternative values of σ are considered. In addition to the our benchmark value, we consider higher values of $\sigma = 0.25$ and 0.30. Corresponding to each value of σ we also choose an alternate value for ϕ so that the model's steady state remains consistent with a 0.89 percent value added share of the household credit sector. Figures 3A through 3G compares the impulse responses from these cases to that of the benchmark model. These plots clearly show that the size of the liquidity effect is strictly decreasing in the size of σ. Otherwise, the behavior of hours worked, consumption, investment, and credit services look similar to the patterns in Figure 2.

To understand the reasoning behind this result, consider the cash constraint on credit producers given by (10). In equilibrium this constraint becomes $p_g q = (d+x)/\sigma$. Intuitively, $1/\sigma$ can be interpreted as a measure of how efficiently credit producers carry out transactions for households. At $\sigma = 1$ credit producers and households are equally cash constrained and hence credit producers will have no incentive to supply credit services. Such a model degenerates to a basic cash-in-advance model where all household transactions will involve cash. All else being equal, $(1/\sigma) > 1$ generates a "multiplier effect" by which a monetary injection expands the availability of nominal credit services to households and hence the size of the liquidity effect. Thus, as σ falls the liquidity effect will begin to dominate the anticipated inflation effect. Notice that this intuition also makes sense given our institutional interpretation of σ. If we view it as the total fraction of required and excess reserves in the banking system, it is reasonable to think that the quantity of credit available in response to a monetary injection would be decreasing in this ratio (with no credit services available in the extreme case of $\sigma = 100\%$).

V. Concluding Remarks

This paper has explored the role of household credit markets in explaining the observed positive and procyclical relationship between money and credit services over the business cycle. Monetary injections through financial intermediaries and credit producers were shown to generate a liquidity effect by which real activity is influenced through an expansion of household credit services. Our quantitative results also suggests that there does exist reasonable parameter values where this effect may dominate the anticipated inflation effects of monetary growth. Furthermore, the model is able to resolve one important difficulty with the basic Lucas-Fuerst liquidity effect model. Because monetary injections increase the availability of household credit services it is actually able to circumvent the inflation tax effect on consumption. Thus, consumption responds positively to the monetary shock as well.

These results also provide a nice complement to recent liquidity effect models emphasizing business credit as an important element in explaining the procyclical behavior of money and the business cycle. However, similar to these models, our set-up also lacks a persistent liquidity effect which is evident in U.S. time series. There are two possibilities to pursue with this issue. First, one could add rigidities which prevent the immediate adjustment of household funds in the periods following an unexpected monetary shock. Second, and perhaps more interesting, is to explicitly analyze the behavior of consumer durable spending in this model. This may not only contribute to the persistence issue but also help explain another important empirical regularity. Over a typical business cycle household investment is procyclical and leads the cycle while business investment lags the cycle. From causal observation, a majority of consumer durables and residential investment is financed with credit as opposed to cash. Thus, our household credit framework may be able to provide a monetary explanation of this phenomena.

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Figure 2A: Employment in Goods Producing Sector

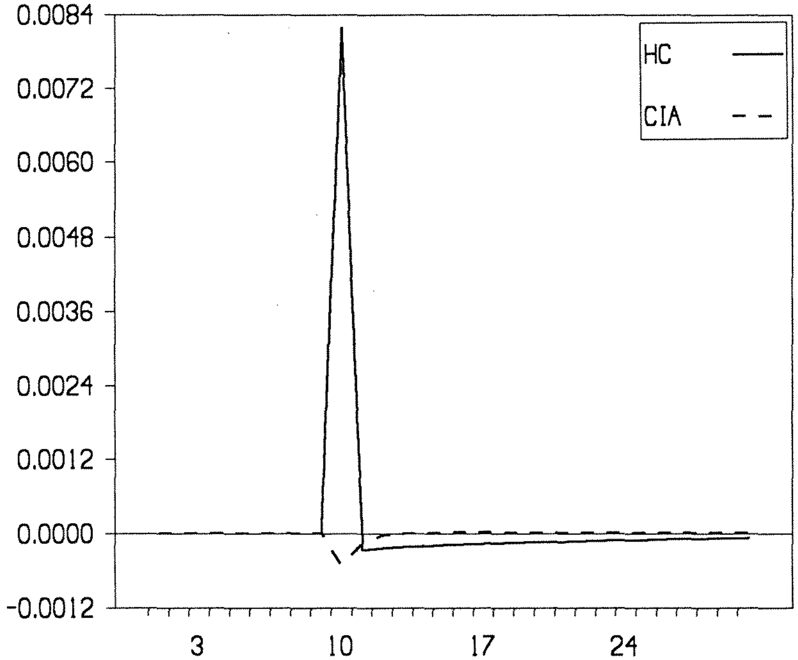


Figure 2B: Employment in Credit Producing Sector

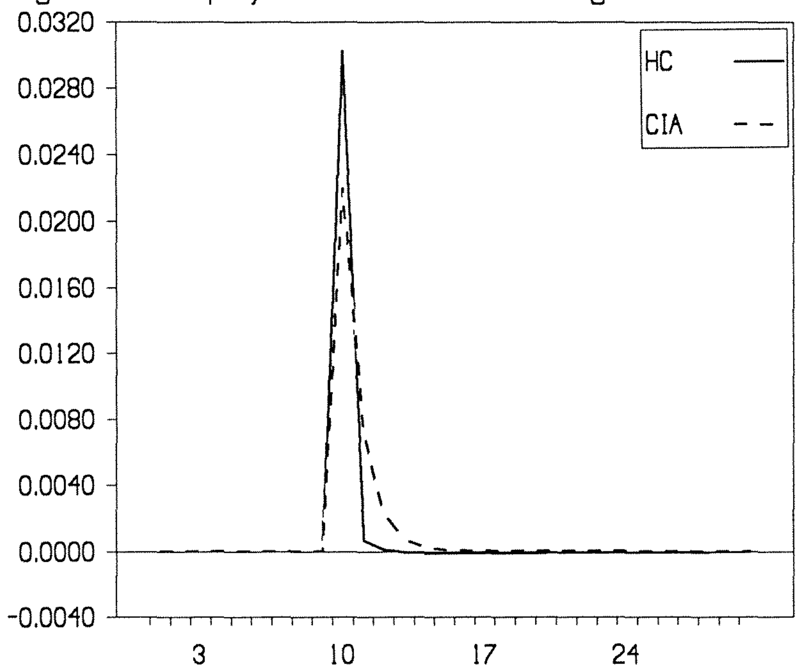


Figure 2C: Aggregate Employment

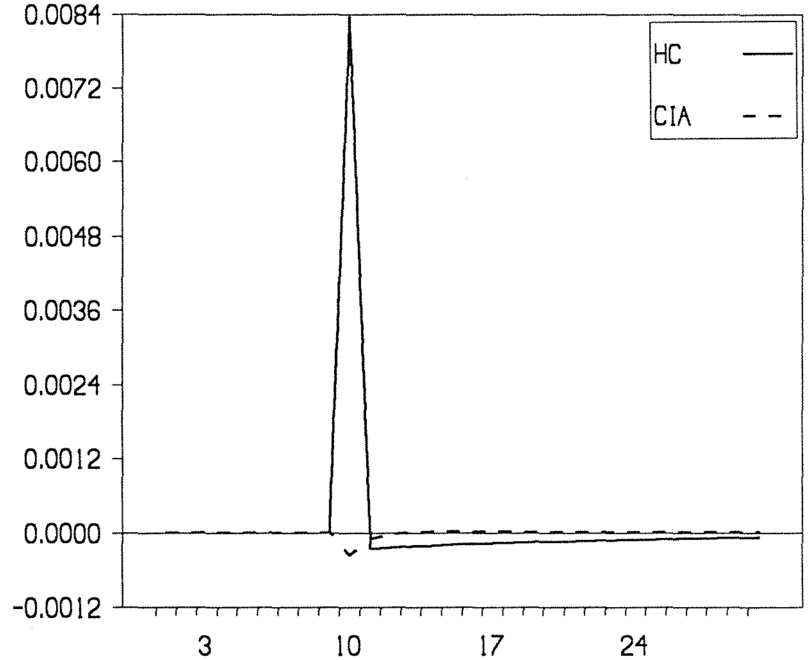


Figure 2D: Credit Services

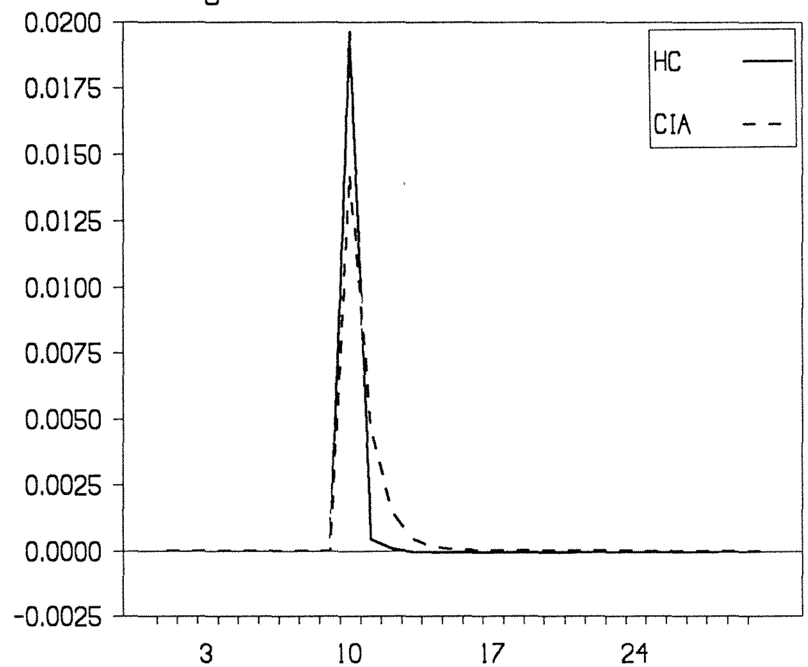
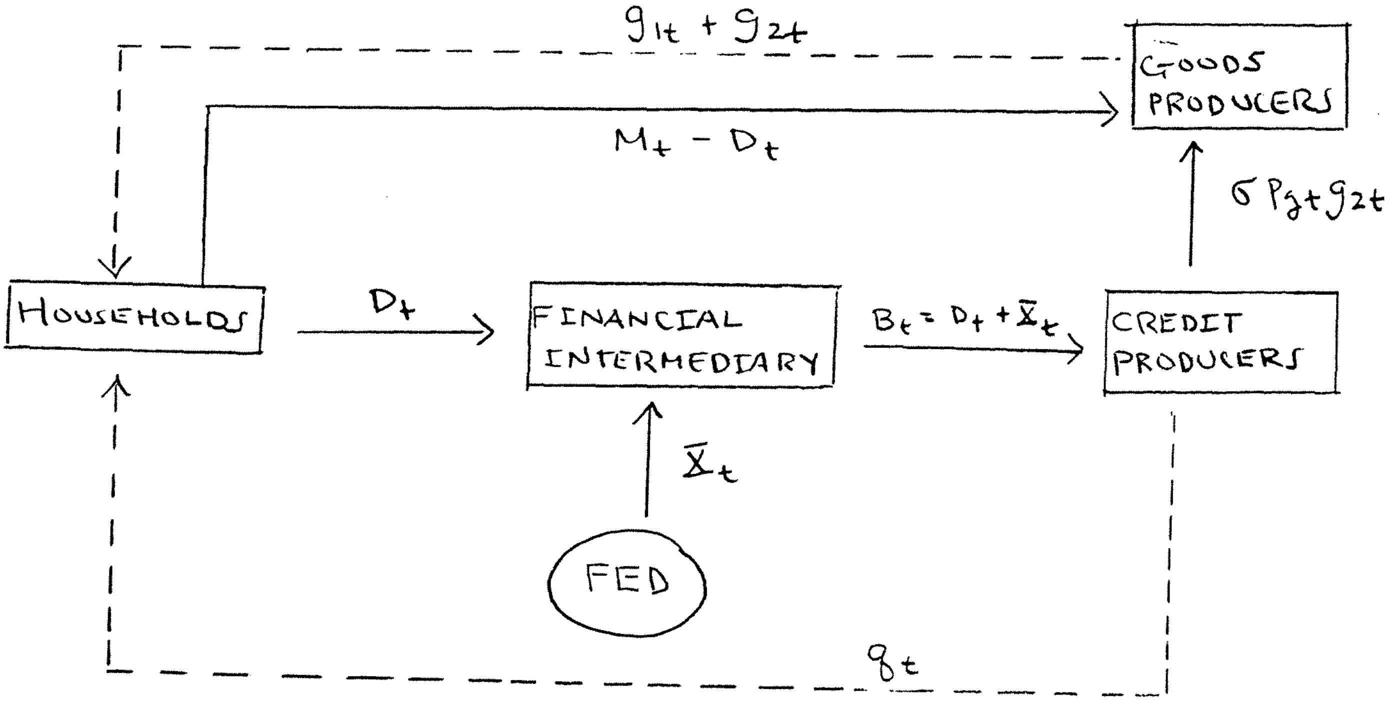


FIGURE 7: FLOW OF CASH + GOODS

(1) Within Period



(2) End-of-Period

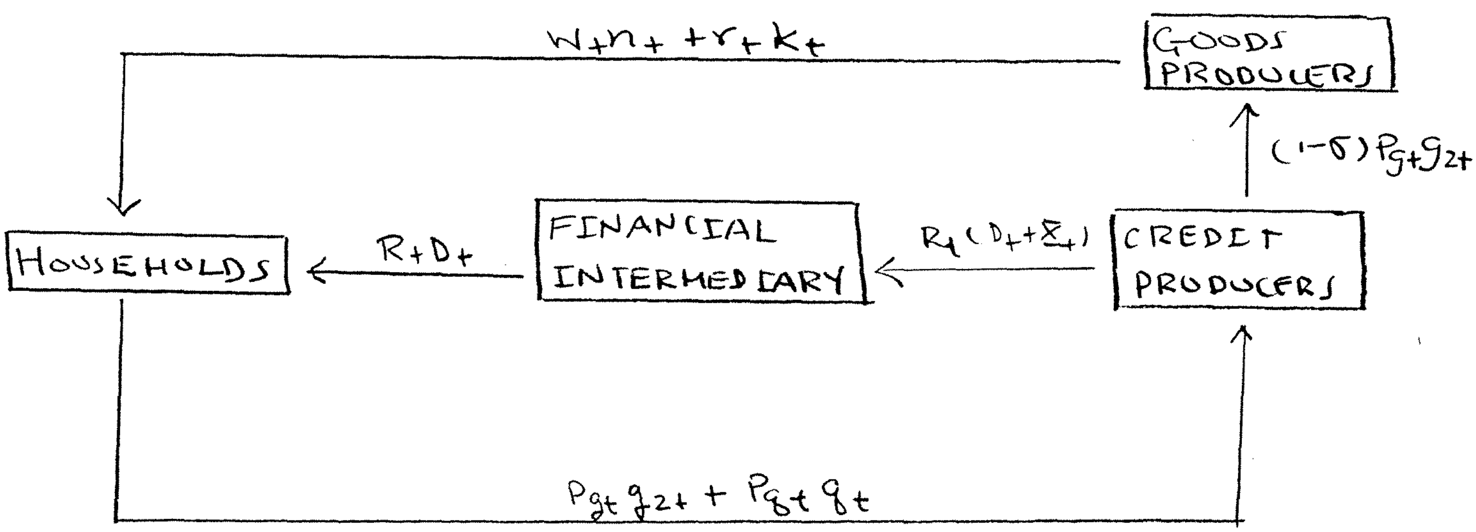


Figure 2E: Consumption

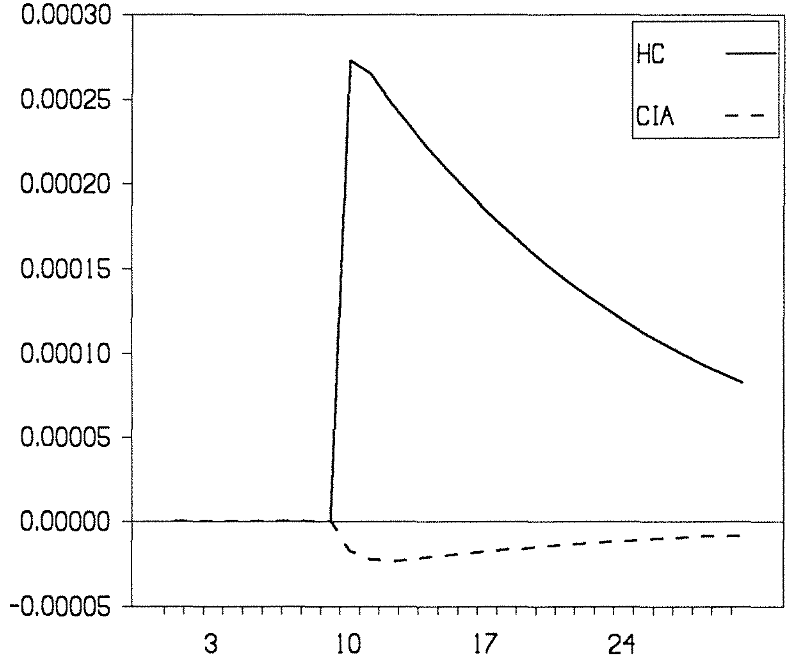


Figure 2F: Investment

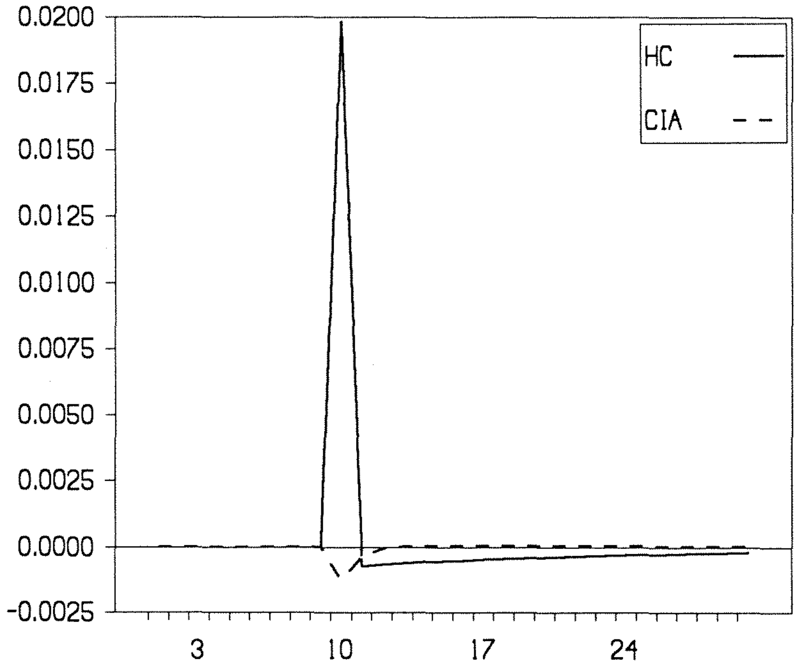


Figure 2G: Nominal Interest Rate

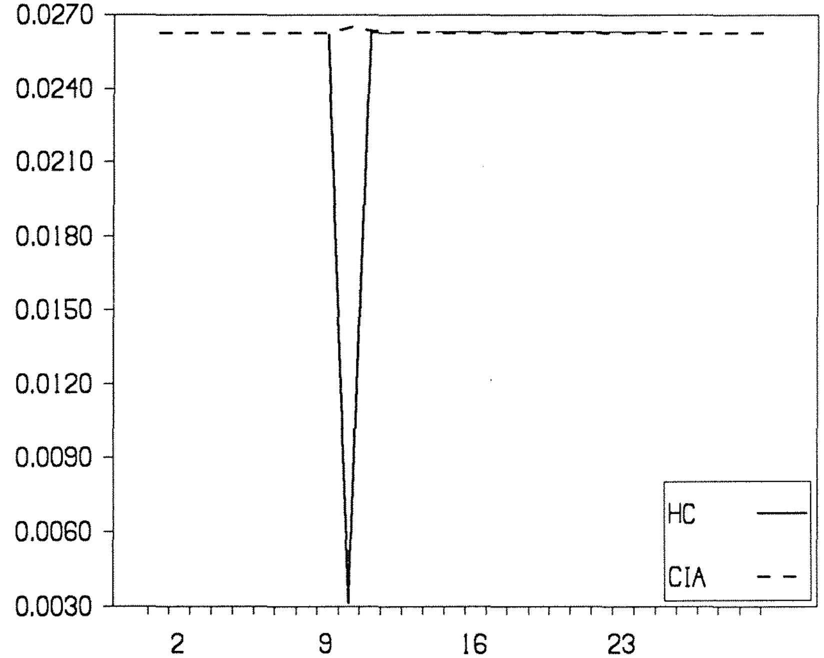


Figure 2H: Nominal Rate and Relative Price of Credit - CIA

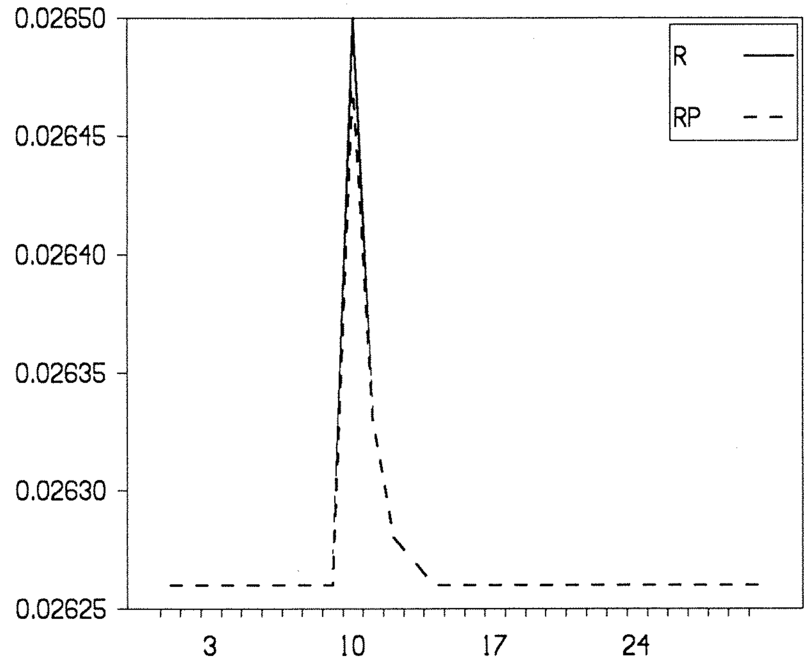


Figure 2I: Nominal Rate and Relative Price of Credit - HC

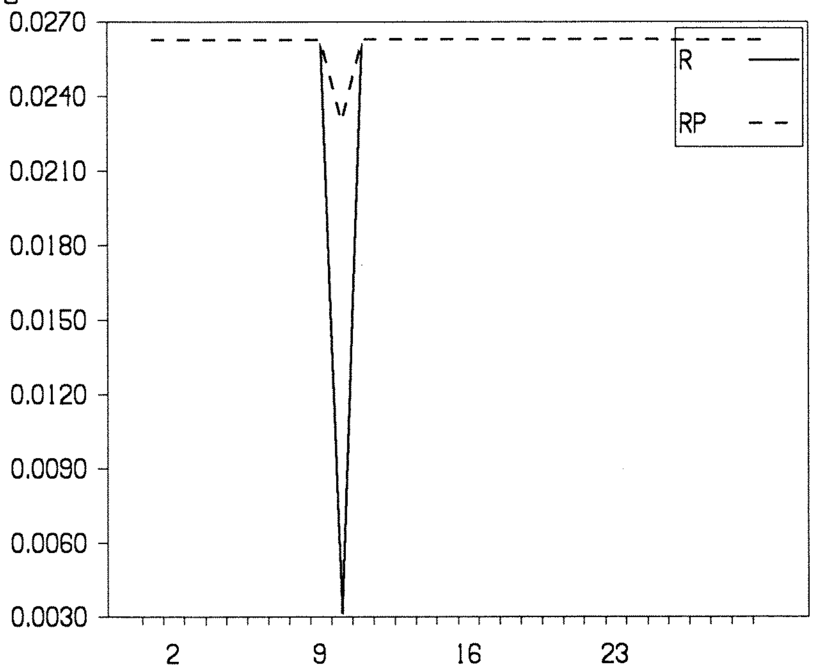


Figure 3A: Employment in Goods Producing Sector

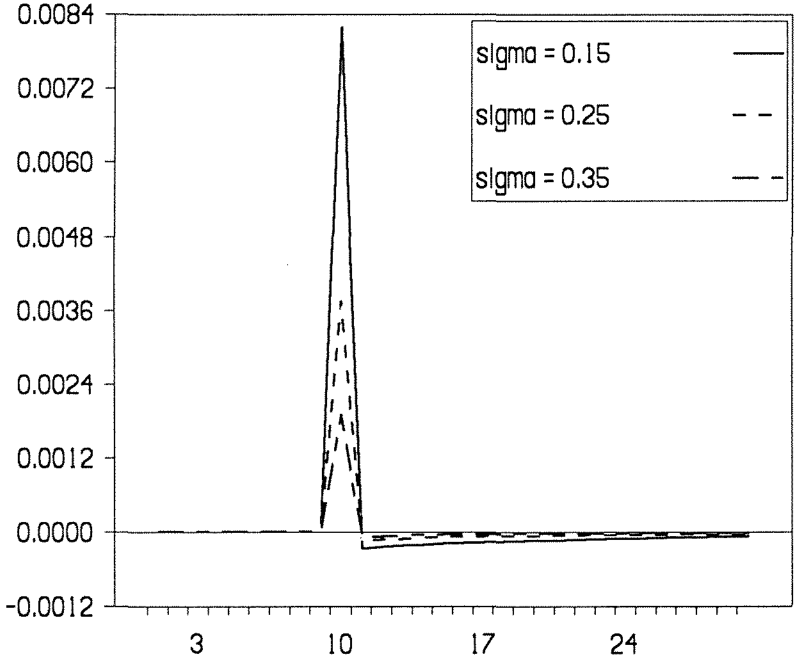


Figure 3B: Employment in Credit Producing Sector

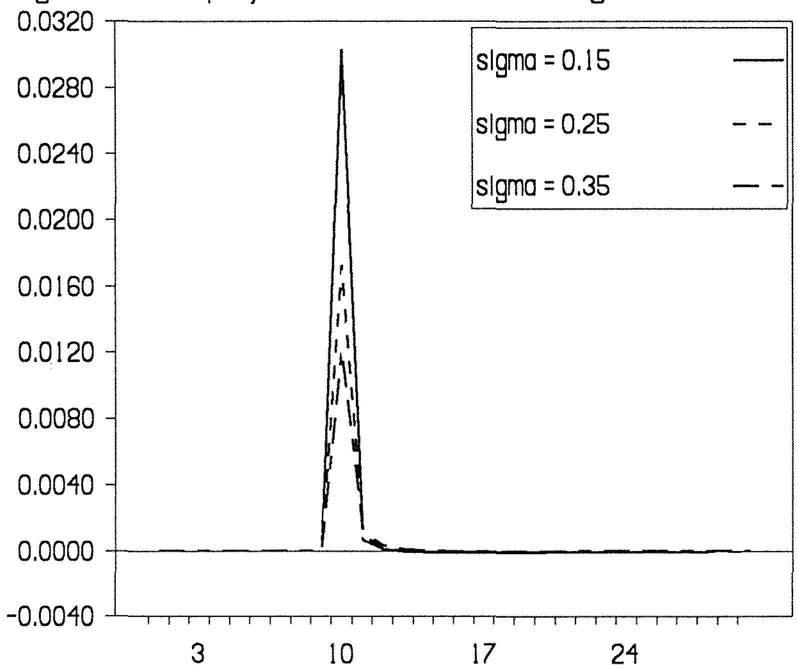


Figure 3C: Aggregate Employment

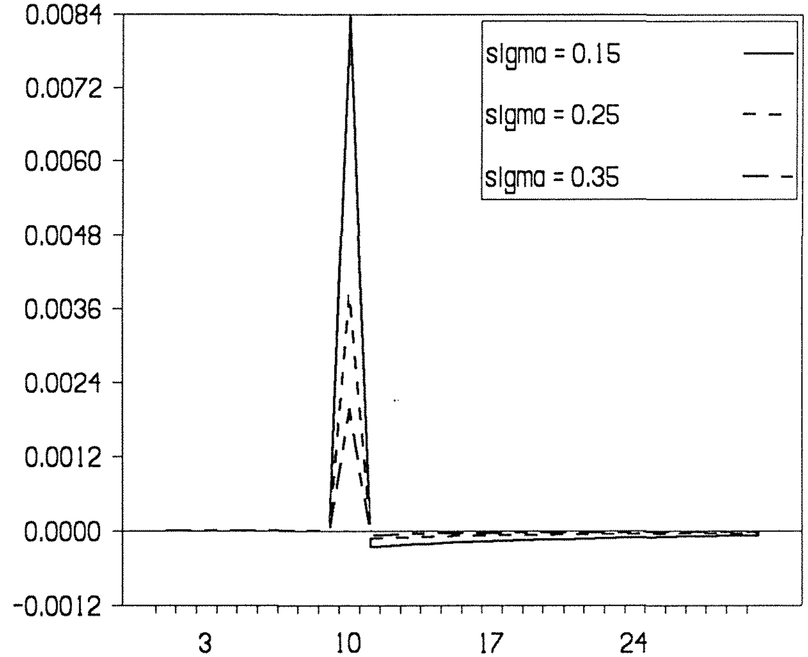


Figure 3D: Credit Services

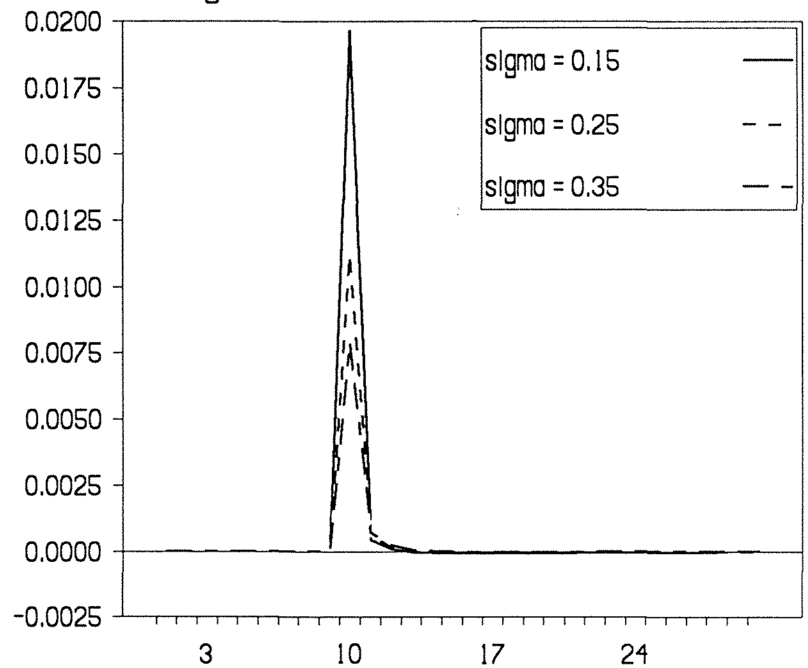


Figure 3E: Consumption

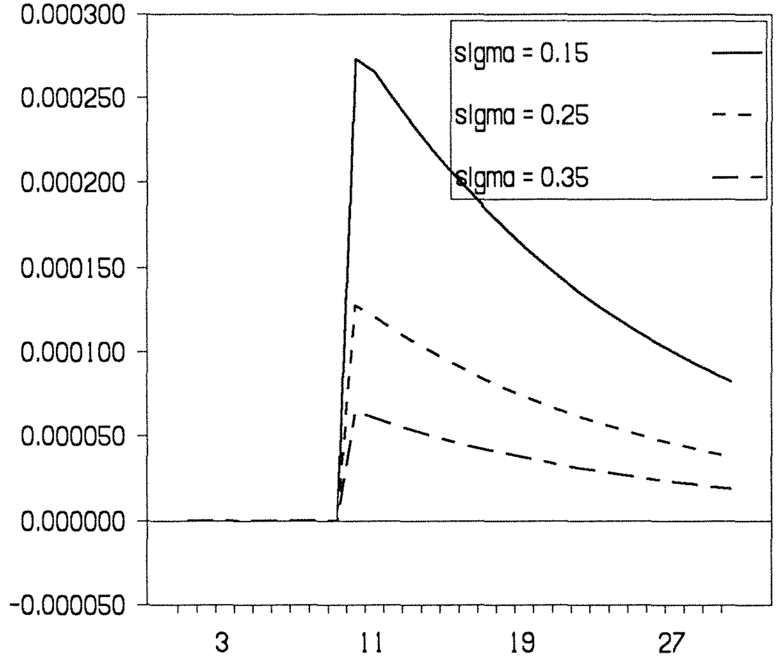


Figure 3G: Nominal Interest Rate

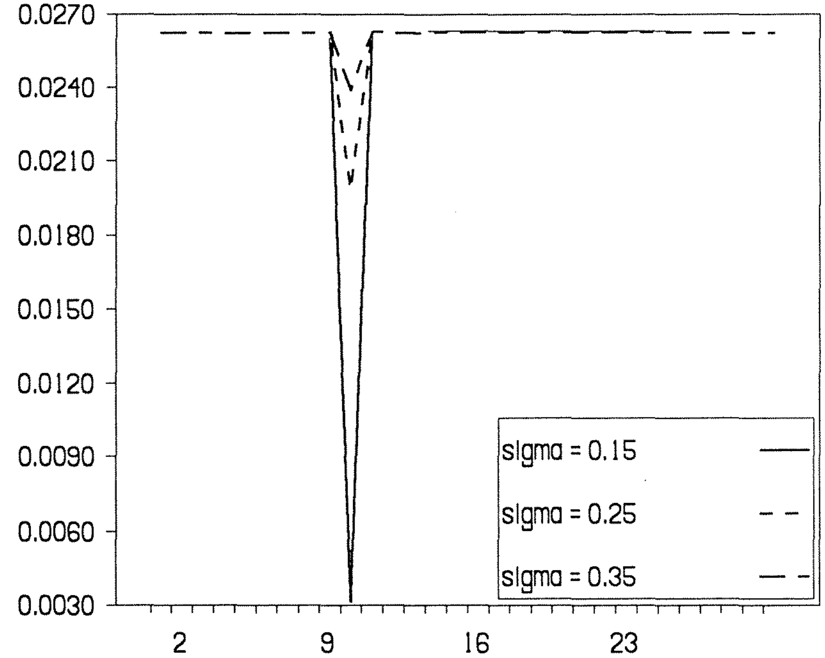


Figure 3F: Investment