Leisure Persistence and Liquidity Effects

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Abstract

In this paper, we investigate whether two-period habit persistence in leisure in the non-linear utility function can generate a persistent drop in nominal interest rate. We consider two models - the basic limited participation model or the benchmark model and the two-period habit persistence in leisure or the leisure model. The results show that the benchmark model can only generate the liquidity effect. The leisure model, however, can generate a persistence drop in nominal interest rate and a persistent increase in the level of employment and output, when there is a positive monetary shock. This is due to sluggishness in decisions on labour supply that prevent the labour market from moving back to the equilibrium immediately after a period of shock.

1. Introduction

It is widely acknowledged that the basic limited participation model can only generate a non-persistent drop in nominal interest rate. Various features are added into the basic model to get the persistent effect. Christiano and Eichenbaum (1992) introduced small costs for adjusting sectoral flow of funds. Hendry and Zhang (1998) presented frictions in the adjustment of prices, wages and portfolios. Blackburn and Jariyapan (2004) showed habit persistence in the consumption and labour supply decisions of agents. They found that only habit persistence in consumption could cause a persistent drop in nominal interest rate, due to the semi-log utility function employed in the study.

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In this paper, two periods of habit persistence in leisure, in the constant relative risk aversion utility function, are introduced into the basic model to investigate whether the feature is able to generate a persistent fall in the nominal interest rate. It is important to stress here that the functional form of the utility function introduced in this paper is nonlinear in both consumption and leisure, which leads to sluggish labour in the labour supply. In view of this, we consider two different versions of a limited participation model, which differ according to the extent of habit persistence in the labour supply decision. The first model is the benchmark case, in which there is no habit persistence. The second model or "the leisure model" is the one that allows habit persistence in leisure to extend for two periods.

2. The Model Economies.

The basic structure of these two models is given by a simplified version of the limited participation model of Christiano et al (1998). The difference between each model lies in the specification of household preferences

2.1 Economic environment

There are three types of economic agents: households, goods-producing firms and financial intermediaries. There is also a monetary authority.

2.2 Households

At the beginning of each period, households possess the economy's entire stock of money, M_t, for which they have two uses: Q_t dollars are set aside to purchase consumption goods, C_t and $M_t - Q_t$ dollars are lent to the financial intermediaries. Consumption and investment expenditure, $P_t(C_t + I_t)$, must be fully financed with cash that comes from two sources: Q_t and current period wage earnings, $W_t N_t$ where W_t is the nominal wage rate and N_t is time devoted to work. I_t is gross investment and produces capital, K_{t+1}, according to the law of motion

$$K_{t+1} = I_t + (1-\delta) K_t \quad (1)$$

for $(0 < \delta < 1)$. The household faces the following cash-in-advance constraint:

$$P_t\left(C_t+K_{t+1}-(1-\delta)K_t\right)\le Q_t+W_tN_t. \quad (2)$$

This equation shows that the household can only buy consumption and investment goods with wages and cash balances that are available at the beginning of a period.

In addition, the household faces the following budget constraint:

$$M_{t+1}\le R_t\left(M_t-Q_t\right)+R_tX_t+D_t+r_tK_t+\left[Q_t+W_tN_t-P_t\left(C_t+K_{t+1}-(1-\delta)K_t\right)\right] \quad (3)$$

where R_t is the gross nominal interest, X_t is a lump sum injection of money from the monetary authority, D_t is the profits received from firms and r_t is the real rental rate on capital. The budget constraint equation shows that the household has four sources of money at the beginning of each period. The first is the interest earnings on cash loans, $R_t\left(M_t-Q_t\right)$ and the second is the lump sum profits from financial intermediaries, R_tX_t. The third source of money is labour income, W_tN_t. The last source is the capital rental income, r_tK_t. The fact that capital rental income appears only in the budget constraint, and not in the CIA constraint, indicates that this income is received at the end of the period. The information sets of the household are given as Ω_{t-1},Ω_t^Q and Ω_t, and are defined as follows: Ω_{t-1} includes all variables dated *t-1* and earlier. Ω_t^Q includes Ω_{t-1} and z_t. Ω_t includes Ω_t^Q and x_t. The z_t and x_t are the state of technology at time t and the growth rate of the money supply at time t, respectively.

For the benchmark model, the representative household's expected lifetime utility is:

$$E\sum_{t=0}^{\infty}\beta^t U\left(C_t,L_t\right), \quad (4)$$

$$U=\frac{\left[C_t^{(1-\gamma)}\left(T-N_t\right)^{\gamma}\right]^{1-\psi}}{1-\psi},T=L_t+N_t \text{ for } \psi\neq 0 \quad (5)$$

where T denotes total time available and L_t denotes the quantity of leisure time.

In the case of the leisure model, the representative household's expected lifetime utility is:

$$E\sum_{t=0}^{\infty}\beta^t U\left(C_t,L_t,L_{t-1},L_{t-2}\right), \quad (6)$$

$$U=\frac{\left[C_t^{(1-\gamma)}\left(T-N_t-b_1\left(T-N_{t-1}\right)-b_2\left(T-N_{t-2}\right)\right)^{\gamma}\right]^{1-\psi}}{1-\psi}, \text{ for } \psi\neq 0, \quad (7)$$

where b_1 and b_2 capture the dependence of current period utility at the level of leisure in period one and two, respectively, and b_1 and $b_2 > 0$.

2.3 Firms

The representative firm hires capital, K_t, and labour, N_t, from households to produce output with the following technology:

$$Y_t = f\left(z_t, K_t, N_t\right) = z_t K_t^{\alpha} N_t^{1-\alpha} \qquad (8)$$

where z_t evolves according to the following law of motion:

$$z_t = \rho_z z_{t-1} + \varepsilon_{z,t} \qquad (9)$$

where $\varepsilon_{z,t}$ is a serially uncorrelated i.i.d. random variable with a standard deviation of σ_{ε_z}.

To produce output, the firm has to borrow cash from financial intermediaries to finance the nominal wage bill, $W_t N_t$. Borrowing takes place at the nominal interest rate R_t. The firm does not have to borrow cash to finance capital because capital is assumed to be credit worthy.
The firm sells its output at a competitive market price P_t and then pays dividends to its shareholders. The dividends paid to a shareholder are equal to the firm's total cash receipts minus its total cash outlays, which is:

$$D_t = P_t Y_t - R_t W_t N_t - r_t K_t. \qquad (10)$$

2.4 Financial Intermediaries

Financial intermediaries receive deposits $M_t - Q_t$ from households and lump sum cash injections, X_t, from the monetary authority. These funds are lent on the loan market at the gross rate of interest R_t. The demand for loans comes from firms who need to finance the nominal wage bill, $W_t N_t$. The loan market clearing condition is given by:

$$W_t N_t = M_t - Q_t + X_t. \qquad (11)$$

At the end of the period, the profits from financial intermediaries $R_t X_t$ are distributed to households.

2.5 Monetary Growth

The money supply evolves according to $M_{t+1} = M_t + X_t$. The growth rate of the money supply is therefore $\left(M_{t+1} - M_t\right) / M_t = X_t / M_t = x_t$. Following Christiano and Eichenbaum (1991), we assume that this growth rate is governed by the following stochastic process:

$$x_t = \rho_x x_{t-1} + \varepsilon_{x,t} \qquad (12)$$

where $\varepsilon_{x,t}$ is a serially uncorrelated i.i.d. random variable with a standard deviation of σ_{ε_x}.

3. Solving the Models

The method used to solve these models is the undetermined coefficients method proposed by Christiano (1998). Here, the leisure model is solved in detail, for the sake of quantitative analysis, since both models only differ in the form of utility function.

The solution procedure starts by solving the representative household's maximization problem. The Lagrangian for this problem is:

$$\max_{\{C_t,N_t,Q_t,M_{t+1},K_{t+1}\}_{t=0}^{\infty}} E\sum_{t=0}^{\infty}\beta^t \left\{ \begin{array}{l} U(C_t,L_t,L_{t-1},L_{t-2}) \\ +\nu_t\left[Q_t+W_tN_t-P_t\left(C_t+K_{t+1}-(1-\delta)K_t\right)\right] \\ +\mu_t\left[\begin{array}{l} R_t(M_t-Q_t)+R_tX_t+D_t+r_tK_t-M_{t+1} \\ +\left[Q_t+W_tN_t-P_t\left(C_t+K_{t+1}-(1-\delta)K_t\right)\right] \end{array}\right] \end{array} \right\} \tag{13}$$

$$\text{where } U=\frac{\left[C_t^{(1-\gamma)}\left(T-N_t-b_1\left(T-N_{t-1}\right)-b_2\left(T-N_{t-2}\right)\right)^{\gamma}\right]^{1-\psi}}{1-\psi}. \tag{14}$$

The first order conditions associated with the household's optimization problem are as follows:

for C_t:

$$U_{C,t}\left(C_t,T-N_t-b_1\left(T-N_{t-1}\right)-b_2\left(T-N_{t-2}\right)\right)=\left(\nu_t+\mu_t\right)P_t \tag{15}$$

for N_t:

$$\begin{aligned} &U_{N,t}\left(C_t,T-N_t-b_1\left(T-N_{t-1}\right)-b_2\left(T-N_{t-2}\right)\right) \\ &+\beta U_{N,t}\left(C_{t+1},T-N_{t+1}-b_1\left(T-N_t\right)-b_2\left(T-N_{t-1}\right)\right) \\ &+\beta^2 U_{N,t}\left(C_{t+2},T-N_{t+2}-b_1\left(T-N_{t+1}\right)-b_2\left(T-N_t\right)\right) \\ &+\left(\nu_t+\mu_t\right)W_t=0. \end{aligned} \tag{16}$$

for Q_t:

$$E\left[\nu_t+\mu_t\left(1-R_t\right)\middle|\Omega_t^Q\right]=0 \tag{17}$$

for K_{t+1}:

$$E\left[-(\nu_t+\mu_t)P_t+\beta E\left[\left(\nu_{t+1}+\mu_{t+1}\right)(1-\delta)P_{t+1}+\left(\mu_{t+1}r_{t+1}\right)\right]\Omega_t\right]=0 \tag{18}$$

and for M_{t+1};

$$\mu_t=\beta E\left[\mu_{t+1}R_{t+1}\middle|\Omega_t\right] \tag{19}$$

From (15) and (16), the static optimality condition for labour supply can be written as:

$$\begin{aligned}&U_{N,t}\left(C_t,T-N_t-b_1\left(T-N_{t-1}\right)-b_2\left(T-N_{t-2}\right)\right)\\&+\beta U_{N,t}\left(C_{t+1},T-N_{t+1}-b_1\left(T-N_t\right)-b_2\left(T-N_{t-1}\right)\right)\\&+\beta^2U_{N,t}\left(C_{t+2},T-N_{t+2}-b_1\left(T-N_{t+1}\right)-b_2\left(T-N_t\right)\right)\\&+U_{C,t}\left(C_t,T-N_t-b_1\left(T-N_{t-1}\right)-b_2\left(T-N_{t-2}\right)\right)\frac{W_t}{P_t}=0.\end{aligned} \tag{20}$$

Let $\Lambda_t=\mu_tR_t$. Then the equation (19) can be written as:

$$\Lambda_t=\beta E\left[R_t\Lambda_{t+1}\middle|\Omega_t\right] \tag{21}$$

When taking the expectation of both sides conditional on Ω_t^Q and making use of $\Omega_t\supseteq\Omega_t^Q$ and the law of iterated mathematical expectations, the equation (21) can be written as:

$$E\left[\tilde{\Lambda}_t-\beta R_t\tilde{\Lambda}_{t+1}\middle|\Omega_t^Q\right]=0 \tag{22}$$

where

$$\tilde{\Lambda}_t=\frac{U_{C,t}\left(C_t,T-N_t-b_1\left(T-N_{t-1}\right)-b_2\left(T-N_{t-2}\right)\right)}{P_t} \tag{23}$$

Next leading equation (19) by one period gives:

$$\mu_{t+1}=\beta E\left[\mu_{t+2}R_{t+2}\middle|\Omega_t\right] \tag{24}$$

which can also be written as:

$$\mu_{t+1}=\beta E\left[\Lambda_{t+2}\middle|\Omega_t\right]. \tag{25}$$

Hence,

$$
\begin{aligned}
&E\left[\mu_{t+1}r_{t+1}\middle|\Omega_t\right]\\
&=E\left[\beta E\left[\Lambda_{t+2}\middle|\Omega_{t+1}\right]r_{t+1}\middle|\Omega_t\right]\\
&=E\left[\beta E\left[\Lambda_{t+2}\middle|\Omega^{Q}_{t+2}\right]r_{t+1}\middle|\Omega_t\right]\\
&=E\left[\beta E\left[\tilde{\Lambda}_{t+2}\middle|\Omega^{Q}_{t+2}\right]r_{t+1}\middle|\Omega_t\right]\\
&=E\left[\beta E\left[\tilde{\Lambda}_{t+2}\middle|\Omega_{t+1}\right]r_{t+1}\middle|\Omega_t\right]\\
&=E\left[\beta E\left[\tilde{\Lambda}_{t+2}r_{t+1}\middle|\Omega_{t+1}\right]\middle|\Omega_t\right]\\
&=E\left[\beta\tilde{\Lambda}_{t+2}r_{t+1}\middle|\Omega_t\right].
\end{aligned}
\tag{26}
$$

Using (23) and (26), the equation (18) may be expressed as:

$$
E\left[\begin{matrix}U_{C,t}\left(C_t,T-N_t-b_1\left(T-N_{t-1}\right)-b_2\left(T-N_{t-2}\right)\right)\\
-\beta\begin{bmatrix}U_{C,t+1}\left(C_{t+1},T-N_{t+1}-b_1\left(T-N_t\right)-b_2\left(T-N_{t-1}\right)\right)(1-\delta)\\+\beta\tilde{\Lambda}_{t+2}r_{t+1}\end{bmatrix}\end{matrix}\middle|\Omega_t\right]=0. \tag{27}
$$

The first order conditions associated with the household's optimization problem are:

$$
E\left[\begin{matrix}U_{C,t}\left(C_t,T-N_t-b_1\left(T-N_{t-1}\right)-b_2\left(T-N_{t-2}\right)\right)\\
-\beta\begin{bmatrix}U_{C,t+1}\left(C_{t+1},T-N_{t+1}-b_1\left(T-N_t\right)-b_2\left(T-N_{t-1}\right)\right)(1-\delta)\\+\beta\tilde{\Lambda}_{t+2}r_{t+1}\end{bmatrix}\end{matrix}\middle|\Omega_t\right]=0, \tag{28}
$$

$$
E\left[\tilde{\Lambda}_t-\beta R_t\tilde{\Lambda}_{t+1}\middle|\Omega^{Q}_t\right]=0, \tag{29}
$$

$$
\begin{aligned}
&U_{N,t}\left(C_t,T-N_t-b_1\left(T-N_{t-1}\right)-b_2\left(T-N_{t-2}\right)\right)\\
&+\beta U_{N,t}\left(C_{t+1},T-N_{t+1}-b_1\left(T-N_t\right)-b_2\left(T-N_{t-1}\right)\right)\\
&+\beta^2U_{N,t}\left(C_{t+2},T-N_{t+2}-b_1\left(T-N_{t+1}\right)-b_2\left(T-N_t\right)\right)\\
&+U_{C,t}\left(C_t,T-N_t-b_1\left(T-N_{t-1}\right)-b_2\left(T-N_{t-2}\right)\right)\frac{W_t}{P_t}=0.
\end{aligned}
\tag{30}
$$

Next, regarding the firm's maximization problem, a firm chooses N_t and K_t so as to maximize its dividends, subject to its production function. The first order conditions are: for N_t ;

$$\frac{W_t R_t}{P_t} = f_{N,t} \tag{31}$$

for K_t ;

$$\frac{r_t}{P_t} = f_{K,t} \tag{32}$$

where $f_{N,t} = \partial f\left(z_t, K_t, N_t\right)/\partial N_t$ and $f_{K,t} = \partial f\left(z_t, K_t, N_t\right)/\partial K_t$.

Then, these equations need to be scaled in order to render them stationary. To this end, the following is defined:

$$\lambda_t = \tilde{\Lambda}_t M_t, q_t = Q_t / M_t, p_t = P_t / M_t, w_t = W_t / M_t, 1+x_t = M_{t+1} / M_t. \tag{33}$$

We can rewrite the scaled households' and firms' optimality conditions as:

$$H_K = E\left[\begin{array}{l} U_{C,t}\left(C_t, T-N_t-b_1\left(T-N_{t-1}\right)-b_2\left(T-N_{t-2}\right)\right) \\ -\beta U_{C,t+1}\left(C_{t+1}, T-N_{t+1}-b_1\left(T-N_t\right)-b_2\left(T-N_{t-1}\right)\right)(1-\delta) \\ +\beta^2 \dfrac{U_{C,t+2}\left(C_{t+2}, T-N_{t+2}-b_1\left(T-N_{t+1}\right)-b_2\left(T-N_t\right)\right)}{p_{t+2}} r_{t+1} \end{array} \middle| \Omega_t \right] = 0. \tag{34}$$

$$H_Q = E\left[\begin{array}{l} \dfrac{U_{C,t}\left(C_t, T-N_t-b_1\left(T-N_{t-1}\right)-b_2\left(T-N_{t-2}\right)\right)}{p_t} \\ -\beta \dfrac{R_t}{(1+x_{t+1})} \dfrac{U_{C,t+1}\left(C_{t+1}, T-N_{t+1}-b_1\left(T-N_t\right)-b_2\left(T-N_{t-1}\right)\right)}{p_{t+1}} \end{array} \middle| \Omega_t^Q \right] = 0 \tag{35}$$

$$
\begin{aligned}
H_N = & U_{N,t}\left(C_t, T-N_t-b_1\left(T-N_{t-1}\right)-b_2\left(T-N_{t-2}\right)\right) \\
& +\beta U_{N,t}\left(C_{t+1}, T-N_{t+1}-b_1\left(T-N_t\right)-b_2\left(T-N_{t-1}\right)\right) \\
& +\beta^2 U_{N,t}\left(C_{t+2}, T-N_{t+2}-b_1\left(T-N_{t+1}\right)-b_2\left(T-N_t\right)\right) \\
& +U_{C,t}\left(C_t, T-N_t-b_1\left(T-N_{t-1}\right)-b_2\left(T-N_{t-2}\right)\right)\frac{w_t}{p_t}=0
\end{aligned} \tag{36}
$$

$$
\frac{w_t R_t}{p_t}=f_{N,t} \tag{37}
$$

$$
\frac{r_t}{p_t}=f_{K,t} \tag{38}
$$

In addition to the above, we have the resource constraint, the cash-in-advance constraint, and the loan market equilibrium condition. After appropriate re-scaling these relationships may be rewritten respectively, as:

$$
z_t K_t^{\alpha} N_t^{1-\alpha}=C_t+K_{t+1}-(1-\delta)K_t, \tag{39}
$$

$$
p_t\left(C_t+K_{t+1}-(1-\delta)K_t\right)=1+x_t, \tag{40}
$$

$$
w_t N_t=1-q_t+x_t. \tag{41}
$$

In the case of the benchmark model, the first order conditions associated with the households and firms are as follows:

$$
H_K=E\left[\begin{array}{l} U_{C,t}\left(C_t, T-N_t\right)-\beta U_{C,t+1}\left(C_{t+1}, T-N_{t+1}\right)(1-\delta) \\ -\beta^2 \dfrac{U_{C,t+2}\left(C_{t+2}, T-N_{t+2}\right)}{p_{t+2}} r_{t+1} \end{array}\middle| \Omega_t\right]=0, \tag{42}
$$

$$
H_Q=E\left[U_{C,t}\left(C_t, T-N_t\right)p_t^{-1}-\beta U_{C,t+1}\left(C_{t+1}, T-N_{t+1}\right)p_{t+1}^{-1}\frac{R_t}{\left(1+x_t\right)}\middle|\Omega_t^Q\right]=0, \tag{43}
$$

$$
H_N=U_{N,t}\left(C_t, T-N_t\right)+U_{C,t}\left(C_t, T-N_t\right)\frac{w_t}{p_t}=0, \tag{44}
$$

$$
\frac{w_t R_t}{p_t}=f_{N,t} \tag{45}
$$

$$
\frac{r_t}{p_t}=f_{K,t}. \tag{46}
$$

4. The Qualitative Properties of the leisure Model

In this part, only, the leisure model's properties are identified. The main ingredient for generating a persistent drop in nominal interest in this model is the two-period habit persistence in leisure.

We start the analysis of how habit persistence generates a persistent drop in nominal interest by drawing the labour demand and labour supply, and these curves are depicted in Figure (1). The labour demand and labour supply are given by equation (37) and (36), respectively.

It is noticable that in the labour supply equation, labour supply depends not only on the present, but also the past and future period. Consequently, a degree of sluggishness is introduced into the dynamics of labour.

Let us start by assuming that the monetary authority has injected a surprise lump sum of cash into the financial intermediaries. The financial intermediaries will then lend all this cash to the firms. In pursuing firms to take the new cash injection, the nominal interest rate has to fall. Due to the fall in the nominal interest rate, the cost of working capital decreases. Also, the demand for labour increases because firms equate the marginal productivity of labour to the cost of hiring labour by taking the cost of the working capital into account. The labour demand curve shifts to the right $(Ld1)$. As a result of the movement in labour demand and labour supply, employment increases from N to N_1.

Due to the sluggish labour supply in this model, the labour supply curve shifts gradually back from $(Ls1)$ to $(Ls2)$ to $(Ls3)$. Also, the labour demand shifts gradually back from $(Ld1)$ to $(Ld2)$ to $(Ld3)$, as capital starts to decrease. The gradual movement in both the labour demand and labour supply curve shows a persistent increase in employment, and leads to a persistent increase in output as well. This persistence in both employment and output implies a persistent drop in nominal interest rate.

5. Quantitative Analysis

5.1 Parameter Values

The common structural parameters of the two models are $\beta,\delta,\alpha,\gamma,\psi,\rho_z,\sigma_z,\rho_m,\sigma_m$. The parameters describing habit persistence in the leisure model are given by b_1, and b_2. Nearly all the parameter values are based on Collard and Erts (1997). An exception is the measure of relative risk aversion (or the inverse of the intertemporal elasticity of substitution) that is set to 5, as in Christiano (1991). The discount factor, β, the rate of capital depreciation, δ, the capital share of aggregate output, α, the preference parameter that determines the relative importance of consumption and leisure, γ, the autoregressive coefficient in productivity shock, ρ_z, and the standard deviation of shock, σ_x and σ_z, are taken directly from Collard and Erts (1997).

The autoregressive coefficient in monetary growth, ρ_x, is set equal to 0.58, which implies that in the benchmark model, the effect of a positive monetary shock causes the nominal interest to fall and return to its steady state value within one period. In the habit persistence, two periods of habit persistence in leisure are both set equal to 0.3 (which satisfies the restriction $b_1 + b_2 < 1$).

Table 1 Summary of parameter values

β	α	δ	γ	ψ	ρ_z	σ_z	ρ_x	σ_x
.99	0.34	0.025	.56	5	0.96	0.01	0.58	0.011

Table 2 Parameter Values for the Leisure Model

b_1	b_2
0.3	0.3

5.2 The Quantitative Results

From the parameter values set above, each model can be solved numerically by linearising the H functions and obtaining the decision rules using Christiano's method. Then, the implications of the model are analysed by studying the impulse responses of the nominal interest rate, output, labour, and consumption to a one standard deviation money growth shock, x_t, in period 2.

Figure (2) shows the impulse response of nominal interest rate to a positive monetary shock, x_t, in period 2 in each model. In the impact period of the shock, the interest rate falls in both cases, as a result of liquidity effect dominance over the anticipated inflation effect. The main difference between the models is the persistence of the response. In the case of the benchmark model, no persistence in nominal interest rate is shown at all, due to the way the model is constructed. However, the leisure model shows a rather different result. This model is capable of generating a certain degree of persistence in interest rate fluctuations and it takes approximately 10 quarters for the nominal interest rate to converge to the steady state level. This is because the current labour supply decision is affected by the labour supply decision in the past two periods, as indicated in equation (36).

The impulse response of employment and output to a positive monetary shock in each model is shown in Figure (3) and (4). There is an initial increase in both variables in all models. In the case of the benchmark model, the employment and output fall below and gradually converge to the steady state after an increase in the impact period. However, the model with habit persistence in leisure shows that both employment and output increase in the impact period of the shock and persist for approximately 5 periods before converging to the steady state level. Also, the magnitude of an increase in both employment and output of the benchmark model is higher than that in the leisure model. These two differences in the impulse response of employment and output are the consequence of sluggishness in the labour supply decision.

6. Concluding Remarks

It can be confirmed once again that the basic limited participation models can generate strong liquidity effects without persistence in employment, output and nominal interest. With the introduction of two periods of habit persistance in leisure in the utility function, the model can generate a persistent drop in nominal interest rate and persistent increase in both employment and output. However, it should be noted that this is largely due to the fact that the utility is non-linear in both consumption and leisure or labour supply. If this were not the case, then the labour supply decision would not be affected by its past, and the persistence in both variables would not be generated. In addition, the introduction of sluggishness in the labour supply decision also leads to the persistence in employment and output, since labour supply is a factor in production.

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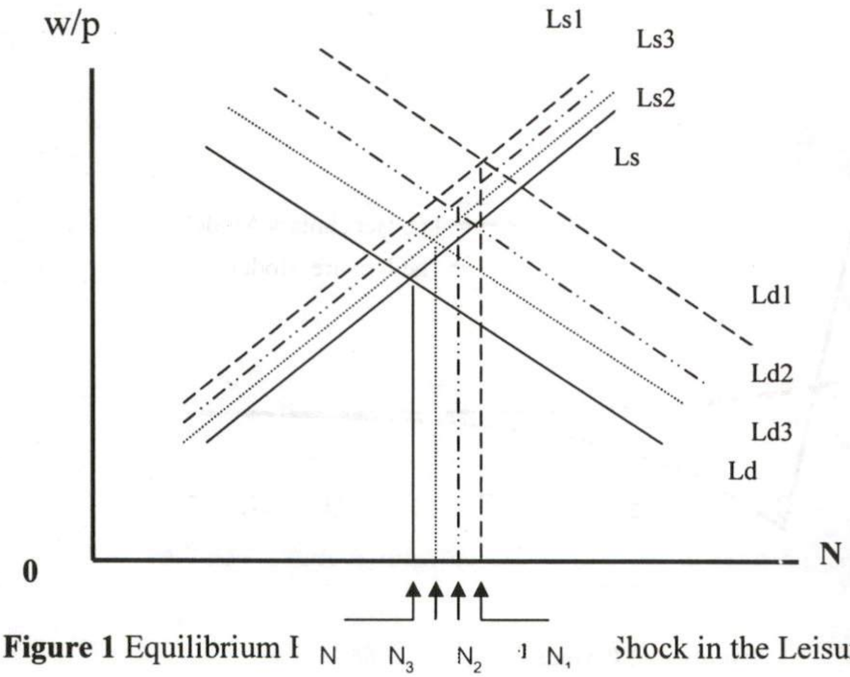

Figure 1 Equilibrium I Shock in the Leisure Model

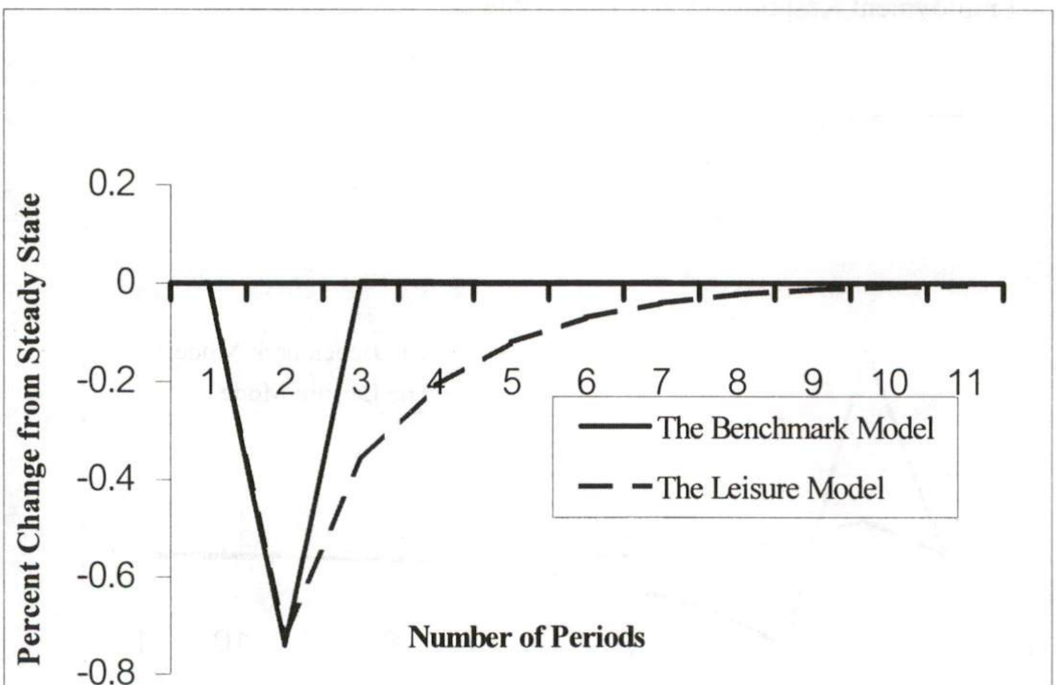

Figure 2 Nominal Interest Rate Response to a Monetary Shock

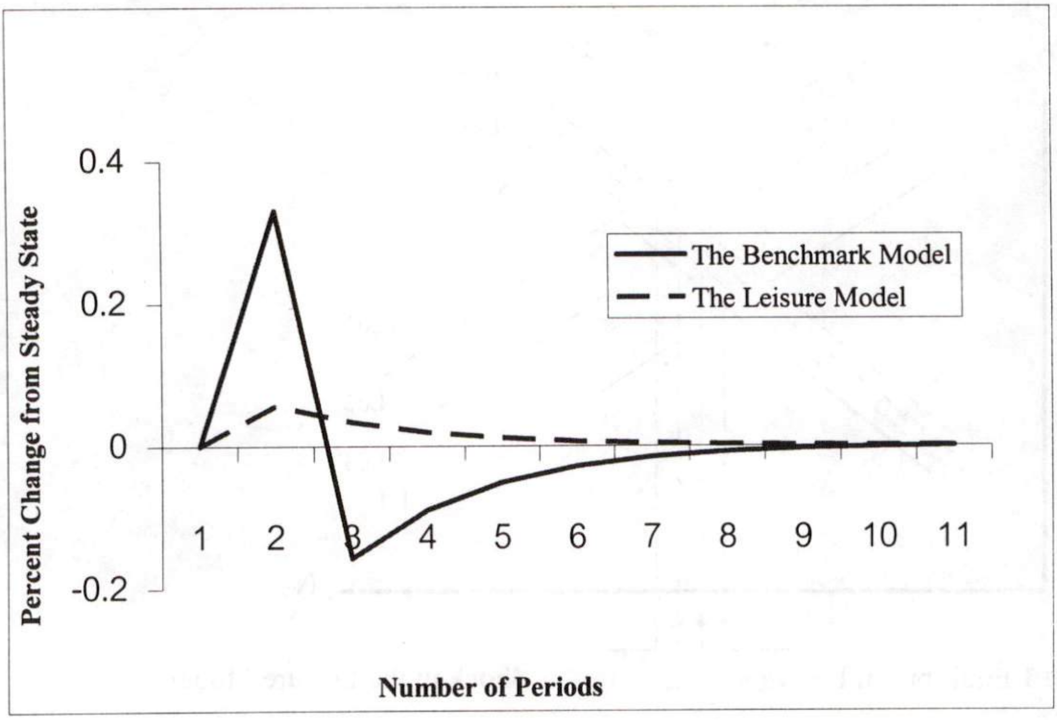

Figure 3 Employment Response to a Monetary Shock

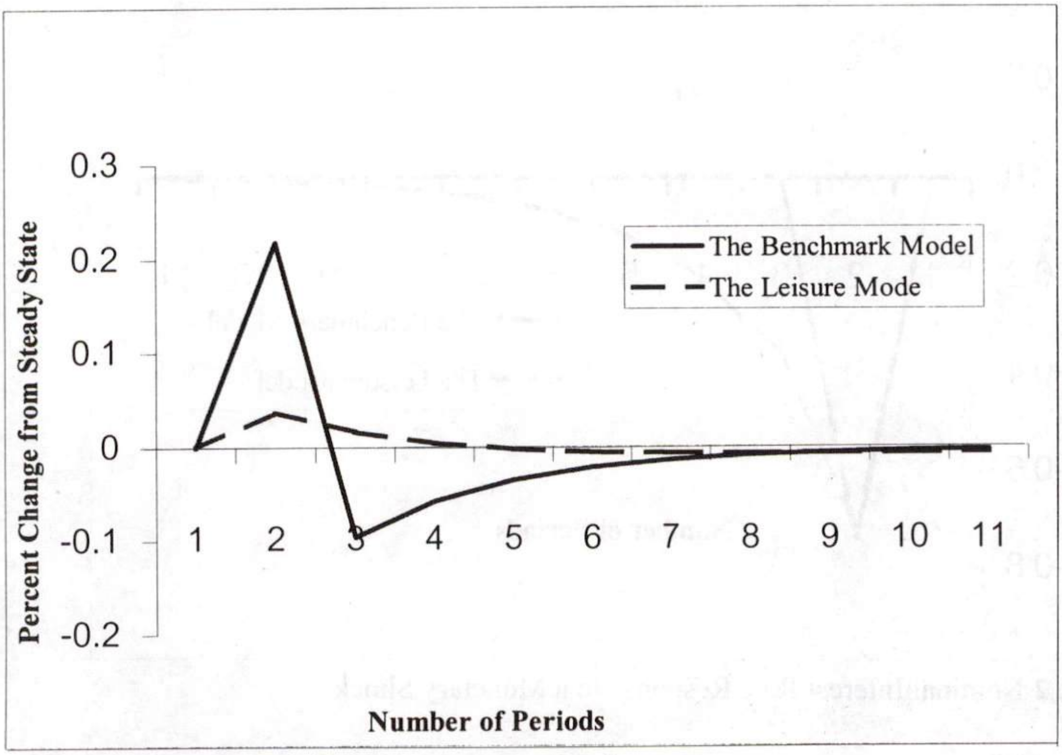

Figure 4 Output Response to a Monetary Shock

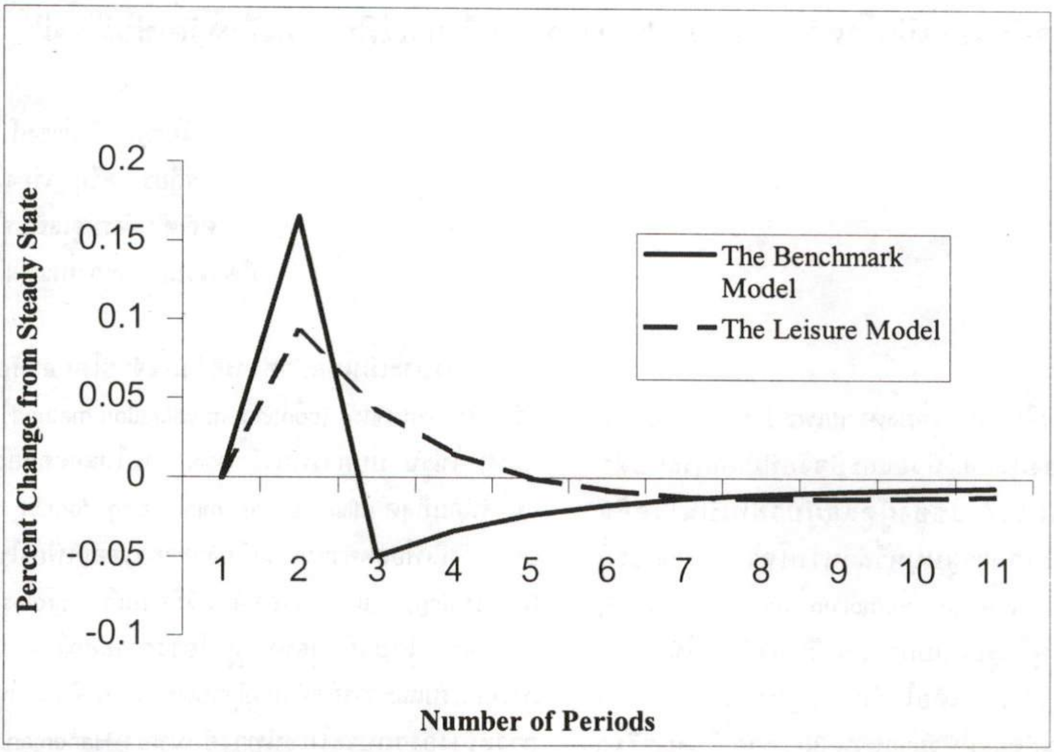

Figure 5 Consumption Response to a Monetary Shock