



WORKING PAPER SERIES

Money Credit and the Cyclical Behavior of Household Investment

Victor E. Li
Chia-Ying Chang

Working Paper 1998-017A
<http://research.stlouisfed.org/wp/1998/1998-017.pdf>

FEDERAL RESERVE BANK OF ST. LOUIS
Research Division
411 Locust Street
St. Louis, MO 63102

The views expressed are those of the individual authors and do not necessarily reflect official positions of the Federal Reserve Bank of St. Louis, the Federal Reserve System, or the Board of Governors.

Federal Reserve Bank of St. Louis Working Papers are preliminary materials circulated to stimulate discussion and critical comment. References in publications to Federal Reserve Bank of St. Louis Working Papers (other than an acknowledgment that the writer has had access to unpublished material) should be cleared with the author or authors.

Photo courtesy of The Gateway Arch, St. Louis, MO. www.gatewayarch.com

MONEY, CREDIT, AND THE CYCLICAL BEHAVIOR OF HOUSEHOLD INVESTMENT

September 1998

Abstract

This paper focuses on a monetary explanation of two business cycle regularities: (i) business and household investment are positively correlated and procyclical and (ii) household investment tends to lead business investment. We construct a general equilibrium framework that explicitly incorporates a credit sector where real resources are employed in the production of costly household and business credit services. Financial intermediaries provide interest bearing accounts to households and loanable funds for credit producers. It is shown that liquidity effects from asymmetric monetary injections to the financial sector increase the availability of consumer and business credit services. The relative strength of these liquidity effects on business and household spending can provide a mechanism which captures both the direction and timing of their corresponding investments expenditures over the cycle. Furthermore, explaining these observations with a household credit channel also resolves some problematic predictions of existing liquidity effect models.

Keywords: Inflation targeting, policy rule, Markov switching

JEL Classification: C50, E52, E58

I. Introduction

The ability to capture the procyclical nature of the components of aggregate expenditures is a major goal of modern business cycle theory. In particular, the cyclical relationship between aggregate business and household expenditures have been the focus of recent empirical and theoretical studies. It is a stylized fact that (i) business fixed investment and household spending on durable goods and residential investment are positively correlated and procyclical over the business cycle and (ii) household investment tends to lead the business cycle while business investment tends to lag the cycle [see Chart 1]. These facts are documented by, among others, Kydland and Prescott (1990), Greenwood and Hercowitz (1991) and Christiano and Todd (1996).¹ Furthermore, Bernanke and Gertler (1995) demonstrates that negative monetary innovations, such as a tightening of the federal funds rate, leads to an immediate decline in residential investment and consumer durables while depressing business investment significantly only in subsequent periods. This finding suggests that these empirical regularities may also be a consequence of the monetary and financial structure of the economy.

This paper investigates how a monetary transmission mechanism which highlights the interaction between household and business investment and the credit market may account for both empirical observations. Following along the lines of the recent liquidity effect literature [Lucas (1990) and Fuerst (1992a)] the real effects of monetary shocks arise from the conventional view that it is financial intermediaries who initially receive cash injections and uses them to augment

¹Christiano and Todd (1996) indicates that the dynamic correlation between output and business investment (household investment) is largest between current output and one period lead (lagged) business investment (household investment).

their supply of loanable funds [Fuerst (1992a) and Christiano and Eichenbaum (1995)]. While previous studies have emphasized this channel as working through business borrowing, Li (1996) evaluates within this class of models the importance of household credit markets in the transmission of monetary policy. By allowing asymmetric injections of cash to flow through the financial sector and to the producers of household credit services, the resultant liquidity effect positively influences the availability of household credit services. It demonstrates that the inclusion of a household credit channel may not only overcome important quantitative deficiencies of existing liquidity effect approaches but also lends theoretical support to the view that consumer credit is an important link between monetary policy and real activity.²

Building on such a framework this current paper analyzes the dynamic implications of introducing an explicit household investment decision and both a consumer and business lending channel. The model consists of a financial sector with firms specializing in the production of both household and firm credit services (credit producers) and financial intermediaries providing interest bearing accounts to households and loanable funds to these credit producers. Households have a choice of financing goods (either non-durable consumption or household investment) with cash or credit services. While a credit transaction allows the household to avoid using “cash-in-advance” it is also costly in that they must first purchase these services from credit producing firms. In turn, credit producers require loanable funds from the financial market to finance household and firm credit purchases within the period.

²Christiano (1991) notes that a major difficulty with the business lending channel is that, without additional restrictions on the timing of investment decisions, the liquidity effect is quantitatively too small to dominate the anticipated inflation effects of positive monetary innovations.

It is shown that combining such a household credit channel with the traditionally emphasized firm lending channel is able to capture both stylized facts in response to a monetary shock. The intuition is straightforward. As cash injections are asymmetrically funneled to the financial market, the expansion of household credit services leads both consumption of durable and non-durables to rise in the period of the shock. The response of business investment depends on two opposing effects. First, the increase in household credit shifts the economy's investment resources towards the accumulation of durable goods and away from business capital. Second, since business capital is also financed in part by borrowing from the financial market, the liquidity effect tends to increase business investment. As a result, the response of business investment may be "optimally sluggish" in the period of the shock while increasing afterwards.

In terms of related literature, viewing this issue from a monetary perspective is a relatively new approach as most theoretical works attempting to capture these facts focus on real explanations. For example, Christiano and Todd (1996) include a business investment planning period in an otherwise standard real business cycle model where resources must be committed to the investment project over several periods before its completion. While this feature explains why business investment will lag the cycle, they do not explicitly consider household investment. Another approach is to consider a household production sector employing home supplied labor and capital in the production of a non-market consumption good [e.g., Benhabib, Rogerson, and Wright (1991)]. In such a framework, enough complementarity between work effort and household capital [Greenwood and Hercowitz (1991)] or in the production of market and home investment [Fisher (1994)] leads to the procyclical behavior of household and business investment in response to productivity shocks. However, these models are not able to capture the second

stylized fact regarding the dynamic correlation between the two investments.

Among the few studies that have focused on a monetary explanation of these facts, the most related to our current study is Fuerst (1992b) where asymmetric monetary injections are first received by shoppers of the household investment good. Consequently, as the economy expands, it initially accumulates the household investment good which, in the periods following the monetary shock, is dissipated by a boom in business investment. While this captures both empirical regularities, Fuerst also points out some problematic predictions of the model. In particular, positive monetary innovations lead to a fall in non-durable consumption and, without sufficient complementarity between durable and nondurable consumption, this drives the nominal rate upwards. Our paper demonstrates that an explicit treatment of both the household and firm credit markets may resolve such difficulties.

The paper proceeds as follows. Section II will outline the basic model and characterize equilibrium conditions. To stress the importance of how liquidity effects interact with household and business credit, Section III first analyzes two benchmark economies: one with only a business lending channel and the other only a household lending channel only. Then we turn to the dynamic implications of the general model for, among other things, the behavior of household and business investment. Section IV concludes with a brief summary.

II. The Model

The model economy is populated by many infinitely lived identical households with preference over consumption of non-durables c_t , a stock of durable goods d_t and leisure at each date t . The household's expected lifetime utility given by

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

where n_t is work effort at date t , $0 < \beta < 1$ is the time discount factor, and E is the expectations operator. The particular functional form of preferences adopted is given by $u(c,d) = \gamma \ln(c) + (1-\gamma) \ln(vd_t)$ and $V(1-n) = A(1-n)$ where $A > 0$, $0 < \gamma < 1$ is the elasticity of substitution between non-durable and durable consumption, and $v > 0$ captures the proportional flow services generated from the stock of durables.

Households can purchase durable and non-durable goods by either cash or credit in the goods market. While similar to Lucas and Stokey (1987) in that all cash transactions are subject to a cash-in-advance constraint while credit transactions can be financed by current income, the distinction between cash and credit goods is made in the transactions technology and not preferences. Let g_{1t} and g_{2t} denote the goods purchased by cash and credit, respectively. Therefore, the total quantity of goods purchased by households must satisfy:

$$g_{1t} + g_{2t} = c_t + I_t^d \quad (2)$$

where

$$I_t^d = d_{t+1} - (1-\delta^d)d_t \quad (3)$$

I_t^d denotes the investment flow of durables at time t with depreciation rate $\delta^d \in (0,1)$. Carrying out credit transactions requires the purchase of household credit services q_t^h produced in the financial sector. A simple linear technology transforming credit services to credit goods is adopted where $g_{2t} = q_t^h$.

Firms in the goods producing sector employ capital k_t and labor n_{1t} to produce output Y_t

according to a Cobb-Douglas constant return to scale production technology:

$$Y_t = F(k_t, n_{1t}) = k_t^\alpha n_{1t}^{1-\alpha} \quad (4)$$

where $\alpha \in (0,1)$. The investment flow of business capital is given by

$$I_t^k = k_{t+1} - (1-\delta^k)k_t \quad (5)$$

where $\delta^k \in (0,1)$ is the capital depreciation rate. A portion of this investment must be financed by firm credit services q_t^f produced in the financial sector.

Producers of credit services employ labor n_{2t} and allocate it to produce a flow of credit services to households and firms with technology given by $q_t^h = Q^h(n_{ht}) = \phi_h n_{ht}^{\eta_h}$ and $q_t^f = Q^f(n_{ft}) = \phi_f n_{ft}^{\eta_f}$, respectively, where $n_{2t} = n_{ht} + n_{ft}$, $\eta_h, \eta_f < 1$, and $\phi_h, \phi_f > 0$.³ Consequently, credit producers must finance a portion of goods purchased with credit by households and firms with borrowed funds from financial intermediaries. Financial intermediaries provide households with interest bearing deposits and loanable funds to the credit producing sector.

The per household supply of money evolves according to

$$M_{t+1}^s = M_t^s + X_t = (1+x_t)M_t^s, \quad (6)$$

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

³Modeling the explicit production of credit services in this way is similar to Aiyagari and Eckstein (1994). The purpose of their study is the effects of monetary stabilization policies on banking size and economic growth.

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 , durables stock d_t , and nominal cash holdings M_t and deposits S_t dollars into the financial intermediary. Note that this decision is made *before* the current monetary transfer is realized. The family then separates. The state of nature is revealed in the form of a monetary injection to the financial intermediary, X_t . The financial intermediary now has available $S_t + X_t$ 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} , and n_{2t} .

The firm then purchases investment goods I_t^k from the goods market at price P_{gt} and finances a fraction of that amount $\theta \leq 1$ with credit services q_t^f purchased from credit producers at price P_{ft} . The shopper first travels to the financial sector to purchase a given amount of credit services q_t^h at price P_{ht} . Households may finance these credit services with end-of-period income. The shopper then travels to the goods market to buy non-durable consumption and durable investment goods at price P_{gt} where g_{1t} is financed with cash and g_{2t} with credit services. Credit producers are obligated to finance household and firm credit purchases in the goods market and a fraction $\sigma \leq 1$ 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, goods producing firms, and credit producers, respectively:

$$P_{gt}g_{1t} \leq M_t - S_t \quad (7)$$

$$\theta p_{gt}I_t^k \leq p_{gt}q_t^f \quad (8)$$

$$\sigma P_{gt}[Q^h(n_{ht}) + Q^f(n_{ft})] \leq B_t \quad (9)$$

At the end of the period the family reunites to enjoy the consumption of non-durable and durable goods. All credit loans (between households, credit producers, goods producers, and the financial intermediary) are repaid and the family pools its cash receipts and enters period $t+1$. This gives us the following budget constraint determining the family's beginning of next period cash holdings:

$$\begin{aligned} M_{t+1} = & [M_t + S_t R_t + W_t n_t - P_{gt}(g_{1t} + q_t^h) - P_{ht}q_t^h] + X_t(1 + R_t) \\ & + [P_{gt}F(k_t, n_{1t}) - W_t n_{1t} - P_{gt}I_t^k - P_{ft}q_t^f] + [P_{ht}Q^h(n_{ht}) + P_{ft}Q^f(n_{ft}) - W_t(n_{ht} + n_{ft}) - B_t R_t] \end{aligned} \quad (10)$$

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 the fourth is the profits of the credit producer less repayment of loans necessary to finance household and firm credit purchases. The optimal choices for the family is thus choosing a sequence $\{g_t, q_t^h, d_{t+1}, n_t, S_t, k_{t+1}, n_{1t}, q_t^f, n_{ht}, n_{ft}, B_t\}$ maximizing (1) subject to (2) - (5) and (7) - (10).

Scaling all nominal variables by the beginning of period money supply M_t^s , denote $m = M_t/M_t^s$, $s_t = S_t/M_t^s$, $b_t = B_t/M_t^s$, $w_t = W_t/M_t^s$, $p_t = P_t/M_t^s$ ($I=g,h,f$). Letting the transition density

for the monetary shock x_t be expressed as $\Phi(x_t, dx_{t+1}) = \text{Prob}(x_{t+1} | x_t)$ and “'” denote next period variables, we can express the family's dynamic programming problem as

$$J(m, k, d, x) = \max_s \int \max_{g_1, q^h, d', n, n_1, k', q^f, n_h, n_f, b} \{u(c, d) + V(1-n) + \beta J(m', k', d', x')\} \Phi(x, dx') \quad (11)$$

subject to

$$c = g_1 + q^h - d' + (1-\delta^d)d \quad (12)$$

$$p_g g_1 \leq m - s \quad (13)$$

$$\theta p_g [k' - (1-\delta^k)k] \leq p_g q^h \quad (14)$$

$$\sigma p_g [Q^h(n_h) + Q^f(n_f)] \leq b \quad (15)$$

$$m' = \frac{m + sR + wn - p_g(g_1 + q^h) - p_h q^h + x(1+R) + p_g F(k, n_1) - wn_1 - p_g I^k - p_f q^f + p_h Q^h(n_h) + p_f Q^f(n_f) - w(n_h + n_f) - bR}{1+x} \quad (16)$$

The market-clearing conditions for goods, credit services, labor, financial intermediary loans, and money are given by $c + I^k + I^d = F(k, n_1)$, $q^i = Q^i(n_i)$ ($i=h, f$), $n = n_1 + n_2$, $b = s + x$, and $m = m' = 1$. Letting λ_1 , λ_2 , and λ_3 denote the Lagrange multipliers associated with constraints (13), (14), and (15), the first order conditions for g_1 , q^h , d' , n , k' , n_1 , n_h , n_f , q^f , b , and s , evaluated at the market-clearing conditions, is given by

$$\frac{u_c(c,d)}{p_g} = \frac{\beta J_m(m',k',d',x')}{1+x} + \lambda_1 \quad (17)$$

$$u_c(c,d) = \frac{\beta}{1+x} J_m(m',k',d',x') [p_g + p_h] \quad (18)$$

$$u_c(c,d) = \beta J_d(m',k',d',x') \quad (19)$$

$$V'(1-n) = \frac{\beta}{1+x} J_m(m',k',d',x') w \quad (20)$$

$$\frac{\beta}{1+x} J_m(m',k',d',x') p_g + \lambda_2 \theta p_g = \beta J_k(m',k',d',x') \quad (21)$$

$$F_n(k,n_1) = \frac{w}{p_g} \equiv \omega \quad (22)$$

$$\frac{\beta}{1+x} J_m(m',k',d',x') [p_h Q_n^h(n_h) - w] = \lambda_3 \sigma p_g Q_n^h(n_h) \quad (23)$$

$$\frac{\beta}{1+x} J_m(m',k',d',x') [p_f Q_n^f(n_f) - w] = \lambda_3 \sigma p_g Q_n^f(n_f) \quad (24)$$

$$\frac{\beta}{1+x} J_m(m',k',d',x') p_f = \lambda_2 p_g \quad (25)$$

$$\frac{\beta}{1+x} J_m(m',k',d',x') R = \lambda_3 \quad (26)$$

$$\int \left\{ \frac{\beta}{1+x} J_m(m', k', d', x') R \right\} \Phi(x, dx') = \int \lambda_1 \Phi(x, dx') \quad (27)$$

where $\omega \equiv w/p_g$ is the real wage. The envelope conditions are given by

$$J_m(m, k, d, x) = \int \left\{ \frac{\beta}{1+x} J_m(m', k', d', x') + \lambda_1 \right\} \Phi(x, dx') \quad (28)$$

$$J_d(m, k, d, x) = \int \left\{ u_c(c, d)(1 - \delta^d) + u_d(c, d) \right\} \Phi(x, dx') \quad (30)$$

$$J_k(m, k, d, x) = \int \left\{ \frac{\beta}{1+x} J_m(m', k', d', x') [p_g F_k(k, n_1) + p_g(1 - \delta^k)] + \lambda_2 \theta p_g(1 - \delta^k) \right\} \Phi(x, dx') \quad (29)$$

The intuition of these conditions are straightforward. For example, equation (18) equates the benefit of purchasing a unit of credit services, given by the marginal utility of consumption of goods purchased with credit, with the cost, given by the lowering of cash balances by the price of both the credit good and credit service. Equations (23) and (24) says that the marginal benefits to credit producers of hiring labor, given by it's marginal product, equals to the cost of both the wage bill and financing a fraction σ of credit purchases with borrowed funds. The central conditions that produce a liquidity effect are (25), (26) and (27). While the family equates the marginal cost of using cash in the goods and financial market on average [i.e., $E(\lambda_1) = E(\lambda_3)$], unexpected positive monetary innovations may lead to a relative scarcity of cash in the goods market and lower nominal rates.⁴

⁴See Fuerst (1993) for a more complete discussion of this liquidity effect.

Reverting back to time subscript notation, (17) and (28) imply the marginal value of cash to the household is simply the expected discounted marginal utility of non-durable consumption in the following period:

$$J_m(m_t, k_t, d_t, x_t) = E_{t-1} \left\{ \frac{u_c(c_t, d_t)}{P_{g,t}} \right\}$$

Using this, equations (19) and (30) gives us an efficiency condition for d_{t+1} :

$$u_c(c_t, d_t) = \beta E_t \left\{ u_d(c_{t+1}, d_{t+1}) + (1 - \delta^d) u_c(c_{t+1}, d_{t+1}) \right\} \quad (31)$$

This condition equates the marginal benefits of accumulating an addition unit of durables, given by the utility generated from its services in the following period as well as the resources its non-depreciated portion makes available for next period's non-durable consumption, with the cost of sacrificing current non-durable consumption. Equations (21), (25) and (29) gives an efficiency condition for the accumulation of business capital k_{t+1} :

$$(1 + \theta \frac{P_{ft}}{P_{gt}}) \frac{P_{gt}}{1 + x_t} E_t \left\{ \frac{u_c(c_{t+1}, d_{t+1})}{P_{g,t+1}} \right\} = \beta E_t \left\{ \frac{P_{g,t+1}}{1 + x_{t+1}} \frac{u_c(c_{t+2}, d_{t+2})}{P_{g,t+2}} [F_k(k_{t+1}, n_{1,t+1}) + 1 - \delta^k + \theta (1 - \delta^k) \frac{P_{f,t+1}}{P_{g,t+1}}] \right\} \quad (32)$$

The left hand side of (32) gives the marginal cost of accumulating additional business capital as the cost of purchasing capital on the goods market and the real cost of financing a fraction θ with funds borrowed from credit producers (expressed in units of next period's marginal utility of consumption). The right hand side is the benefits of the capital's marginal product next period and the resources saved by not having to finance the un-depreciated portion of the capital stock from the

credit market. The efficiency condition for work effort n_t comes from (20) and (22):

$$A = \frac{\beta p_{gt} F_n(k_t, n_{1t})}{1+x_t} E_t \left\{ \frac{u_c(c_{t+1}, d_{t+1})}{p_{g,t+1}} \right\} \quad (33)$$

This simply equates the disutility of additional work effort to the expected benefits of the additional real wage it will generate for next period. Finally, the optimal portfolio decision for financial market deposits s_t given by

$$E_{t-1} \left\{ \frac{u_c(c_t, d_t)}{p_{gt}} \right\} = E_{t-1} \left\{ (1+R_t) \frac{\beta}{1+x_t} \frac{u_c(c_{t+1}, d_{t+1})}{p_{g,t+1}} \right\} \quad (34)$$

This saving decision is made before the realization of the monetary shock so that the expected marginal benefits and costs are based upon the information set of variables observed in period $t-1$.

Using (26), equations (23) and (24) relate the relative price of credit for households and firms to the nominal rate and the marginal productivity of labor in credit production relative to that in goods production:

$$\frac{p_{ht}}{p_{gt}} = \frac{F_n(k_t, n_{1t})}{Q_n^h(n_{ht})} + \sigma R_t \quad \text{and} \quad \frac{p_{ft}}{p_{gt}} = \frac{F_n(k_t, n_{1t})}{Q_n^f(n_{ft})} + \sigma R_t \quad (35)$$

Combining (18) with (35) gives us an expression for the nominal rate as

$$R_t = \frac{1}{\sigma} \left[\frac{u_c(c_t, d_t) F_n(k_t, n_{1t})}{A} - 1 - \frac{F_n(k_t, n_{1t})}{\phi Q_n(n_{2t})} \right] \quad (36)$$

The cash constraint (15) and loan market clearing determines the goods market price as

$$p_{gt} = \frac{s_t + x_t}{\sigma[Q^h(n_{ht}) + Q^f(n_{ft})]} \quad (37)$$

and credit services market clearing and (14) implies employment in firm credit production can be solved solely as a function of the level of business investment:

$$\theta[k_{t+1} - (1 - \delta^k)k_t] = Q^f(n_{ft})$$

Using this, (12), (13), (37) and goods market clearing gives an implicit expression for n_{ht} :

$$Q^h(n_{ht}) = \frac{F(k_t, n_{1t}) - I_t^k - \sigma \theta I_t^k (1 - s_t) / (s_t + x_t)}{1 + \sigma(1 - s_t) / (s_t + x_t)} \quad (38)$$

We can define a *competitive equilibrium* as a sequence $\{d_{t+1}, k_{t+1}, n_{1t}, s_t\}$ satisfying (31), (32), (33) and (34) given (35), (36), (37), and (38). We now turn to the stochastic properties of the model and their implications for the behavior of business and household investment.

III. Cyclical Properties of the Model

This section considers three variants of the above model: (i) firm credit only -- the FC model, (ii) household credit only -- the HC model, and (iii) the general case with both household and firm credit -- the HFC model. This allows us to separate out the contribution of the household and business lending channels in explaining the cyclical effects of unanticipated monetary shocks.

The FC Model

The FC model closes down liquidity effects working through household credit and assumes that consumption goods are pure cash goods while durable purchases are pure credit goods (i.e., can be purchased without cash or credit services).⁵ In this special case, the imposed restrictions are that $c_t = g_{1t}$, $q_t^h = n_{ht} = 0$, and the worker-shopper portion of cash receipts (i.e., the first bracketed term in (10)) becomes $[M_t + S_t + R_t + W_t n_t - P_{gt}(g_{1t} + I_t^d)]$. The Euler condition for d_{t+1} in (31) becomes

$$\frac{P_{gt}}{1+x_t} E_t \left\{ \frac{u_c(c_{t+1}, d_{t+1})}{P_{g,t+1}} \right\} = E_t \left\{ u_d(c_{t+1}, d_{t+1}) + (1-\delta^d) \beta \frac{P_{g,t+1}}{1+x_{t+1}} \frac{u_c(c_{t+2}, d_{t+2})}{P_{g,t+2}} \right\} \quad (31')$$

An equilibrium is a sequence $\{d_{t+1}, k_{t+1}, n_{1t}, s_t, n_{ft}, R_t, p_{ft}, p_{gt}, c_t\}$ solving (31'), (32), (33), and (34) given p_{ft}/p_{gt} in (35), constraints (7) and (8), and the credit and goods market clearing condition.

The HC and HFC Model

The HC model with only a household lending channel is the limiting case of the general model where $\theta = 0$ so that the purchase of business capital does not require credit services. The model with household and firm credit, the HFC model, is the general model described in Section II.

Simulation Methodology and Results

The model is solved using a linear-quadratic approximation technique that linearizes Euler equations with a Taylor series approximation about the non-stochastic steady. The resulting system

⁵ This set-up is similar to the standard Lucas-Fuerst model, but important differences include the absence of the wage bill in the firm's credit constraint, the explicit treatment of costly credit services production, and, of course, the inclusion of durables.

of linear difference equations is then solved for decision rules that are linear in the model's state variables. The money growth rate in the model follows a stationary AR(1) process:

$$x_{t+1} = (1 - \rho)x^* + \rho x_t + \epsilon_{t+1}, \quad (37)$$

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 business cycle studies [e.g., Cooley and Hansen (1989)] and monetary models with consumer durables [Fuerst (1992b)] we set $\alpha = 0.36$, $\beta = 0.99$, and $\delta^* = 0.02 = \delta^d$. The value of $A = 0.388$ is chosen to give a steady state hours worked of about one third. We choose $\eta_h = \eta_f = 0.35$ consistent with estimates of the production function for credit services by Aiyagari and Eckstein (1994). The money supply process is set as $x^* = 0.012$ and $\rho = 0.32$ based on the benchmark parameterization of Christiano (1991) and Fuerst (1993).⁶ The parameter γ is set to 0.1 and v is chosen so that each model's steady state ratio of stock of durables to business capital is 1.13, an estimate indicated by Greenwood and Hercowitz (1991).

Parameters ϕ_f is chosen to give a steady state value added of the banking sector of 2.7% in FC and HFC [based on Diaz-Gimenez et. al. (1992)], ϕ_h is set so that the fraction of cash to credit goods purchased by households is 83% in HC and HFC [see Cooley and Hansen (1991)], $\theta = 1$ and 0 in FC and HC, respectively, and in HFC it is chosen so that the ratio of firm to total firm and consumer bank loans is 57%.⁷ Finally, since in equilibrium $\sigma = (s+x)/[q^h+q^f]$ is the ratio of the

⁶ The general model will also consider the more persistent money supply process with $\rho = 0.81$ consistent with both the 1959-69 and entire 1959-84 sample periods.

⁷ Source: *Federal Reserve Bulletin*, Feb. 1997, Table 1.26, Assets and Liabilities of Large Commercial Banks, Loans and Leases in Bank Credit, commercial and industrial; consumer.

quantity of cash deposited into the financial sector to credit services, a rough proxy for this parameter may be the ratio of aggregate reserves to either demand deposits or total consumer and business loans. With this, we set $\sigma = 0.10$.⁸

Each economy's stochastic equilibrium is analyzed for both the cash-in-advance (CIA) case, where s_t is chosen after the monetary shock is revealed, and the liquidity effect (LQ) case. Furthermore, the HC model also considers a "sluggish-capital" specification where k_{t+1} is chosen before the realization of x_t .⁹ In this case the expectations operator in equation (32) is conditional on period $t-1$ information. Impulse response plots are generated for a one time, one percent shock to the money growth rate x_t in period 5. With the exception of the nominal rate, the vertical axis of these diagrams denote percent deviations from steady state.

Figure 1 displays the simulation results for the FC model. The CIA case leads to the following expected results. Figure 1A shows the drop in non-durable consumption and subsequent rise which leads to an increase in consumption growth. This and the anticipated inflation effect places upward pressure on the nominal rate and the relative price of firm credit, as shown in 1C and 1D. Employment in the goods and credit producing sector and output falls. 1E indicates that household and business investment move in opposite directions. The increased cost of firm credit drives down business investment and, since durables are not constrained by the inflation tax, it rises in response to the monetary innovation.

⁸ Source: *Federal Reserve Bulletin*, Feb. 1997; the ratio of reserves to demand deposits is roughly 15% while the ratio of reserves to consumer and industrial loans is considerably smaller, around 4%.

⁹ The sluggish capital specification is used by Christiano and Eichenbaum (1995) to generate a dominant liquidity effect in the Lucas-Fuerst model.

The LQ case is able to generate a dominate liquidity effect, leading to a fall in the nominal rate and the relative price of credit. Figure 1F shows that the resultant surge in firm credit and business investment now coincides with an increase in household investment. However, employment in goods production and output continue to fall by roughly the same as in the CIA case, leading non-durable consumption to fall by a greater amount. Thus, although liquidity effects in the FC model is able to capture a positive co-movement between business and household investment, it is unable to explain the timing of these activities and has counterfactual implications for the model's other real variables.

Figure 2 indicates the impulse response plots for the HC model. The pure anticipated inflation effect in CIA increases the cost of household borrowing and the nominal rate, decreases non-durable consumption, labor supply to goods production, and output. Employment allocated to credit production actually rises as households shift away from cash goods and increase their demand for credit transactions. Business investment responds positively to the monetary shock since it can now be purchased without costly credit services. The decline in household investment mirrors that of non-durable consumption as credit becomes more costly. The negative correlation between the two investment (Figure 2I) and contemporaneous response to the shock are in contrast to both stylized facts.

A liquidity effect in the HC model, which dominates given our parameterization, is able to remedy many of these counterfactual implications. In particular, as the unanticipated shock lowers the nominal rate, credit producers respond by expanding the availability of credit services to households. This leads to a surge in both non-durable consumption and household investment in the period of the shock. Employment in credit production rises and the ability to circumvent the cash

constraint provided by the supply of additional credit services leads to an increase in overall work effort and employment in goods production as well. However, as shown in Figure 2J, business investment falls in the period of the shock and rises afterwards. Similar to Fuerst (1992b) cash injections to the household sector reallocates the economy's investment resources towards accumulating consumer durables at the expense of "crowding-out" business capital. The liquidity effect has lowered the relative cost of investing in household capital to business capital. While household investment is procyclical, it is negatively correlated with business investment.

One possible way to reconcile this counterfactual prediction is to assume that business investment decisions must be made in advance and cannot respond to current monetary innovations. Impulse responses for the SC model are also given in Figure 2. Again the liquidity effect dominates and is even more pronounced than in LQ — nominal rates fall in the period of the shock, employment in both sectors rises, and both non-durable consumption and household investment respond positively to the monetary shock. Figure 2K compares the cyclical behavior of business and household investment. Notice that because, by assumption, business investment does not change in the period of the shock, the sharp decline in durable investment in the following period leads to a delayed boom in business investment, giving us the desired lead-lag relationship between the two investments.

This exercise demonstrates that if significant planning and commitment of resources is an important feature of business investment, then both stylized facts can be explained. While this feature may be important when distinguishing the purchase of consumer durables (such as a television set or washing machine) to that of constructing a new factory, it is not immediate why the timing of decisions should be different for residential investment and fixed business investment.

Thus, sluggish business capital cannot be the only explanation for these facts.

Our general model combining both consumer and business borrowing (HFC) offers an alternative explanation. Recall that by treating durables as a “costless” credit good, liquidity effects in FC were able to capture a positive and co-incident relationship between household and business investment. However, the absence of a household lending channel led to a decline in non durable consumption and overall economic activity. By introducing household credit and closing down the business lending channel, HC/LQ improves on this latter dimension, but business and household investment are co-incident and negatively correlated. This suggests that an operative business and household lending channel may be able to resolve these inconsistencies.

The HFC impulse response plots for both CIA and LQ are contained in Figure 3. The CIA case yields no surprises and the results are as expected. However, LQ looks remarkably similar to the SC model — there is a dominant liquidity effect, non-durable consumption rises, and household and business investment are procyclical with business capital lagging durables. The important difference is that since business investment is free to change in response to monetary shocks it is now “optimally” sluggish, rising slightly in the period of the shock and continuing to rise afterwards.

Intuitively, this result is driven by two opposing effects on the response of business investment. As in the HC model the expansion of household credit services leads to a crowding-out of business capital. However, as the liquidity effect also expands credit services to goods producing firms, the costs of purchasing productive capital goods falls and business investment rises. Thus, if the relative liquidity effect on household credit slightly dominates that on business investment in the period of the shock, then both stylized facts can be captured without ex-ante restrictions on the timing of business investment.

To test the robustness of these results in the SC and HFC models, we also consider a more persistent money supply process given by $\rho = 0.81$ (Figures 2L and 3M). While the liquidity effect is diminished, it still dominates; and the lead-lag relationship between the two investment becomes more dramatic as the volatility of business investment relative to household investment rises. Also, since the timing of investment expenditures depends on the relative size of the liquidity effect on households and firms, it is also sensitive to factors which alter the steady state fraction of household cash to credit goods and firm to household credit services. In particular, choosing parameters that lower the fraction of goods households purchase with cash tends to weaken the liquidity effect on households (since the marginal value of an extra credit good is diminished). To retain the relative liquidity effect between households and firms that is able to explain the timing of their corresponding investments requires offsetting parameter values which reduce the fraction of credit services allocated to firms, and hence the size of the liquidity effect on firms.¹⁰ While we cannot rule out reasonable parameter values that do not deliver these stylized facts, the parameter values necessary to explain this empirical regularity in the context of our model do fall into a range that is plausible.

IV. Conclusion

This paper has investigated the role of household credit in providing a monetary explanation for the observation that business and household investment are positively correlated and procyclical

¹⁰ For example, if we lowered steady state $g_1/(g_1 + g_2)$ to 50% [the less conservative value also considered by Cooley and Hansen (1991)], then a steady state value of $q^f/(q^f + q^h)$ must be in the neighborhood of around 34 percent to deliver the lagging business investment feature. This value is also plausible using the fraction of firm credit to total bank loans as given in the *FRB Bulletin*.

and that the former tends to lag the latter. Monetary injections which flow asymmetrically towards the financial sector positively influences both household borrowing and firm credit services used by businesses seeking to finance investment projects. We verified the possibility that if the size of these liquidity effects on the business and household sector are in an appropriate range then it is possible to explain these empirical regularities without exogenous restrictions regarding the timing of these investment decisions. Furthermore, delivering these stylized facts in such a manner and permitting households to finance both non-durable and durable goods with credit reconciled another problematic prediction with traditional liquidity effect models — it is able to capture that non-durable consumption also responds positively to monetary injections. While we provided a specific mechanism to explain these facts, this paper suggests the importance of an explicit treatment of household and business credit markets when attempting to account for differences in the pattern of their corresponding investment expenditures.

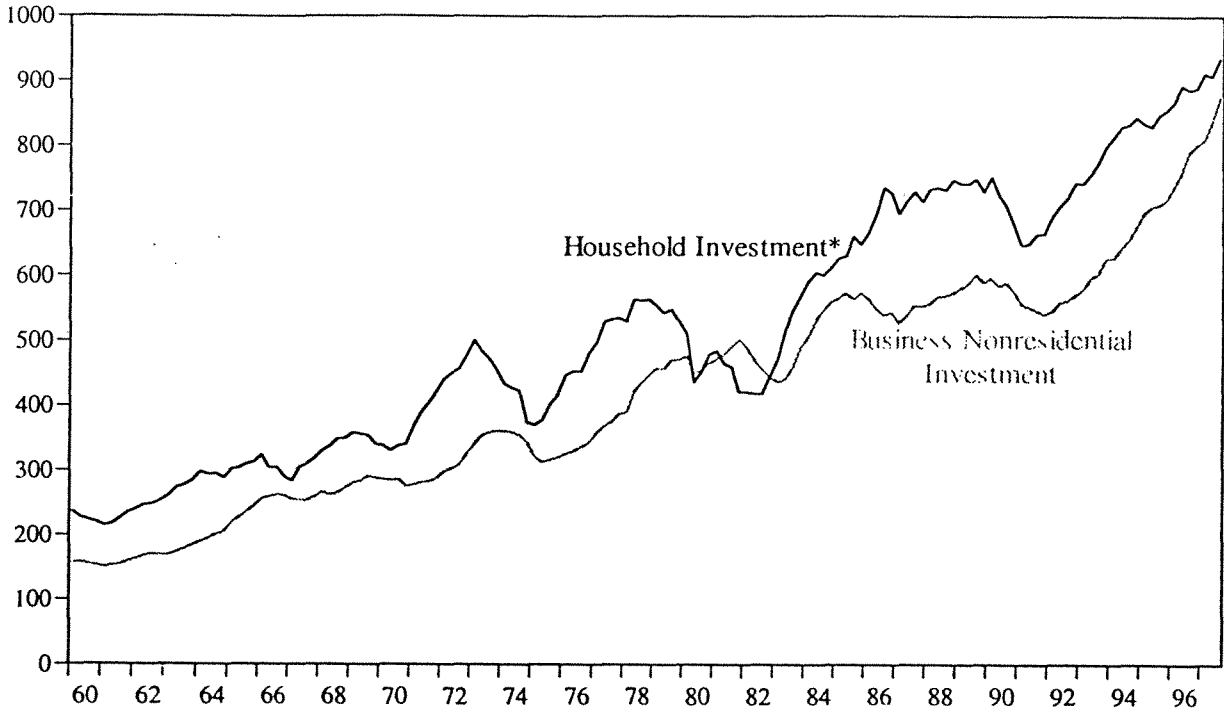
REFERENCES

- Aiyagari, S. Rao and Zvi Eckstein (1994). "Interpreting Monetary Stabilization in a Growth Model with Credit Goods Production." Working Paper 525, Federal Reserve Bank of Minneapolis.
- Benhabib, Jess; Rogerson, Richard; and Randall Wright (1991). "Homework in Macroeconomics: Household Production and Aggregate Fluctuations." *Journal of Political Economy* 99: 1166-87.
- Bernanke, Ben and Mark Gertler (1995). "Inside the Black Box: The Credit Channel of Monetary Policy Transmission." *Journal of Economic Perspectives* 9: 27-48.
- Christiano, Lawrence J. (1991). "Modeling the Liquidity Effect of a Money Shock." *Federal Reserve Bank of Minneapolis Quarterly Review*, Winter.
- Christiano, Lawrence J. and Martin Eichenbaum (1995). "Liquidity Effects, Monetary Policy, and the Business Cycle." *Journal of Money, Credit, and Banking* 27.
- Christiano, Lawrence J. and Richard M. Todd (1996). "Time to Plan and Aggregate Fluctuations." *Federal Reserve Bank of Minneapolis Quarterly Review*, Winter.
- Cooley, Thomas F. and Gary D. Hansen (1989). "The Inflation Tax in a Real Business Cycle Model." *American Economic Review* 79: 733-48.
- Diaz-Gimenez, Javier, Edward Prescott, Terry Fitzgerald, and Fernando Alvarez (1992). "Banking in Computable General Equilibrium Economies." *Journal of Economic Dynamics and Control* 16: 533-559.
- Cooley, Thomas F. and Gary D. Hansen (1991). "The Welfare Cost of Moderate Inflation." *Journal of Money, Credit, and Banking* 23: 483-503.

- Fisher, Jonas (1994). "Relative Prices, Complementarities, and Co-Movement Among Components of Aggregate Expenditures." Working Paper, University of Western Ontario.
- Fuerst, Timothy S. (1992a). "Liquidity, Loadable Funds, and Real Activity." *Journal of Monetary Economics* 29: 3-24.
- Fuerst, Timothy S. (1992b). "Household Investment and the Compositional Effects of Monetary Injections." Working Paper, Northwestern University.
- Fuerst, Timothy S. (1993). "Liquidity Effect Models and their Implications for Monetary Policy." Working Paper.
- Greenwood, Jeremy and Zvi Hercowitz (1991). "The Allocation of Capital and Time Over the Business Cycle. *Journal of Political Economy* 99: 1188-1214.
- Kydland, Finn E. and Edward Prescott (1990). "Business Cycles: Real Facts and a Monetary Myth" *Federal Reserve Bank of Minneapolis Quarterly Review*, Spring.
- Li, Victor E. (1996). "Household Credit and the Monetary Transmission Mechanism." Working Paper, Penn State University.
- Lucas, Robert E. Jr. (1990). Liquidity and Interest Rates." *Journal of Economic Theory* 50: 237-64.
- Lucas, Robert E. Jr. and Nancy L. Stokey (1987). "Money and Interest in a Cash-in-Advance Economy." *Econometrica* 55: 491-513.

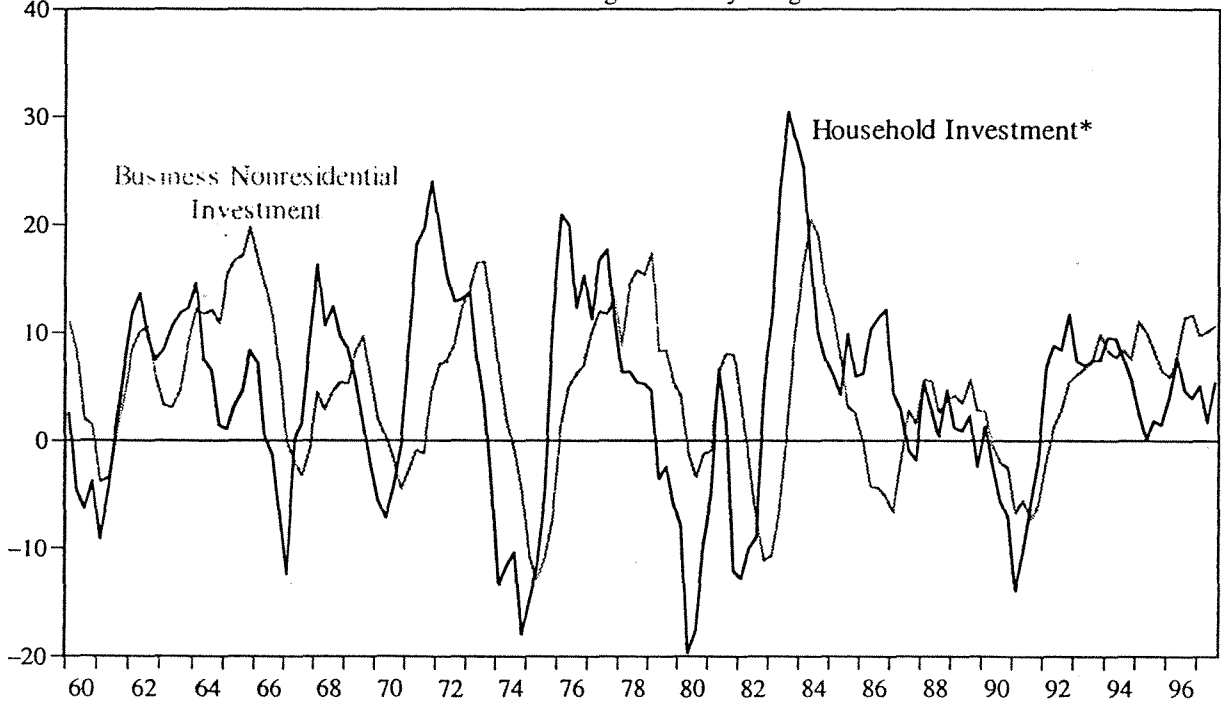
Chart 1: Business and Household Investment*

Billions of chained (1992) dollars



Percent

Percent change from one year ago



*Quarterly U.S. data, 1960:1 - 1996:4. Household investment is defined as investment in consumer durables and residential structures.

Figure 1A: Non-Durable Consumption - FC

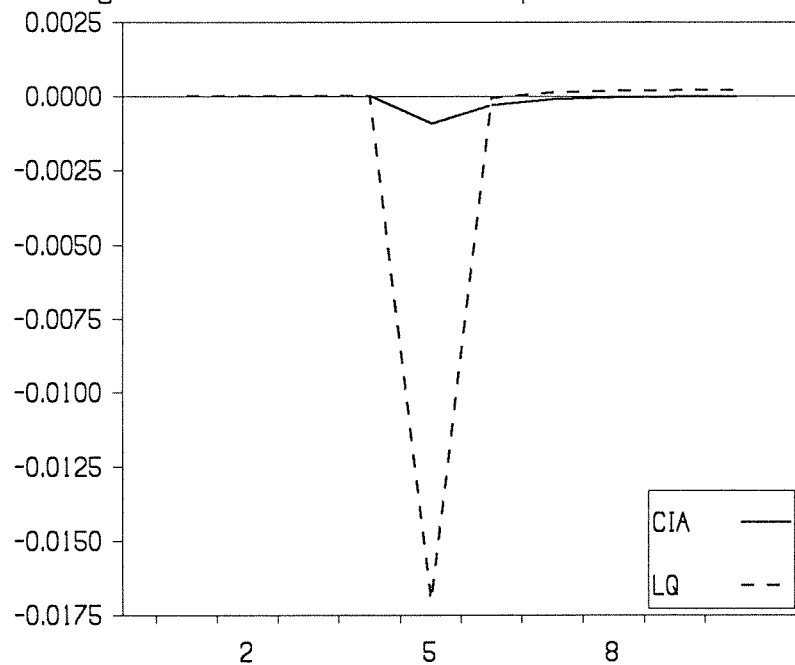


Figure 1B: Output - FC

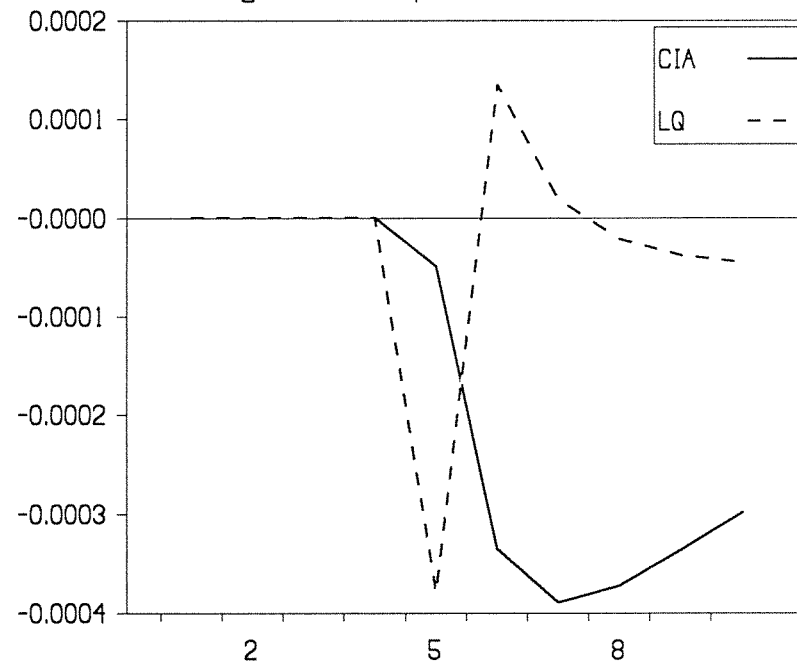


Figure 1C: Nominal Interest Rate - FC

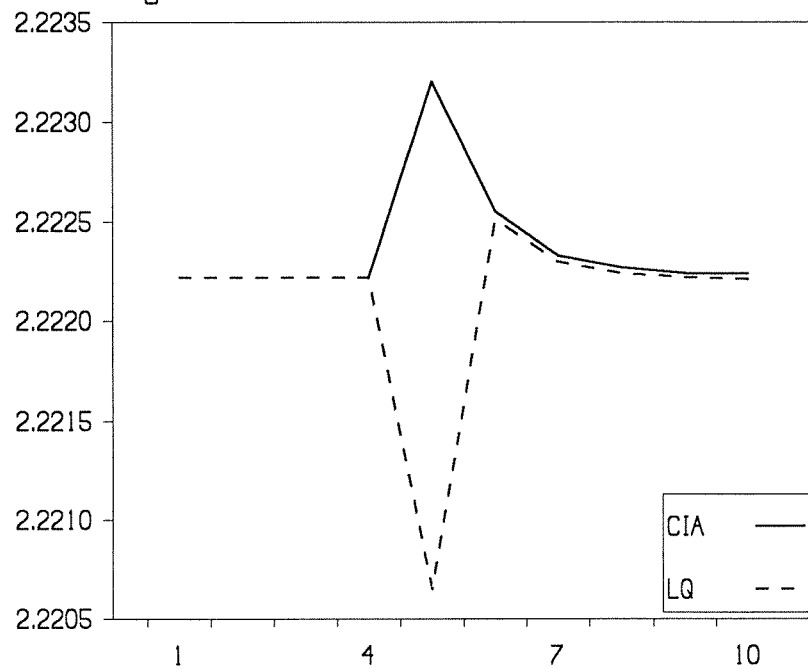


Figure 1D: Rel. Price of Firm Credit - FC

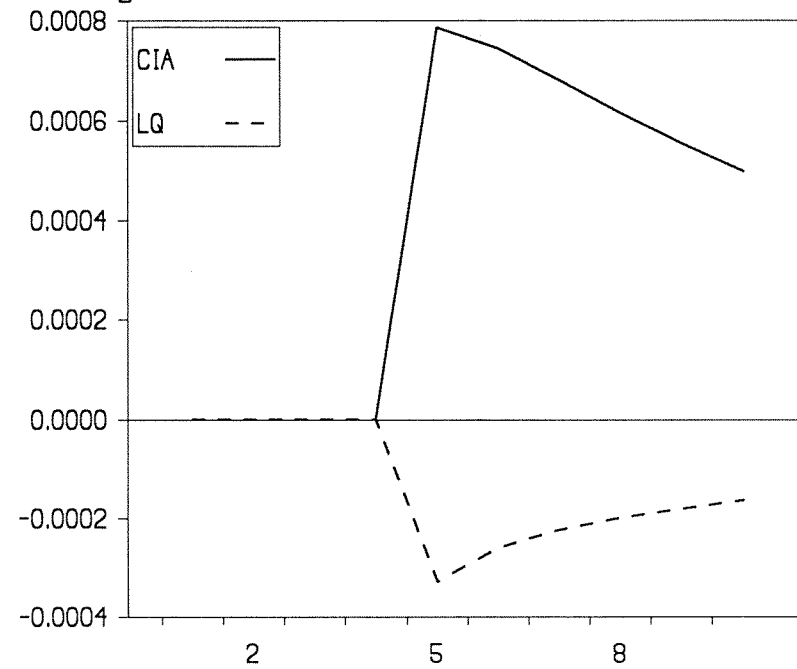


Figure 1E: Business and Household Investment -- FC/CIA

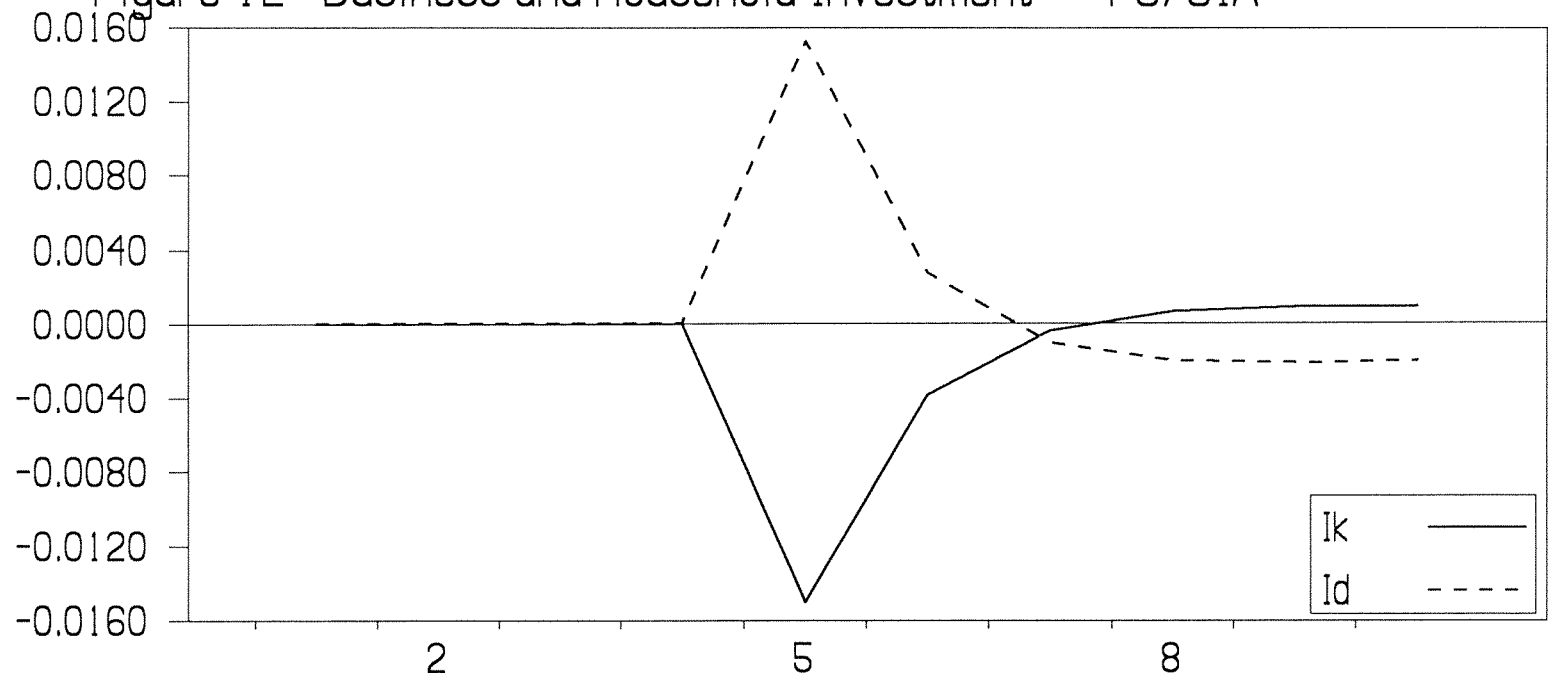


Figure 1F: Business and Household Investment -- FC/LQ

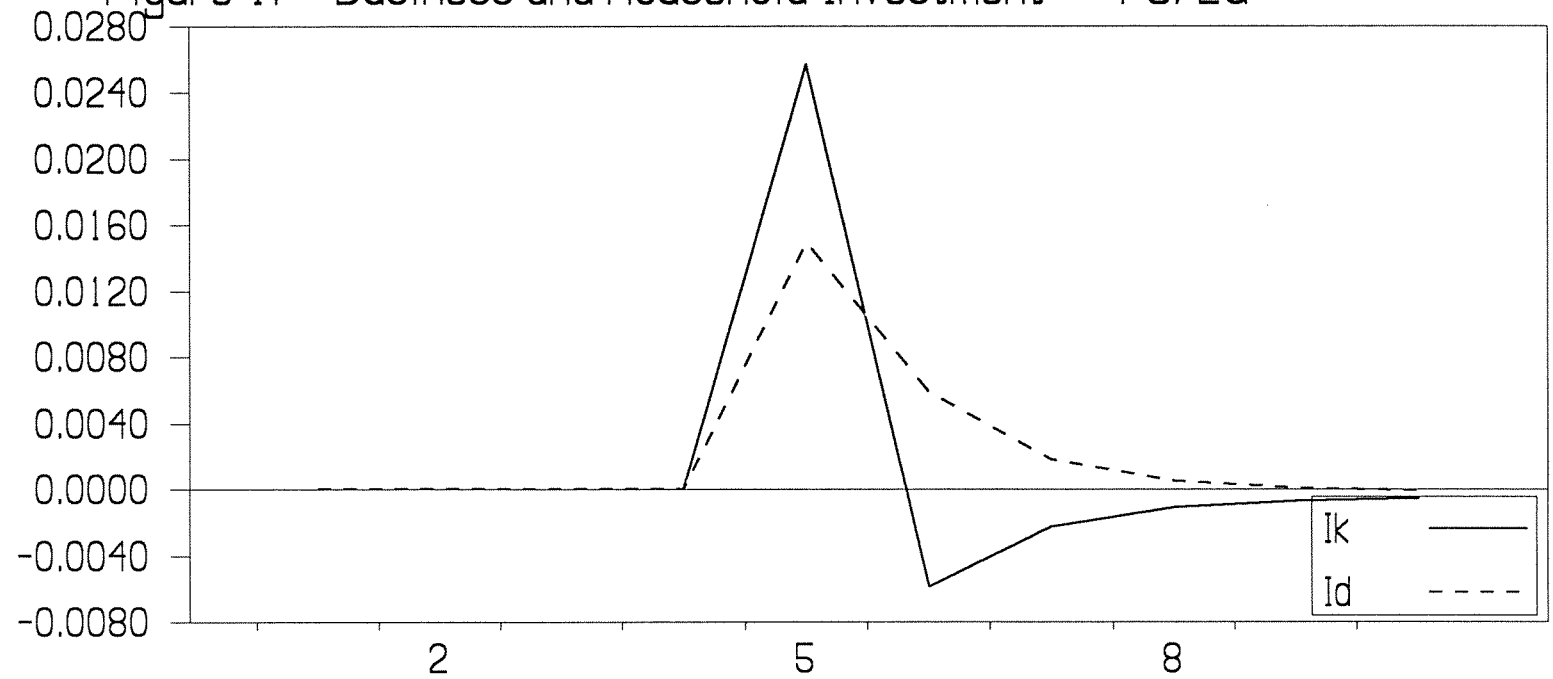


Figure 2A: Non-Durable Consumption - HC

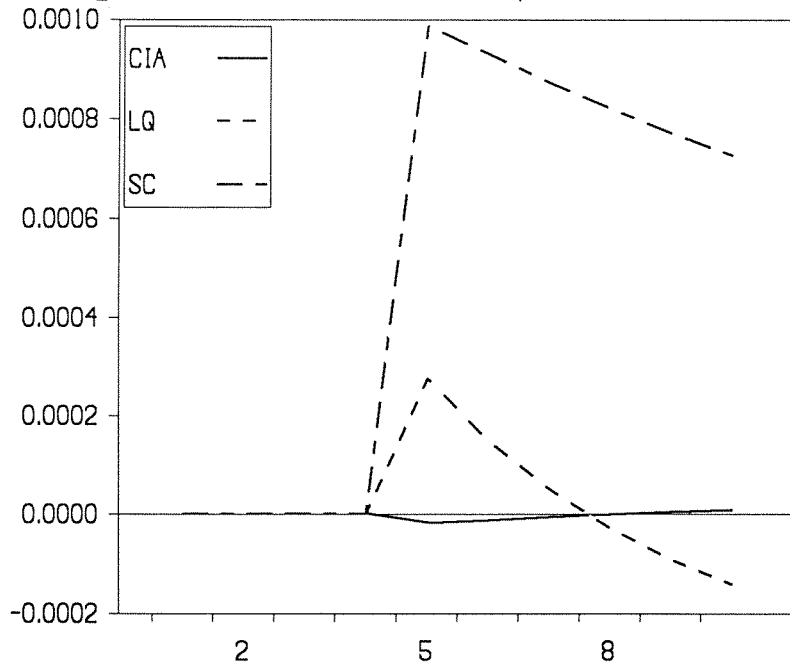


Figure 2B: Cash Goods - HC

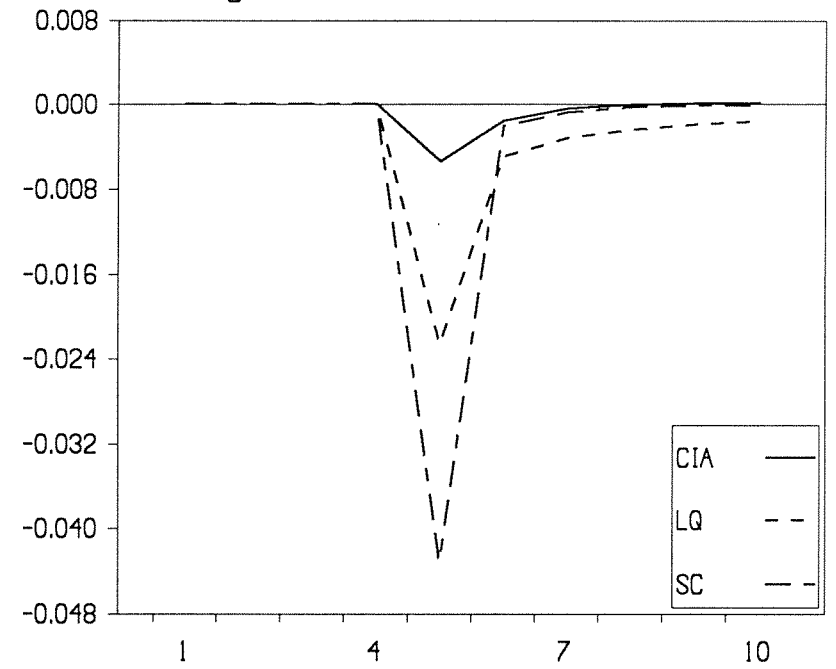


Figure 2C: Employment In Goods Production - HC

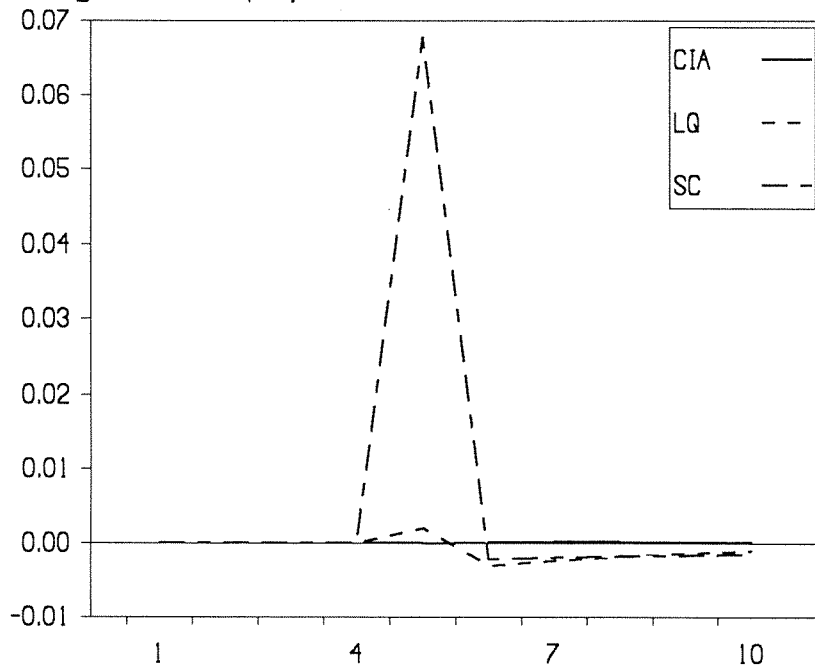


Figure 2D: Credit Goods - HC

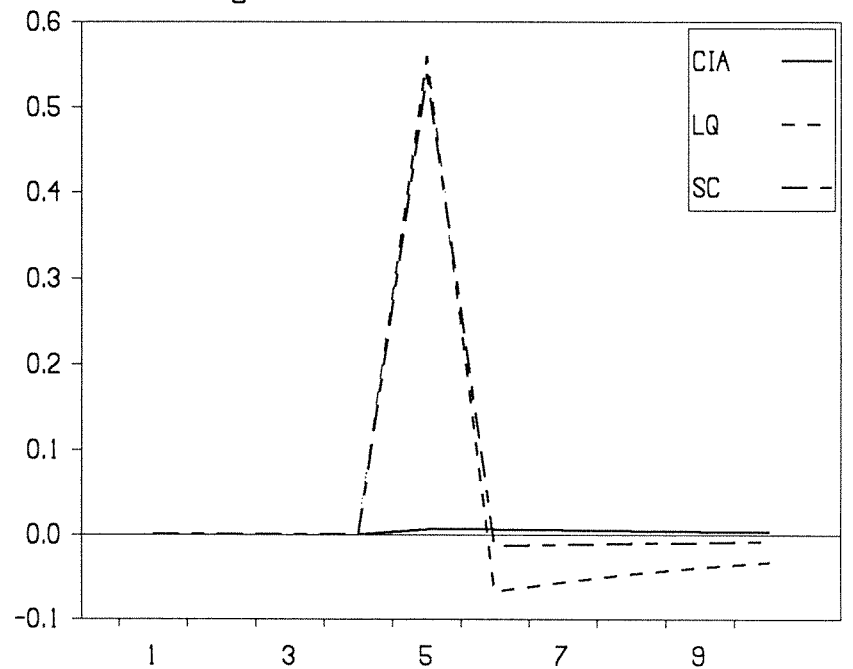


Figure 2E: Output - HC

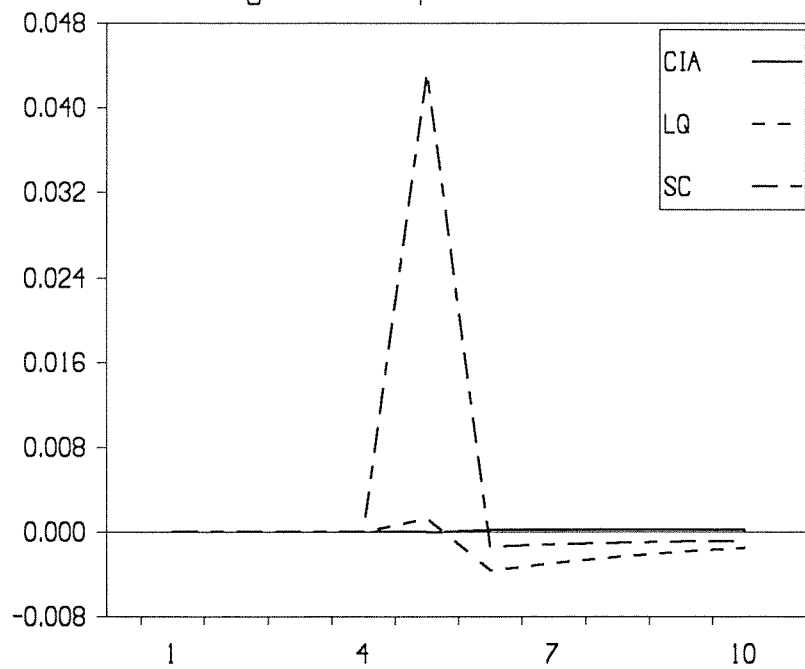


Figure 2F: Goods Price - HC

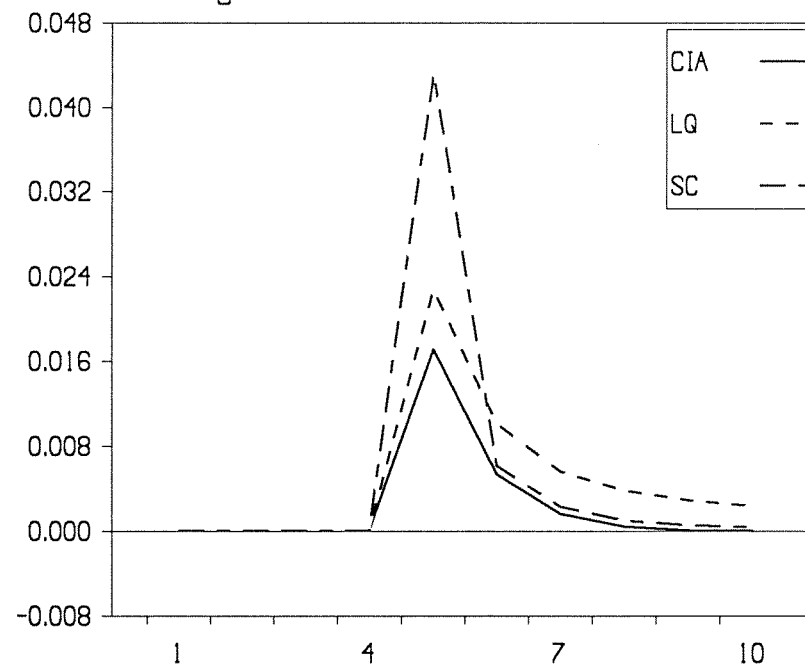


Figure 2G: Nominal Interest Rate - HC

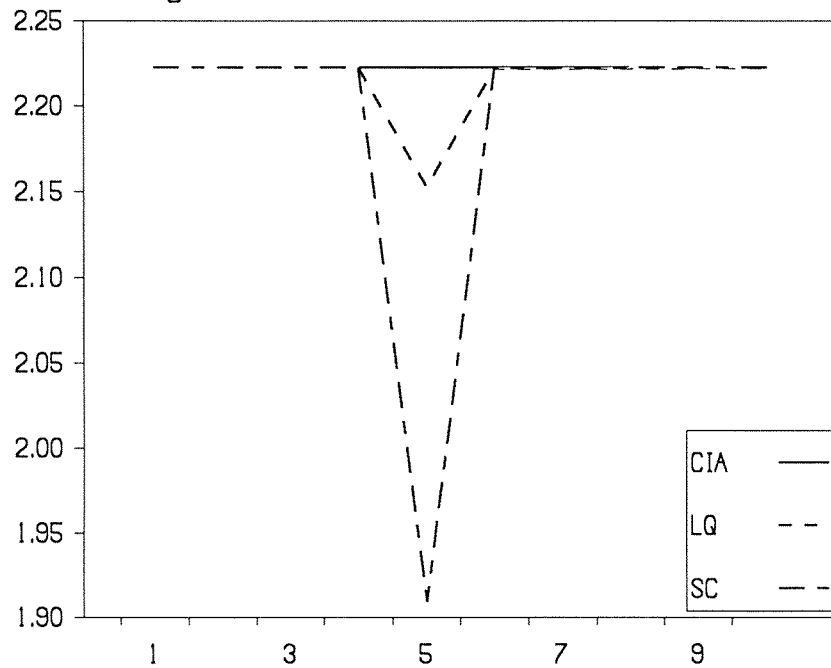


Figure 2H: Rel. Price of Household Credit - HC

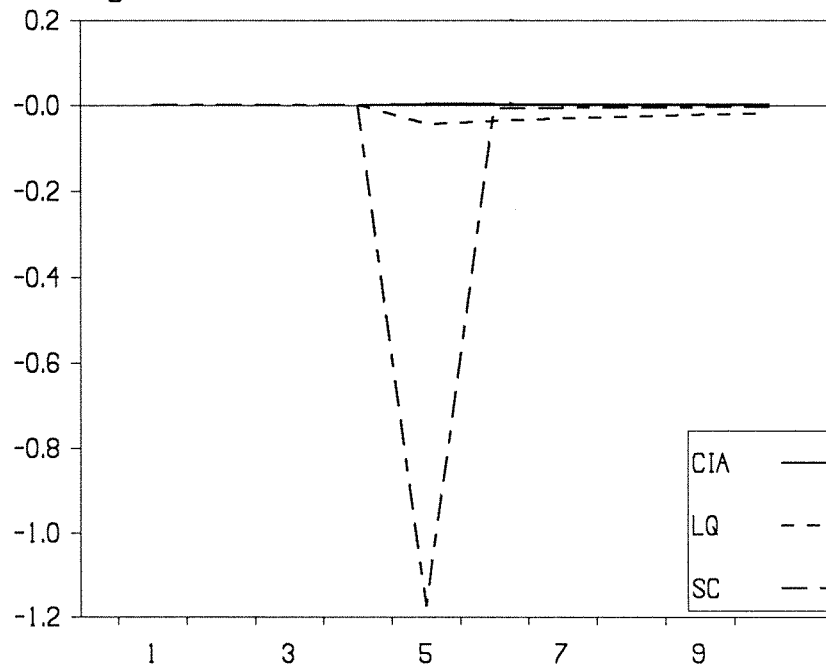


Figure 2I: Business and Household Investment -- HC/CIA

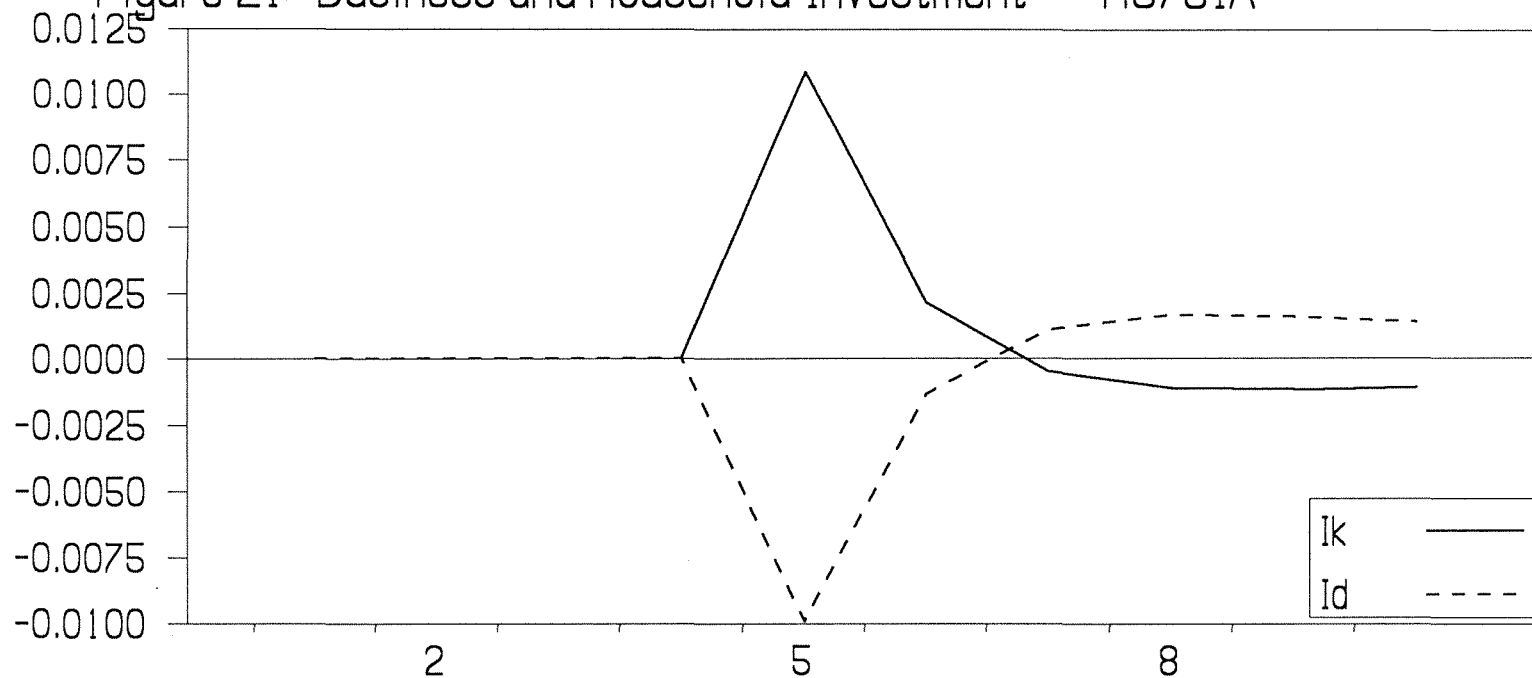


Figure 2J: Business and Household Investment -- HC/LQ

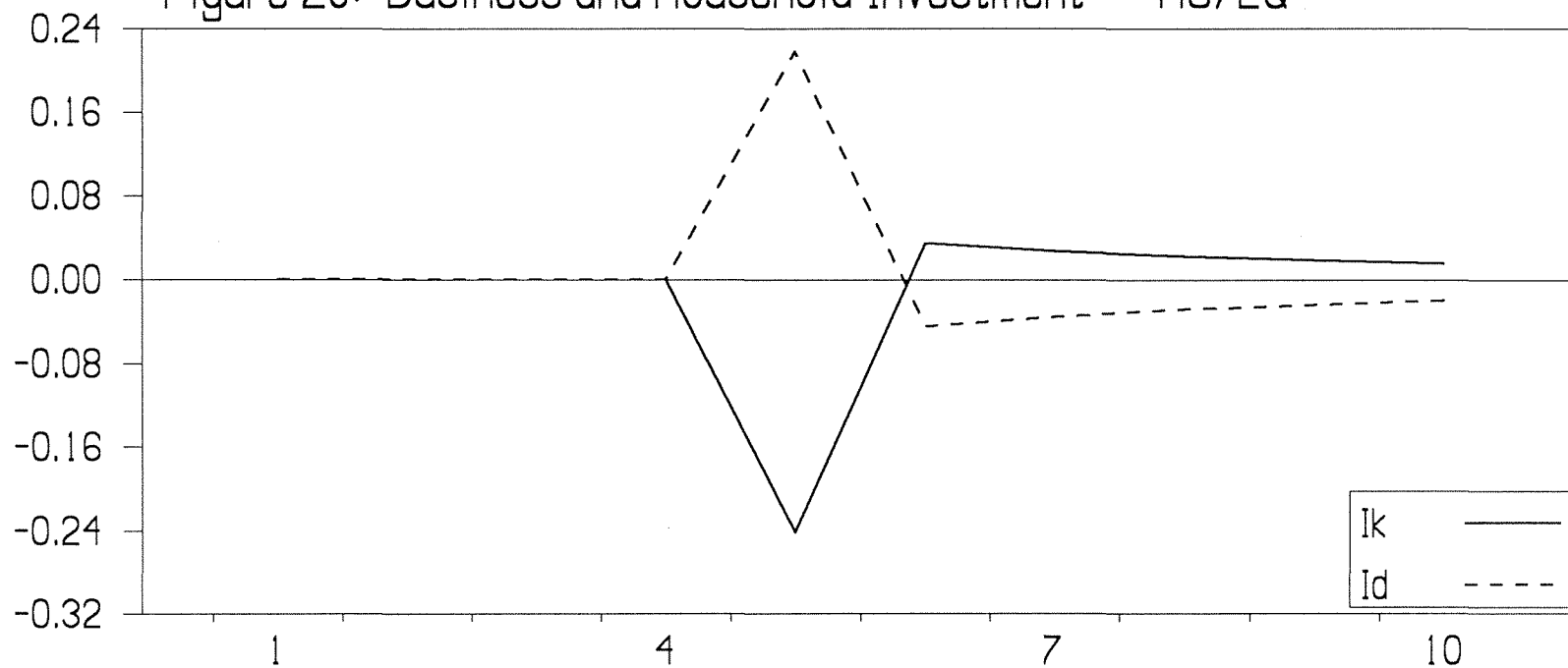


Figure 2K: Business and Household Investment -- HC/SC ($\rho = 0.32$)

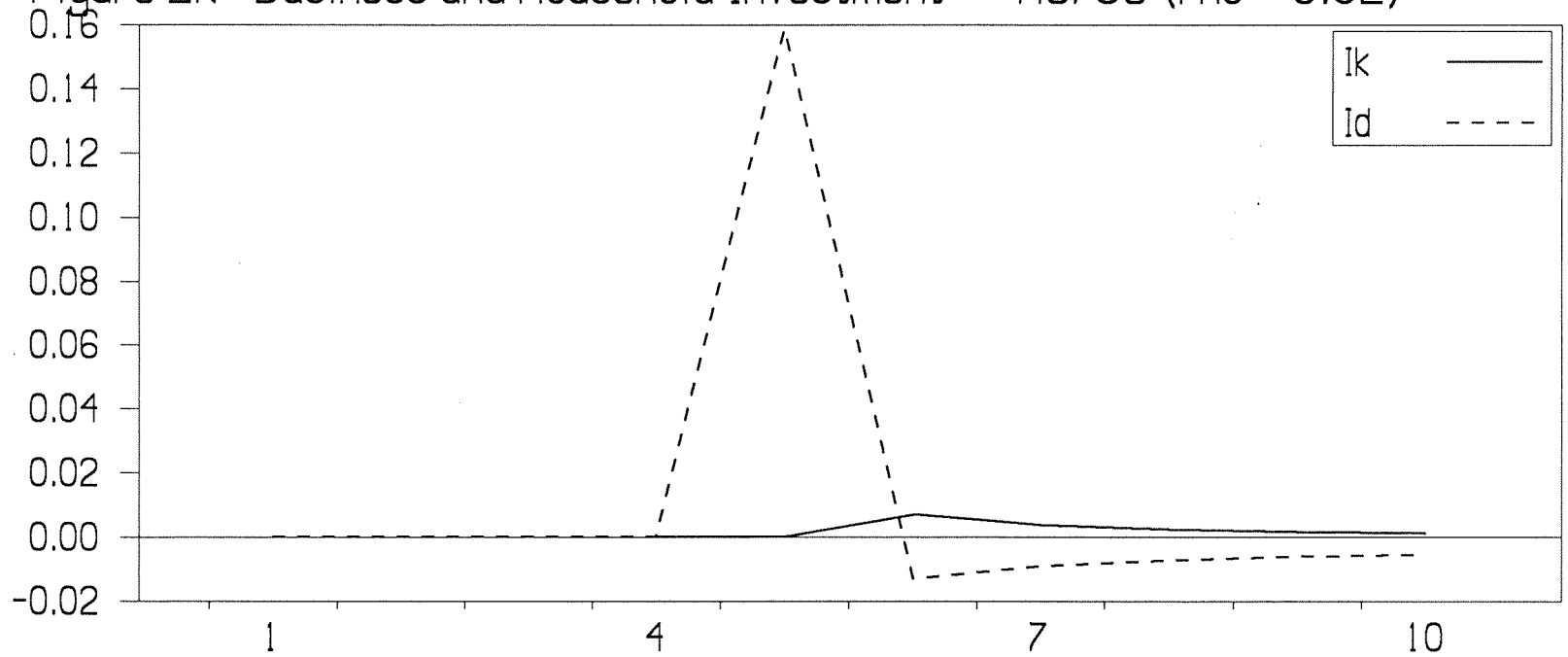


Figure 2L: Business and Household Investment -- HC/SC ($\rho = 0.81$)

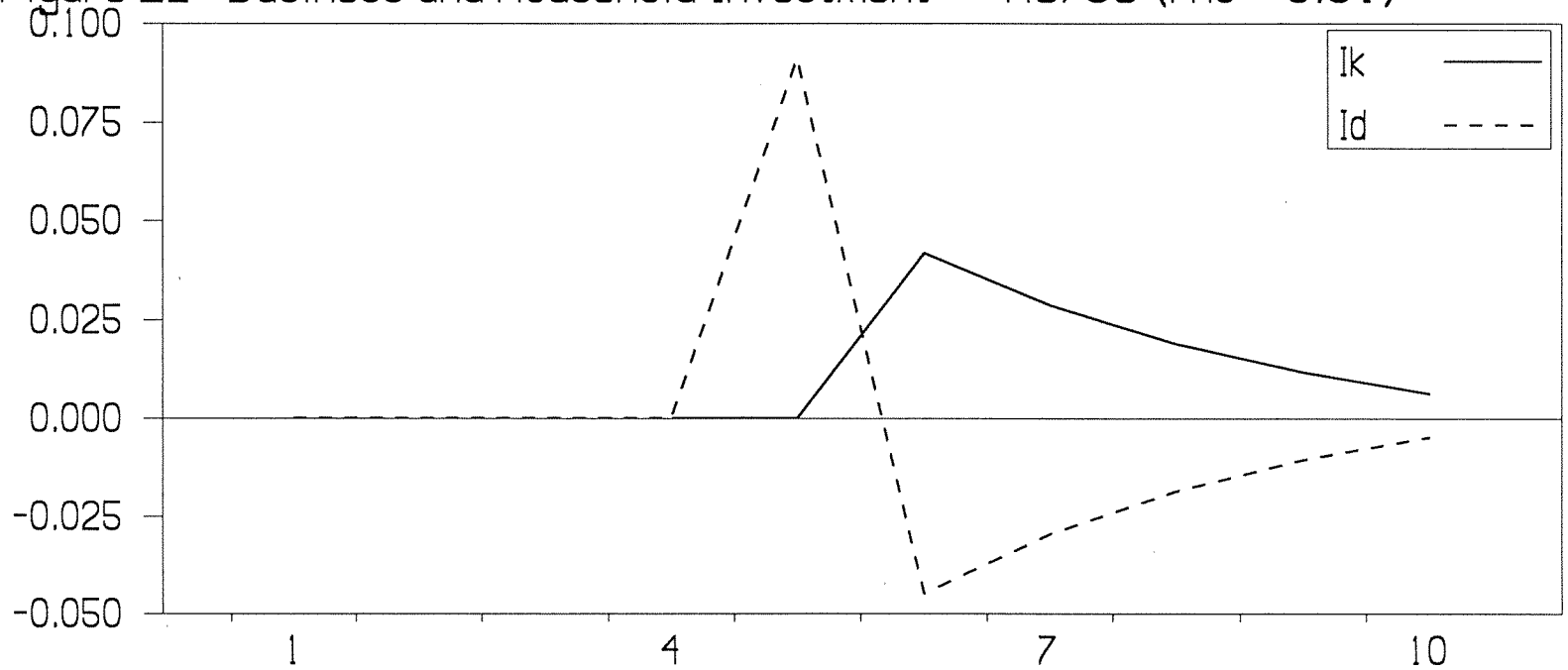


Figure 3A: Non-Durable Consumption - HFC

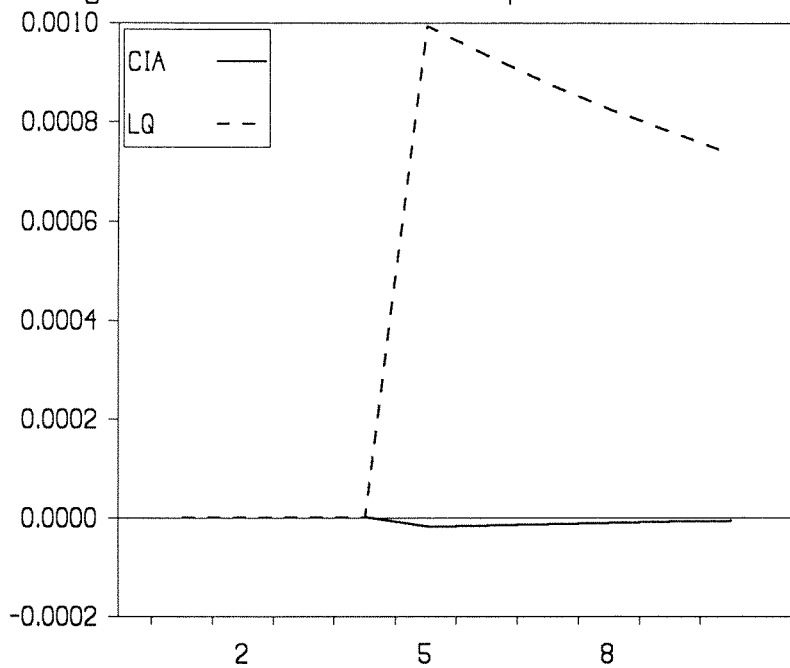


Figure 3B: Cash Goods - HFC

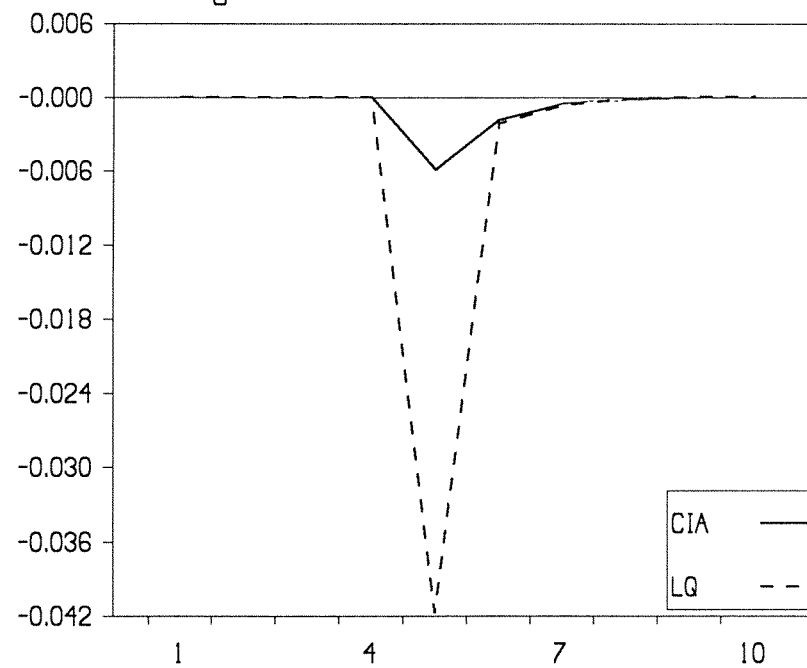


Figure 3C: Employment in Goods Production - HFC

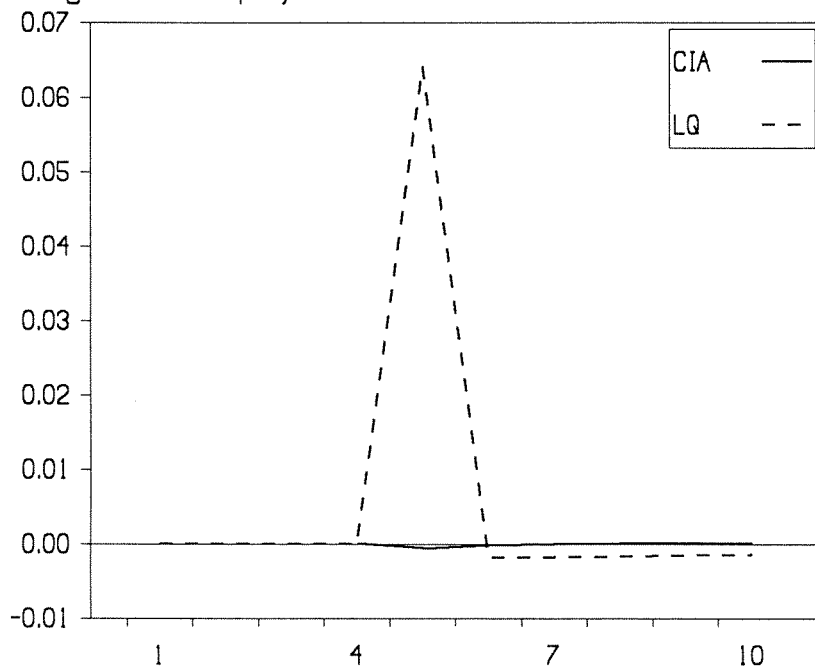


Figure 3D: Credit Goods - HFC

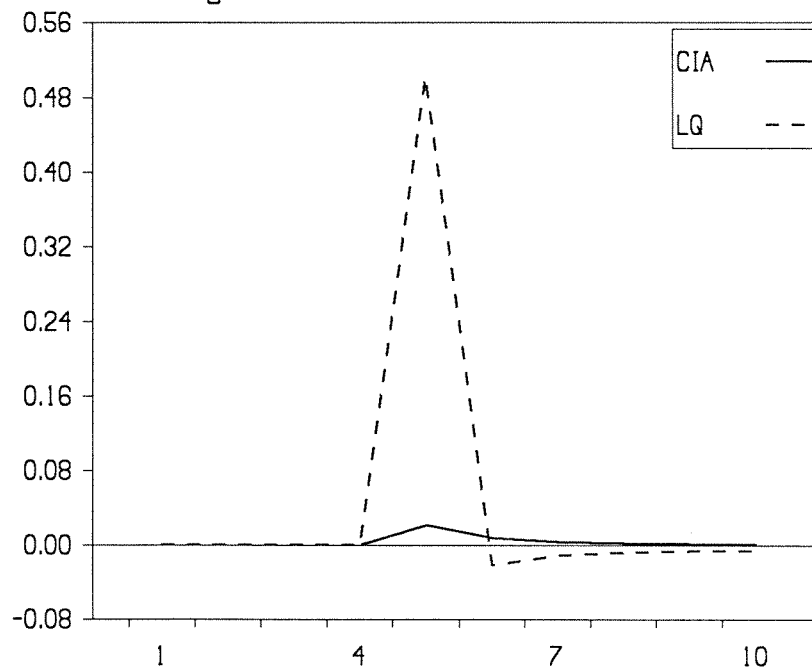


Figure 3E: Firm Credit Services - HFC

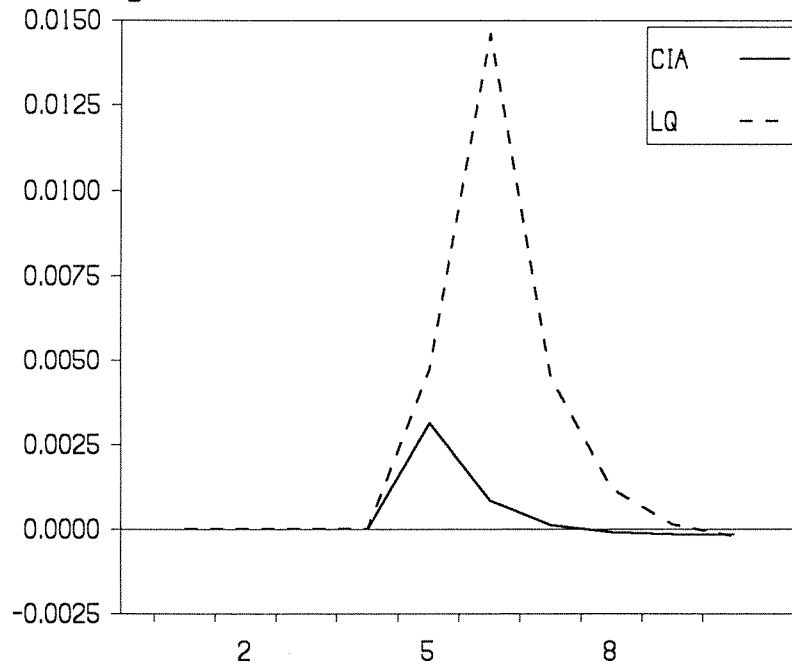


Figure 3F: Output - HFC

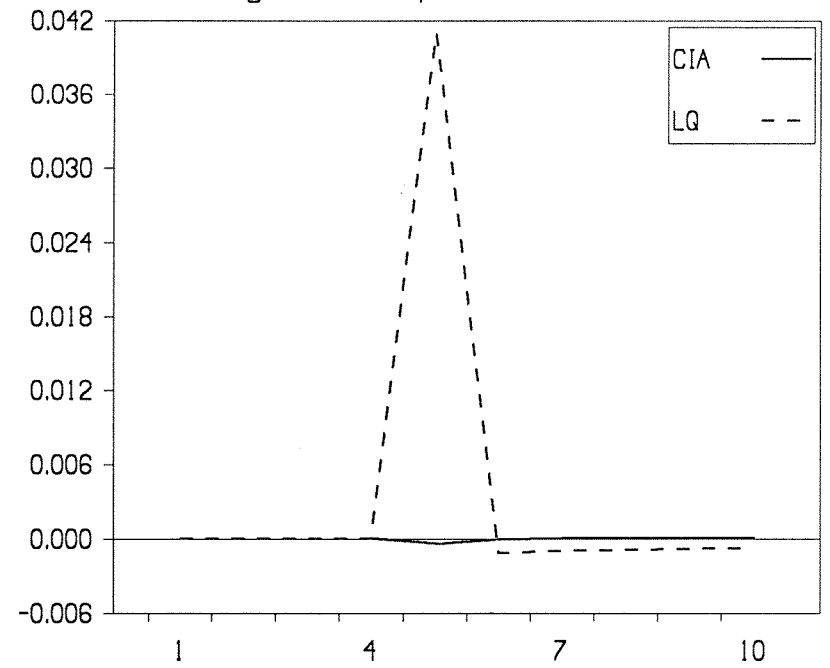


Figure 3G: Nominal Interest Rate - HFC

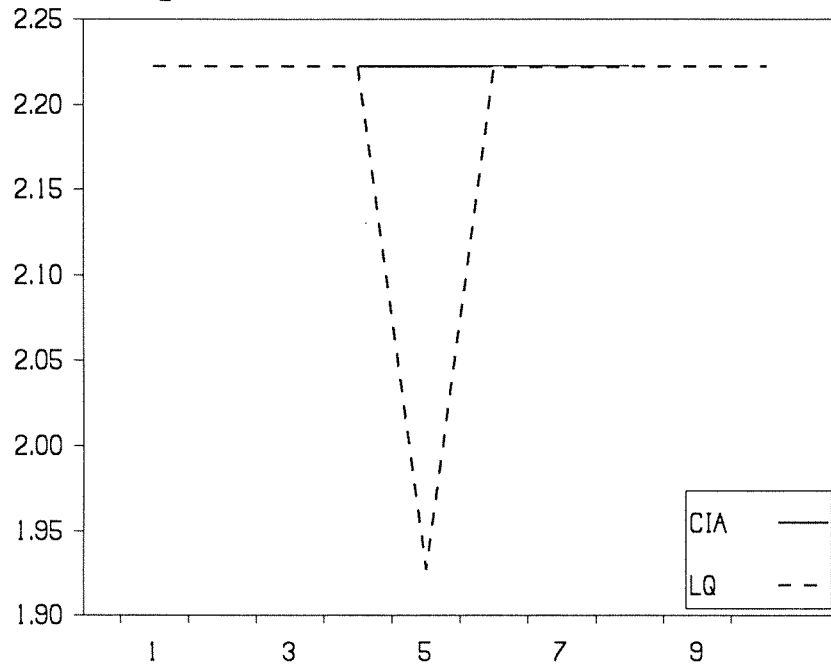


Figure 3H: Goods Price - HFC

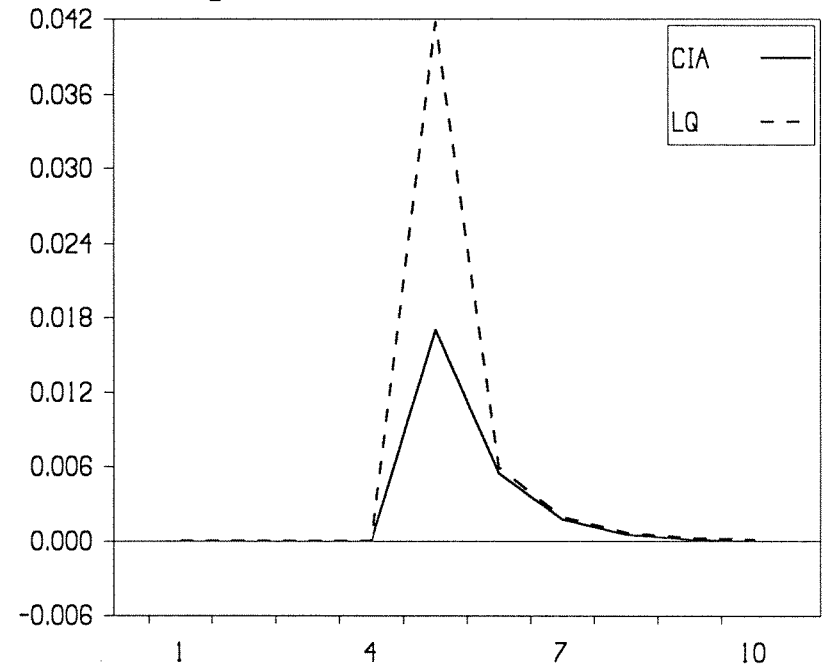


Figure 3I: Rel. Price of Household Credit - HFC

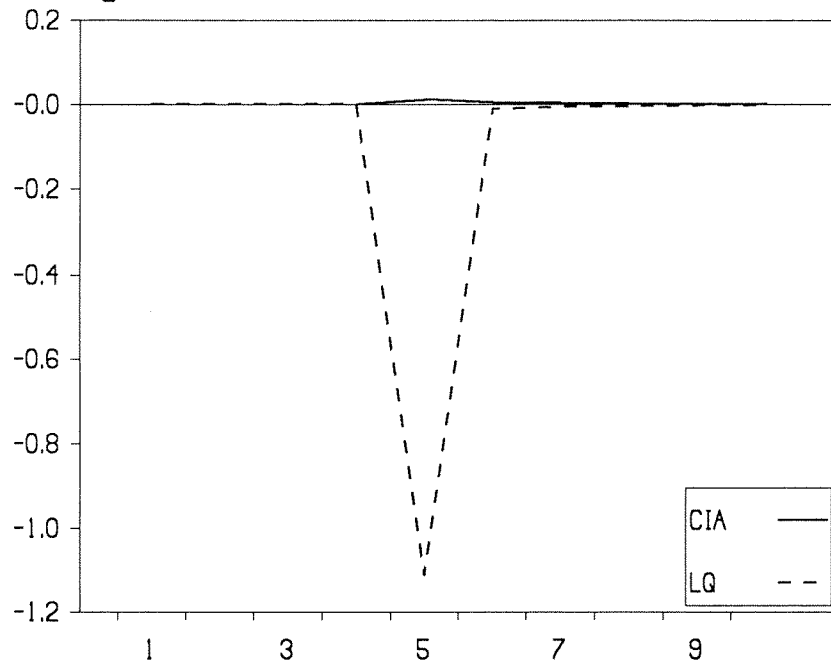


Figure 3K: Business and Household Investment -- HFC/CIA

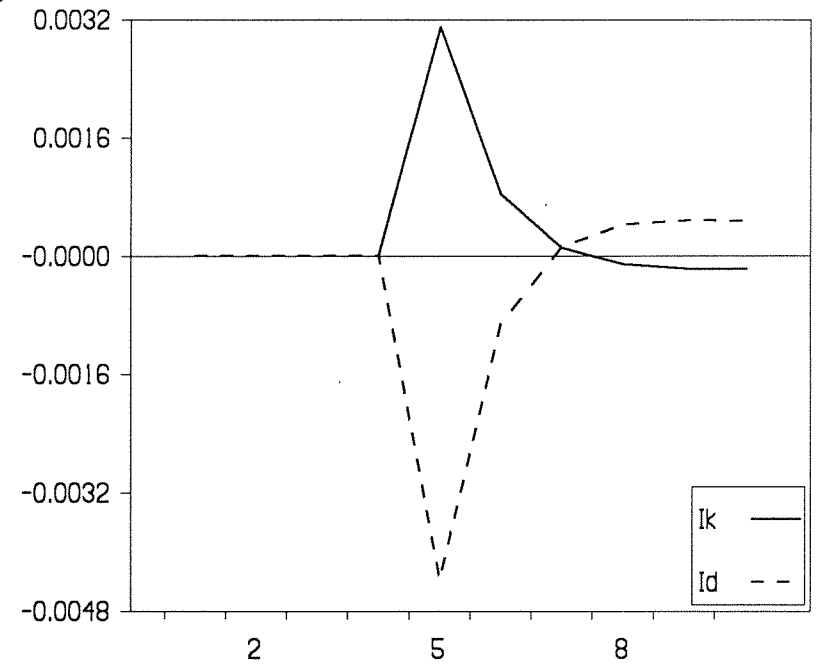


Figure 3J: Rel. Price of Firm Credit - HFC

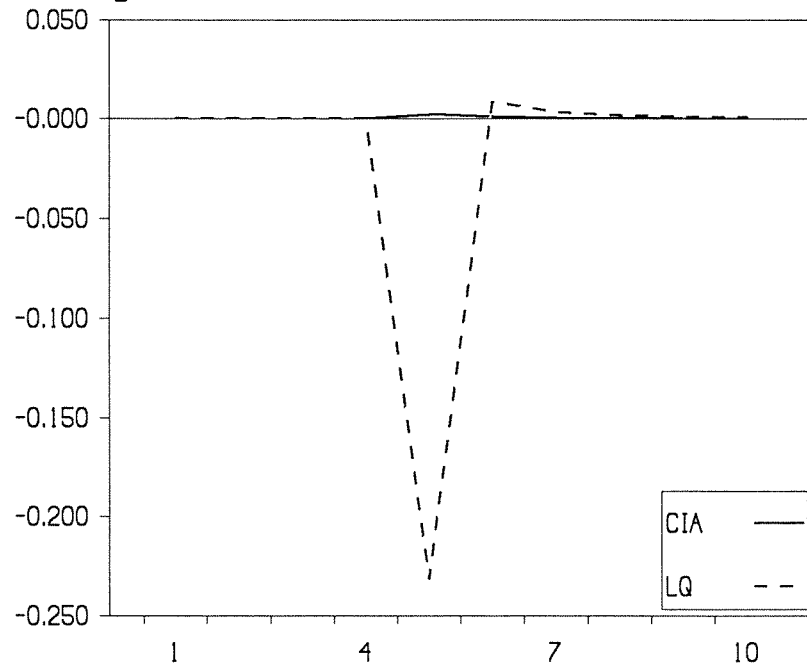


Figure 3L: Business and Household Investment -- HFC/LQ ($\rho = 0.32$)

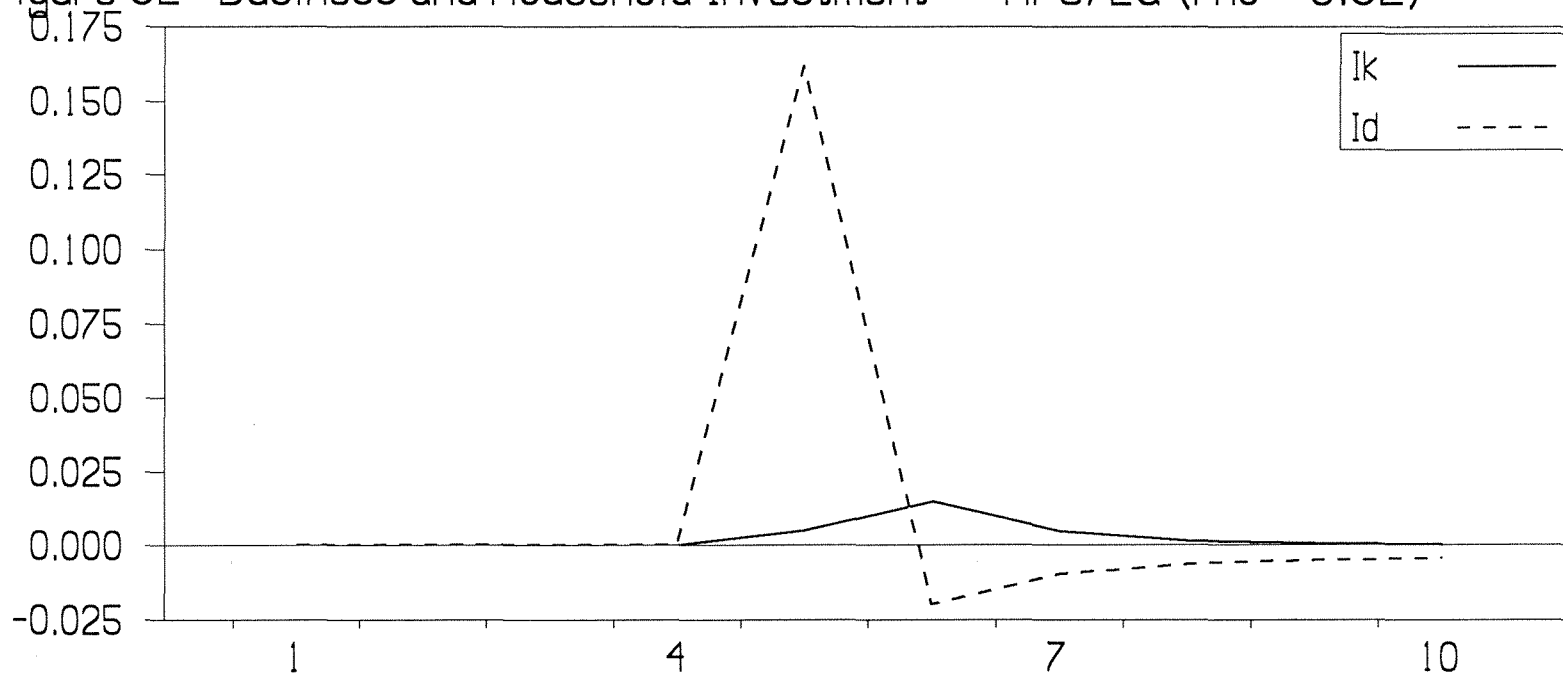


Figure 3M: Business and Household Investment -- HFC/LQ ($\rho = 0.81$)

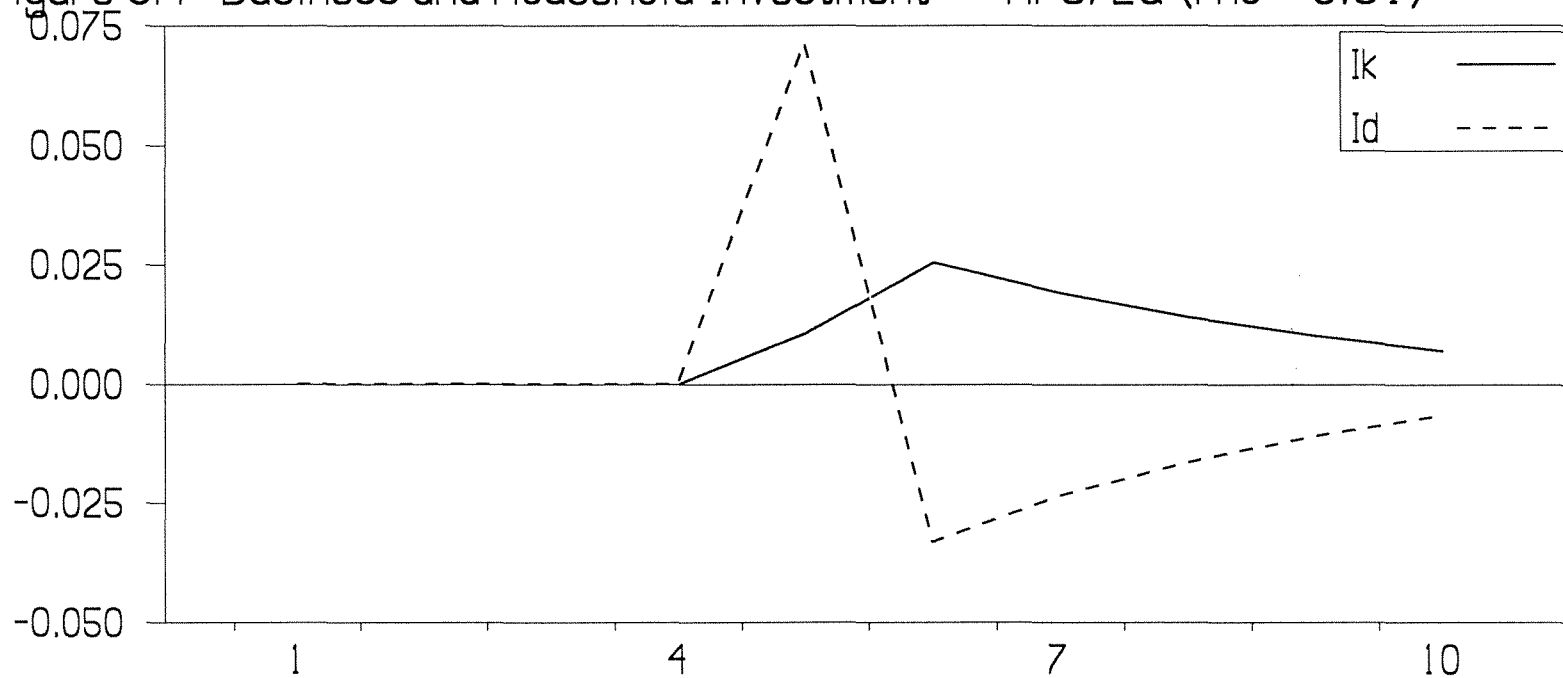


Figure 3A: Non-Durable Consumption - HFC

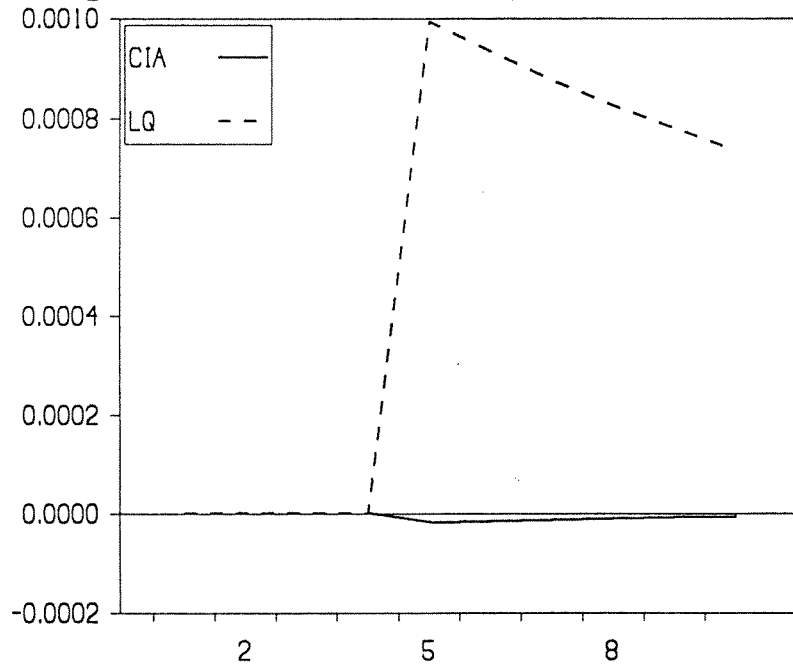


Figure 3B: Cash Goods - HFC

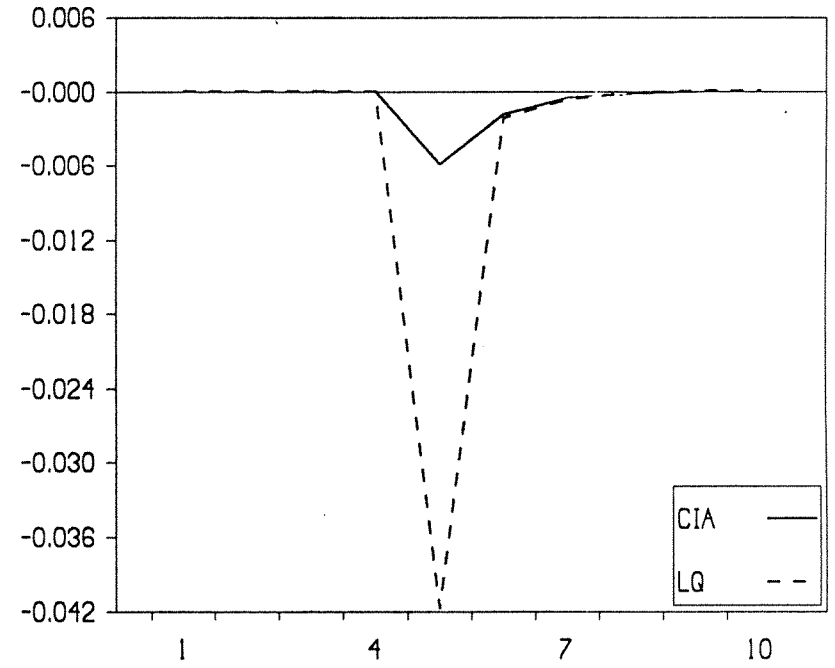


Figure 3C: Employment in Goods Production - HFC

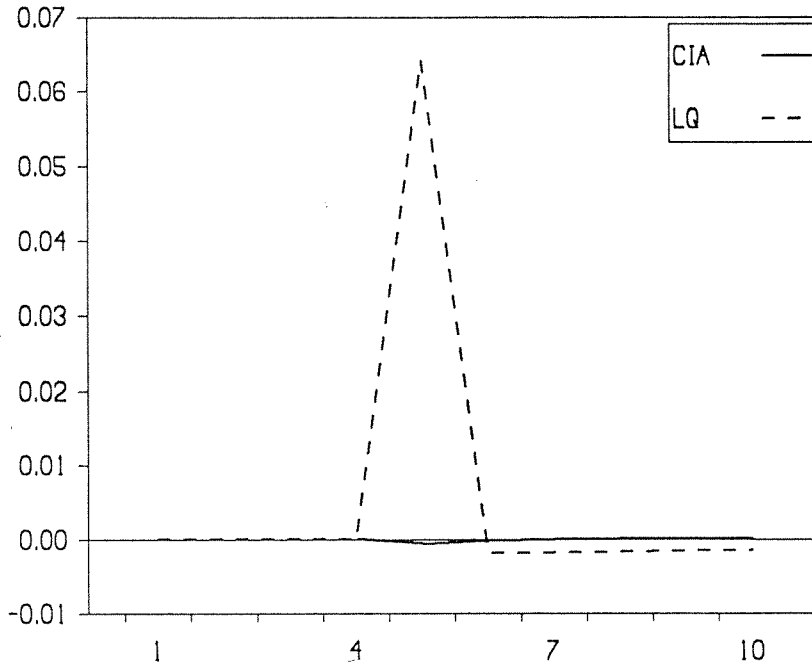


Figure 3D: Credit Goods - HFC

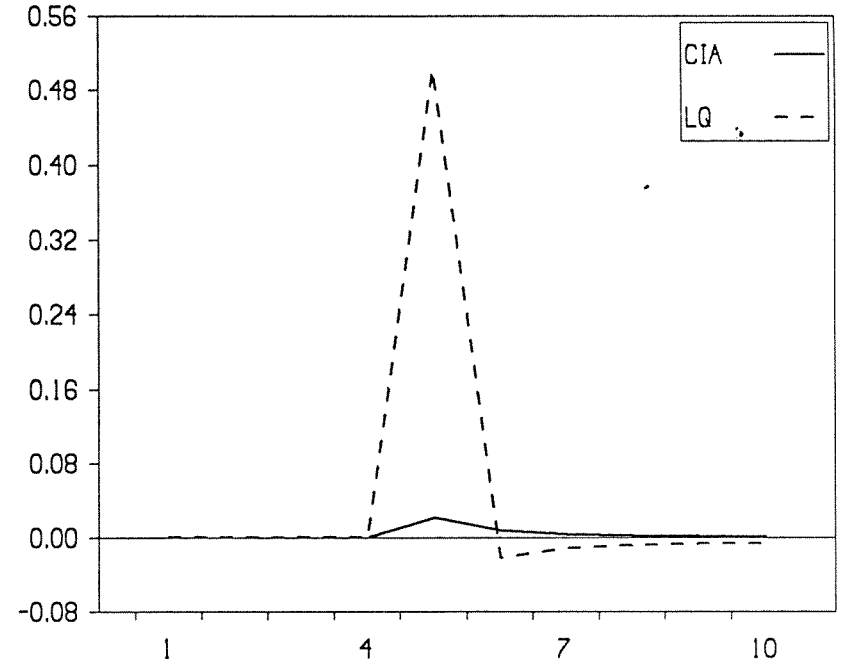


Figure 3E: Firm Credit Services - HFC

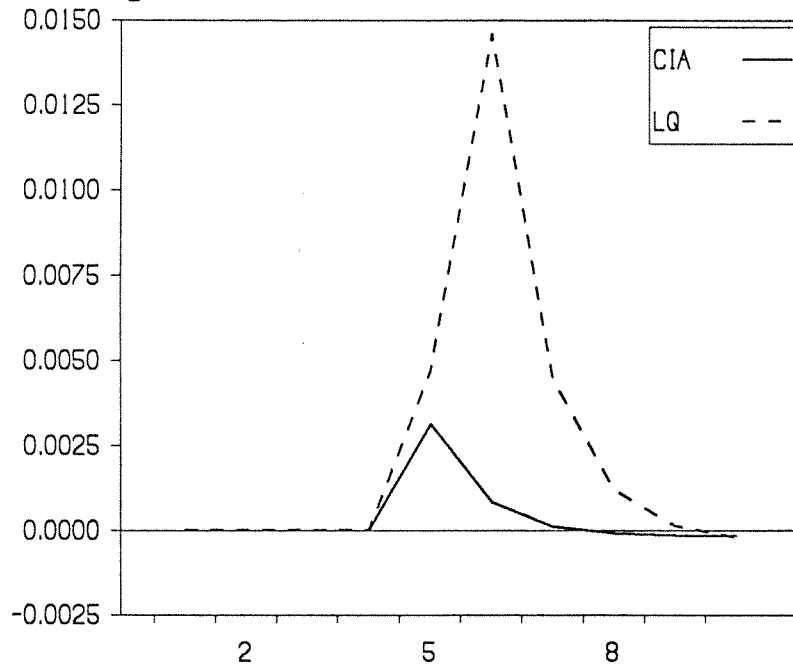


Figure 3F: Output - HFC

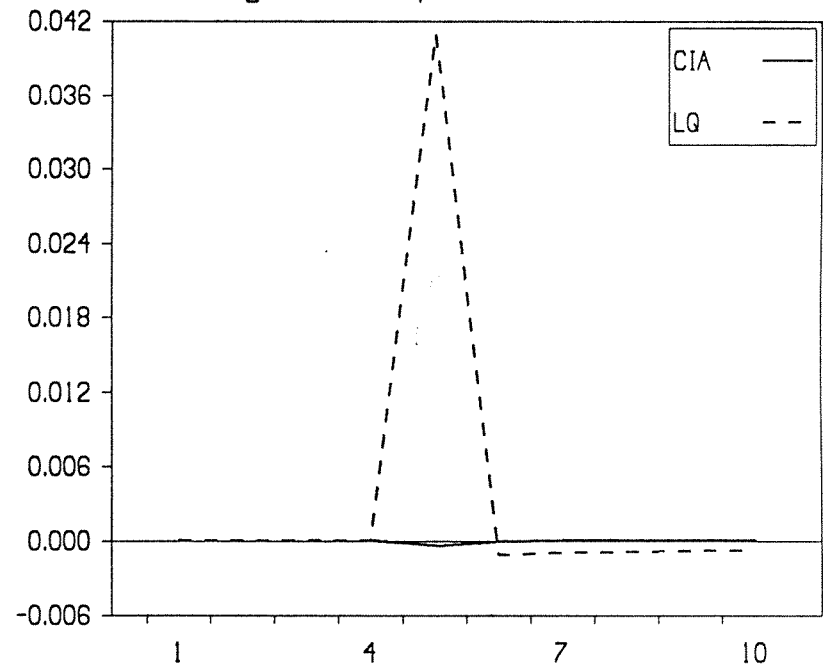


Figure 3G: Nominal Interest Rate - HFC

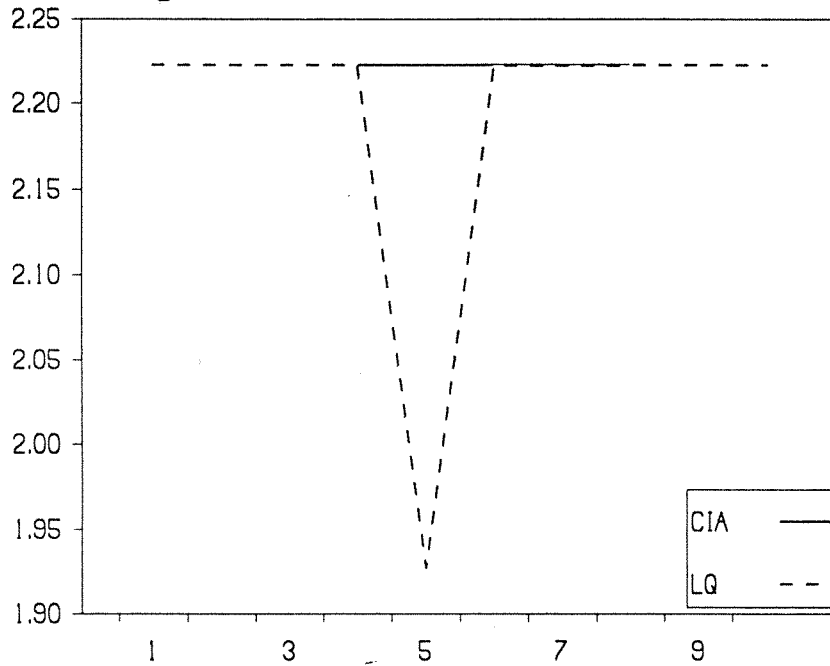


Figure 3H: Goods Price - HFC

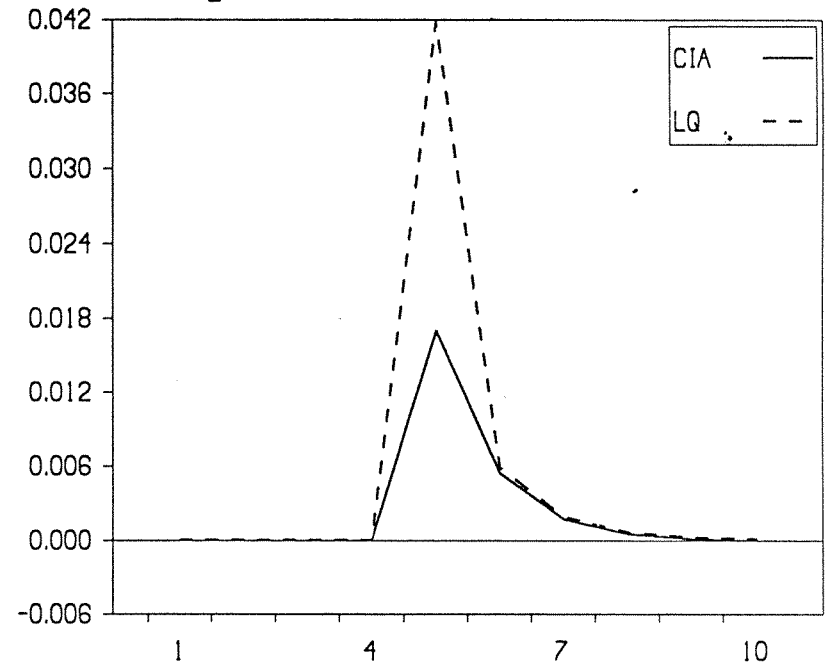


Figure 3I: Rel. Price of Household Credit - HFC

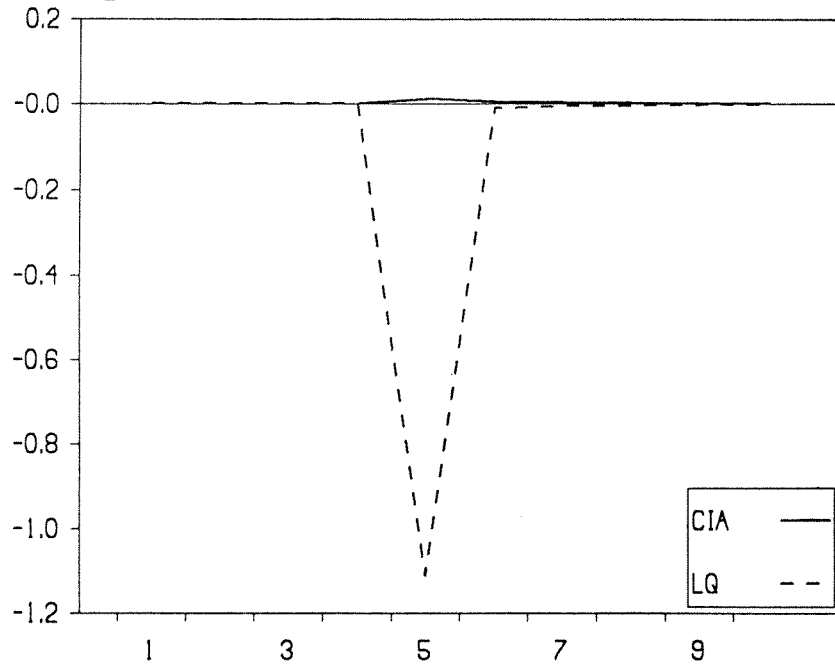


Figure 3K: Business and Household Investment -- HFC/CIA

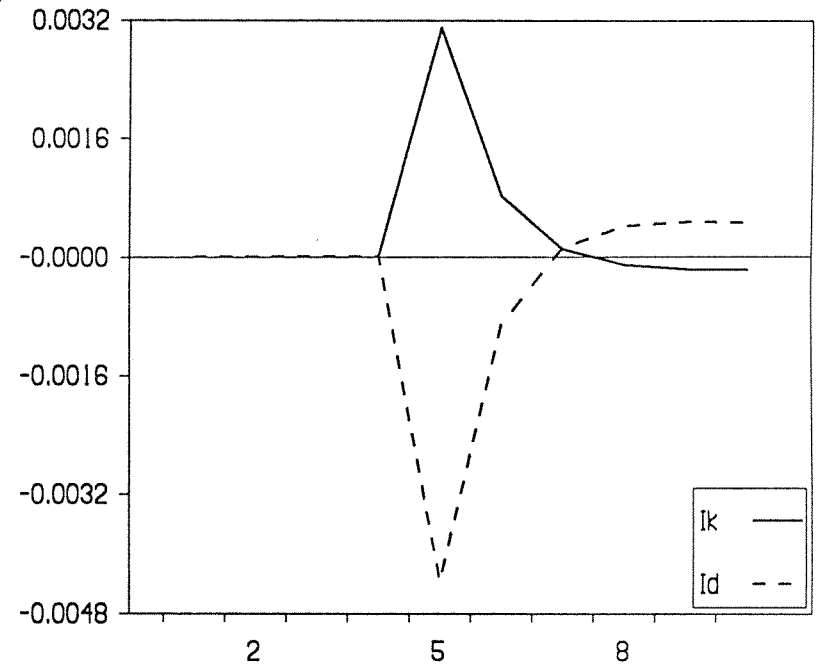


Figure 3J: Rel. Price of Firm Credit - HFC

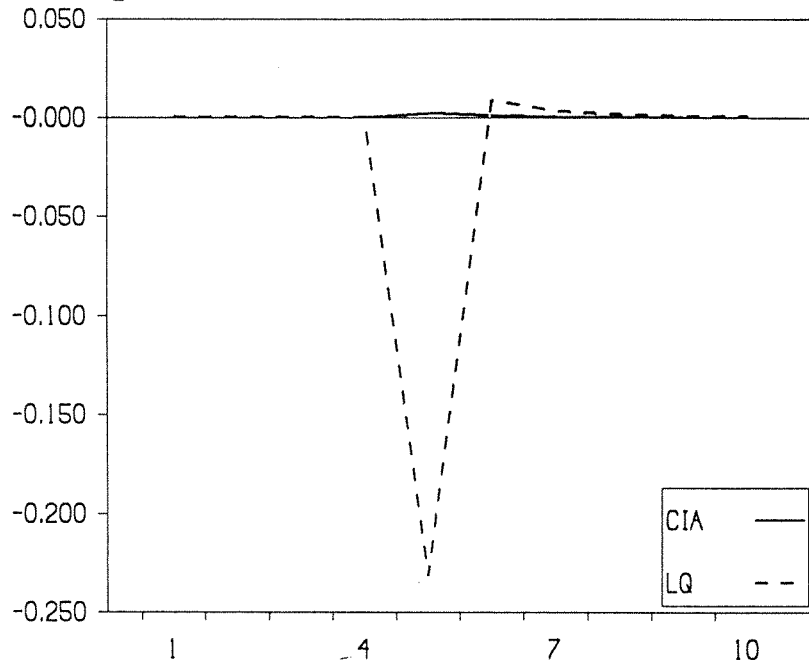


Figure 3L: Business and Household Investment -- HFC/LQ ($\rho = 0.32$)

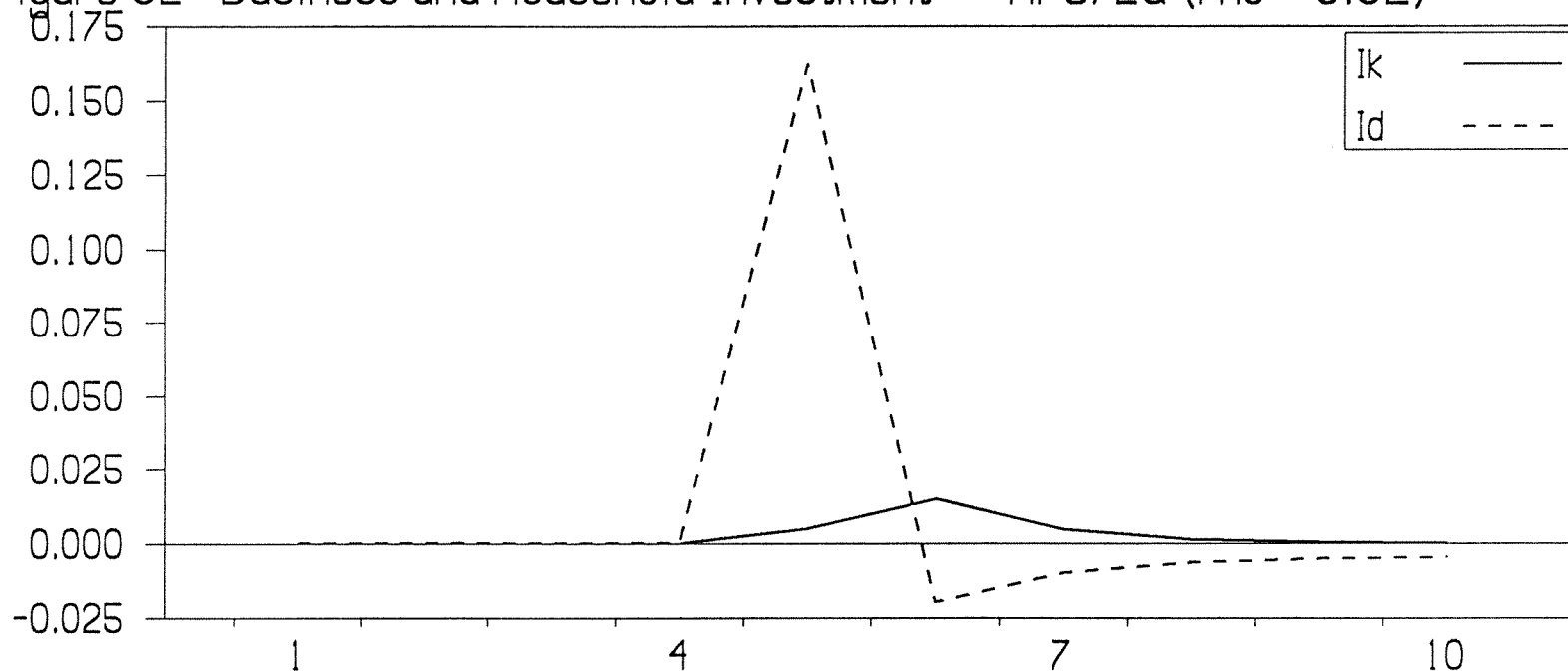


Figure 3M: Business and Household Investment -- HFC/LQ ($\rho = 0.81$)

