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"Comovement, Excess Volatility, and Home Production"

by

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Comovement, Excess Volatility, and Home Production

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Abstract

Two investment anomalies in aggregate home production models are investigated: excess volatility and comovement. Adjustment cost in capital accumulation reduces both volatility and the negative correlation in investments on capital goods in the market and at home. Investments comove to the extent that durable goods and time are good substitutes in consumption activities. Consumers substitute durable goods for time at home when the opportunity cost of time is high during booms. Based on the Consumer Expenditure Survey, I show that households' expenditure shares on durable goods are negatively associated with household leisure, indicating that durable goods are relatively good substitutes for time.

Key Words: Home Production, Comovement, Volatility

JEL Classification Codes: E32, J22

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1. Introduction

Economic development has led to a large secular decline in the workweek. The allocation of non-working time may now rival that of working time in importance to economic welfare. Since Becker (1965) and Mincer (1962), the value of non-market activity has been explicitly incorporated into economic analysis in terms of forgone earnings. Recently, home production has also been incorporated into equilibrium business models to address a variety of issues (e.g., Benhabib, Rogerson and Wright (1991), Greenwood and Hercowitz (1991), McGrattan, Rogerson and Wright (1997) and Perli (1997)). In particular, home production improves the quantitative performance of the labor market by providing intratemporal substitution of time in addition to intertemporal substitution of leisure. However, it tends to generate anomalies in the movement of investments. Investments on durable goods in the market and at home are extremely volatile and strongly negatively correlated; they move together in the data with a correlation of 0.47.

Greenwood and Hercowitz (1991) first generated comovement in investments based on (i) highly correlated technology shocks between market and home sector, (ii) complementarity between durable goods and time in home production, and (iii) labor augmenting productivity shock in home production. However, the merits of home production disappear if the shocks are highly correlated between the sectors. Furthermore, assumption (ii) seems to be inconsistent with the data — durable goods appear to be good substitutes for time in consumption (e.g., Abbot and Ashenfelter

(1976) and Barnett (1979)). Based on the U.S. Consumer Expenditure Survey, I estimate the elasticities of expenditure share with respect to a household's leisure for six categories of goods including durable and non-durable goods. This measure tells us how consumers substitute goods for time in consumption activities when their work-hours increase. Durable goods seem to be a relatively good substitute for time. A one percent increase in household leisure is associated with .13 and .47 percent decreases in the expenditure share of durable goods for married and non-married households, respectively.

This paper suggests a simple way to resolve the volatility and comovement issues in aggregate home production models. The resolution requires (i) a small adjustment cost in capital accumulation and (ii) substitutability between durable goods and time in consumption. Unlike in a one-sector model, in a multi-sector model investment in one sector can increase enormously at the price of investment in the other sector, without affecting consumption significantly. This implies that in response to shifts in relative productivity, investments are extremely volatile and strongly negatively correlated. As was shown by Baxter (1996), introduction of a small adjustment cost in capital accumulation reduces not only volatility but also the negative correlation of investments.

Following Becker (1965), I interpret home production as the final stage of consumption activities. Any consumption activity requires both goods and time as input to produce "effective consumption." For example, cleaning a house requires tools and labor, and watching a play in a theater requires a ticket and time to watch.

The full costs of these activities equal the sum of market goods' prices and the forgone value of time. A high opportunity cost of time implies that labor is a relatively expensive input in "consumption production." Procyclical demand for consumer durables is consistent with procyclical productivity, investment, and hours in the market sector if durable goods and time are good substitutes (e.g., a dishwasher, microwave, or refrigerator). Calibration shows that both volatility and comovement of investments match those in the data under the substitution elasticities available from the empirical literature on consumer demand.

Other studies on comovement include Hornstein and Praschnik (1997), Fisher (1997), and Einarsson and Marquis (1997). Hornstein and Praschnik (1997) develop an explanation based on the input-output structure. Fisher (1997) achieved comovement under the complementarity of investments in resource constraint. Complementarity in investments can be interpreted as an adjustment cost because it generates a concave production-possibility frontier. Einarsson and Marquis (1997) achieved comovement of investments and hours at the same time by introducing human capital accumulation but complementarity in home durable goods and time is still required.

The paper is organized as follows. Section 2 presents the model. Section 3 calibrates and simulates the models under various specifications. In Section 4, based on the U.S. Consumer Expenditure Survey, the cross-sectional pattern of leisure and expenditure is investigated showing that durable goods are a better substitute for time than are non-durables goods and services. Section 5 is the conclusion.

2. The Model

The economy contains a large number of identical, infinitely lived households. At time t, the representative household maximizes the utility defined over various types of consumption activities:

$$U = E_t \sum_{\tau=t}^{\infty} \beta^{\tau-t} \frac{Z_\tau^{1-\sigma} - 1}{1-\sigma} \tag{1}$$

$$Z_t = \prod_{j=1}^{J} Z_{jt}^{\mu_j}, \qquad \mu_j > 0, \ \sum_{j=0}^{J} \mu_j = 1 \tag{2}$$

$$Z_{jt} = \left((1-\alpha_j) X_{jt}^{1-\frac{1}{\varepsilon_j}} + \alpha_j (Q_{jt} L_{jt})^{1-\frac{1}{\varepsilon_j}} \right)^{\frac{\varepsilon_j}{\varepsilon_j - 1}} \quad \text{for } j = 1, \ldots, J. \tag{3}$$

E_t denotes expectation at time t and β a discount factor. Z_{jt} is the utility from consumption activity j that requires goods X_{jt} and time devoted to it L_{jt}. Q_{jt} represents the technological progress in home production.[1] There are many different ways in which the household can achieve effective consumption in terms of goods-labor intensity. For example, suppose Z_j is the utility from clean dishes. Households can use their own hands (a labor-intensive way) or use a dishwasher (a goods-intensive way). This specification is general enough to include the conventional leisure-goods utility function. Assuming one of the home production functions Z_j has time input only, it will generate a conventional leisure-goods utility form. The representative consumer faces two constraints: time and money income:

$$\sum_{j=1}^{J} L_{jt} + N_t = 1 \tag{4}$$

$$\sum_{j=1}^{J} C_{jt} + I_t = (1-\tau_N)W_t N_t + (1-\tau_K)R_t K_t . \tag{5}$$

N_t is labor supply, C_{jt} is purchase of good j, and I_t is investment in market capital stock K_t at time t. W_t and R_t denote the wage rate of labor and rental rate of capital at time t. The tax rate on labor income and capital income is τ_N and τ_K, respectively. Accumulation of stocks of capital and consumer durable goods is subject to adjustment cost as in Baxter (1996):

$$K_{t+1} = \phi_K (I_t / K_t) K_t + (1-\delta_K) K_t \tag{6}$$

$$X_{jt+1} = \phi_j (C_{jt} / X_{jt}) X_{jt} + (1-\delta_j) X_{jt} , \tag{7}$$

[1] This labor-augmenting technological progress parallel to that in the market is needed to support the constant time allocation along the balanced growth path in steady state.

where ϕ is a concave function: $\phi'() > 0, \phi''() \leq 0$, X_{jt} is the stock of good j at time t, and δ_K and δ_j are depreciation rates of capital in the market and goods j. For non-durable goods, $\delta_j = 1$ and consumption equals current purchases ($X_{jt} = C_{jt}$).

The fact that goods have different substitutability with time has an interesting implication on the cyclical behavior of labor supply and demand for goods. In a traditional labor-leisure approach, an increase in real wages induces more labor work and less leisure unless the income effect dominates the substitution effect. Here, the same result can be obtained via substitution of more goods-intensive consumption activity, that is, higher input of X_j's and lower input of L_j's. A rise in the cost of time relative to goods (an increase in real wages) would induce a reduction in the amount of time and an increase in the amount of goods used per unit of utility in consumption activity. This approach interprets the procyclical behavior of the labor supply as a change of consumption pattern over the business cycles, from a time-intensive consumption pattern to a goods-intensive consumption pattern. Therefore, a surge of demand for consumer durable goods during expansions will be consistent with procyclical labor productivity provided durable goods and time are good substitutes.

The representative firm produces goods and maximizes its profit each period by hiring labor and capital with a production function

$$Y_t = A_t K_t^{1-\alpha} (Q_t N_t)^{\alpha}, \tag{8}$$

where A_t is total factor productivity and Q_t is the deterministic trend of technology that grows at rate γ. The government purchases G_t each period ($G_t = \tau_N W_t N_t + \tau_K R_t K_t$), so that the goods-market equilibrium is

$$\sum_{j=1}^{J} C_{jt} + I_t + G_t = Y_t. \qquad (9)$$

3. Calibration and Simulation

This section calibrates and simulates the model economy. Consumption activities are aggregated into two categories: one requires durable goods and the other requires non-durable goods and services, $Z_t = Z_{St}^{\mu} Z_{Dt}^{1-\mu}$, where subscript D denotes durable goods and S denotes non-durables and services. The time constraint and goods market equilibrium are $L_{Dt} + L_{St} + N_t = 1$ and $C_{Dt} + C_{St} + I_t + G_t = Y_t$, respectively.

A rational expectation equilibrium of this economy is a set of stochastic process for the endogenous variables $\{Y_t, K_t, X_t, N_t, \phi_t, C_{St}, C_{Dt}, I_t, \Psi_t, \Lambda_t\}$ that satisfies the first-order conditions of consumer utility maximization and producers' profit maximization, and the resource constraint given the exogenous process $\{A_t\}$.[2] Ψ_t and Λ_t are the shadow price of capital in the market and at home (Lagrange multipliers), respectively. Given the existence of trends in technology, we need to

[2] Subscript D is dropped for the stock of consumer durable goods.

transform the economy so that it admits a stationary solution. When the labor-augmenting technological progress is at the same rate both in the market and at home (e.g., $Q_t = Q_{Dt} = Q_{St}$), given the constant returns to scale production functions in Z_D and Z_S, there exists a balanced growth path. Dividing the variables by the technology index, (e.g., $k_t = K_t / Q_t$), we can transform the economy into a stationary one. The model is solved numerically using a log-linear approximation of the system of first-order conditions and constraints of the stationary economy around the steady state as in King, Plosser, and Rebelo (1988).[3]

Parameters of the model are calibrated by the following criteria; (i) prior information in the literature, (ii) consistency with the steady-state ratios among endogenous variables based on the U.S. data (iii) volatility of investments. Parameter values for the benchmark case are summarized in Table 1. Labor share of market production function α is 2/3. The depreciation rate for both market capital and

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[3] The system of equations can be simplified further by solving endogenous variables $\{\hat{y}_t, \hat{N}_t, \hat{\phi}_t, \hat{c}_{St}, \ldots\}$ as functions of $[\hat{k}_t\ \hat{x}_t\ \hat{\psi}_t\ \hat{\lambda}_t]$ where circumflex indicates the percentage deviation from the steady-state values [e.g., $\hat{k}_t = \log(k_t / k)$, etc.]. This implies that the rational expectation equilibrium is a solution to the following stochastic difference equation:

$$\begin{bmatrix} \hat{k}_{t+1} \\ \hat{x}_{t+1} \\ E_t\hat{\psi}_{t+1} \\ E_t\hat{\lambda}_{t+1} \end{bmatrix} = \Psi \begin{bmatrix} \hat{k}_t \\ \hat{x}_t \\ \hat{\psi}_t \\ \hat{\lambda}_t \end{bmatrix} + \Phi_0 E_t \hat{A}_{t+1} + \Phi_1 \hat{A}_t ,$$

where Ψ is the 4 × 4 matrix and Φ_0 and Φ_1 are 4 × 1 matrces. We assume that exogenous variables $\{\hat{A}_t\}$ are subject to a stationary stochastic process. Thus, by Blanchard and Kahn (1980), there exists a unique solution when the matrix Ψ has two eigenvalues with modulus less than one and the other two eigenvalues with modulus greater than one. For the calibrated consumer durable goods is 10% annual. In steady state, time spent in the market is 1/3 of total available time. Utility is logarithmic: $\sigma = 1$. Discount factor β is chosen to yield an annual return to capital of 4% with annual growth rate of consumption 1.6%. Tax rates for both labor and capital are 20%.

As a benchmark case, Cobb-Douglas technologies are used for Z_D and Z_S ($\varepsilon_D = \varepsilon_S = 1$). For the labor share for durable goods consumption, I use the average of those in the literature, $\alpha_D = 0.81$.[4] With no information for non-durable goods, I use the same number as the market production function, $\alpha_S = 2/3$. The average consumption expenditure share of non-durable goods and services is 0.89 for 1954:I-1996:IV in the U.S., and this leads to the value for $\mu = 0.103$.[5] The stochastic process of total factor productivity shifts in the market is $\hat{A}_t = 0.95\hat{A}_{t-1} + e_{At}$. The standard deviation of e_{At} is 0.0076, as in the literature.

The adjustment cost function is parameterized as follows. First, there is no adjustment cost incurred maintaining the steady-state level of capital in the market and at home (i.e., $\phi_K(i/k) = i/k$ and $\phi_X(c_D/x) = c_D/x$. Second, in steady state, Tobin's q (the ratio of the price of existing capital to the price of new capital) is one for both capital and durable goods: $\phi_K'(i/k) = 1$ and $\phi_X'(c_D/x) = 1$. Finally, we need to specify the elasticity of the investment/capital ratio with respect to Tobin's q:

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values discussed in the next section, and for all sufficiently nearby values, there indeed exists two stable eigenvalues.

[4] They are 0.87 in Greenwood and Hercowitz (1991), 0.92 in Benhabib, Rogerson, and Wright (1991), 0.794 in McGrattan, Rogerson, and Wright (1997) and 0.68 in Greenwood, Rogerson, and Wright (1995).

$\eta_K = [(i/k)\phi_K''/\phi_K']^{-1}$ and $\eta_X = [(c_D/x)\phi_X''/\phi_X']^{-1}$. There is no adjustment cost in the benchmark case, $\eta_K = \eta_X = \infty$ ($\phi'' = 0$).

Table 2 reports the selected moments of models. Column (1) is the benchmark case. As is well known from the earlier studies, investments are extremely volatile and strongly negatively correlated (-0.83). The relative volatility of investment on consumer durable goods and market capital to output are 19.5 and 5.62, respectively, while those in the data are 2.96 and 3.05.[6] The impulse response function illustrates this anomaly of investment clearly. Figure 1 shows the impulse response of investments and stocks of durables in the market and home to a one percent increase in productivity in the market. The purchase of home durable goods drops enormously in the first period. It decreases more than 30% and market investment increases more than 10% in the first period. Almost half the capital accumulation in the market is done within a quarter. Although the two investments move together after the first period, initial response dominates the later movement and generates a strong negative correlation.

Moments of the model with adjustment cost are reported in column (2). With no direct estimate for η, I follow Baxter (1996) in tying this value to the volatility of investments in the data. I use $\eta_K = 80$ for capital in the market, and the same value is used for consumer durables ($\eta_X = 80$). Adjustment cost not only suppresses the

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[5] μ is determined from $\frac{C_D}{C_S} = \frac{(1-\alpha_D)(1-\mu)}{\delta_X(1-\alpha_S)\mu}$.

[6] Data of investments are nonresidential fixed investment for the market sector and expenditure on consumer durable goods for the home sector.

volatility but also reduces the negative correlation of investments by mitigating the extreme initial response. The correlation decreases to -0.24. However, investment at home still decreases in the first period (Figure 2).

Now, suppose durable goods are relatively better substitutes for time than non-durables and services are as the empirical evidence suggests. The estimates from Abbot and Ashenfelter (1976) are used. These numbers are conservative estimates for ε_D and ε_S because these estimates are substitution elasticities between total leisure and goods.[7] Abbot and Ashenfelter (1976) report three sets of estimates: (i) $\varepsilon_D = 1.50$, $\varepsilon_S = 0.59$ (ii) $\varepsilon_D = 1.83$, $\varepsilon_S = 0.48$ (iii) $\varepsilon_D = 2.59$, $\varepsilon_S = 0.34$.[8] The results for the model with (i) and (iii) are in columns (3) and (4), respectively. Two investments comove with correlation of 0.20 and 0.49, respectively (0.47 in the data). At the same time, substitutability between durable goods and time increases the volatility of expenditure on durable goods and decreases that of non-durables and service. Figure 3 shows the

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[7] This can be shown under our specification as follows. Dropping the constant term, the first-order condition for time and goods is $\ln(C_{jt}/L_{jt}) = \varepsilon_j \ln(W_t/P_{jt})$, where P_{jt} is the price of good j at time t. Running the regression with total non-market time L_t instead of L_{jt} is equivalent to omitting a variable $\ln(L_{jt}/L_t)$: $\ln(C_{jt}/L_t) = \varepsilon_j \ln(W_t/P_{jt}) + \ln(L_{jt}/L_t) + e_{jt}$ where e_{jt} is the error term. Thus, the OLS estimate of ε_j is

$$\hat{\varepsilon}_j = \varepsilon_j + \frac{\text{cov}\,(\ln(W_t/P_{jt}), \ln(L_{jt}/L_t))}{\text{var}\,(\ln(W_t/P_{jt}))}.$$

The sign of the second term depends on the correlation between relative time and the real wage. When the substitution elasticity is the same across consumption activities $\varepsilon_j = \varepsilon$, for all j, the time spent on different activities will not be correlated with the real wage. However, when goods have different substitution elasticity with time, the relative time spent on goods that are relatively good substitutes for time will decrease as the real wage increases. Therefore, the second term is negative for the goods that are better substitutes for time and positive for the goods that are relatively complementary with time.

[8] Table V in Abbot and Ashenfelter (1976). For non-durable goods and services, they report estimates for five categories. I use the average of these categories.

impulse response of this case. Because of strong demand for durable goods when the price of time is expensive, expenditure on consumer durable goods increases with investment in the market from the first period. Two caveats are needed at this point. First, for the comovement of investments, what matters is the relative not the absolute magnitude of elasticities. As long as durable goods are relatively better substitutes for time than are non-durable goods and services, the two investments comove. Second, without adjustment cost, substitutability itself does not improve the correlation of investments significantly. The extreme initial response dominates the substitution effect.

4. Some Evidence from the Consumer Expenditure Survey

In this section, I investigate the cross-sectional pattern of leisure and expenditure shares of goods based on the Consumer Expenditure Survey (CEX). First, durable goods and non-durable goods (and services) are compared. Although durable goods show strong substitutability for time in general, the substitutability depends on the characteristics of the goods. For example, one might expect that durables such as refrigerators, microwaves, and dishwashers save time at home, while entertainment-related durable goods such as audio equipment are likely to be complementary with time. In addition, services such as baby-sitting are likely to be a good substitute for time while the expense for traveling is likely to be complementary with time. To demonstrate this, I classify the goods into several sub-categories. Among durable goods, entertainment durable goods are of interest. For non-durable goods and services, food at home, food outside home, and household operation services are examined separately. In the classification of goods, the classification codes provided by Bureau of Labor Statistics are used.

Consider the following regression. Index i represents the household and index l is a six-digit identification code of goods in CEX data. The expenditure on good l by household i is $P_l X_{il}$:

$$\ln\left(\frac{\sum_{l \in j} P_l X_{il}}{\sum_{all} P_l X_{il}}\right) = b_0 + b_Y \ln\left(\sum_{all} P_l X_{il}\right) + b_L \ln L_i + b_H' H_i + e_{ij}. \tag{10}$$

The left-hand side is the log of expenditure share of goods in category j. The interpretation of b_Y is the slope of Engel Curve of consumption category j: a percentage increase of share in response to a percentage increase in total expenditure. We use total expenditure as a proxy of permanent income of the household. This also avoids a serious measurement error problem in reported income in survey data. L_i is the leisure of household i, and b_L shows the relative substitutability with time of category j goods: a percentage change of share of good j associated with a percentage increase in leisure. For goods that are relatively good substitutes for time, b_L is negative, and for those goods that are relatively complementary with time, b_L is positive. Controls for household characteristics $\boldsymbol{H}_i$ include years of schooling of the household's head, age of household head, family size, number of children under age 18, number of children under age 2, and dummies for home ownership and for quarter and year of the interview.

The pooled cross-sectional CEX data for 1990-1994 are used. CEX is a quarterly outgoing rotation data set. Each household has up to four consecutive quarterly surveys.[9] One fourth of the sample departs and is replaced each quarter. Because annual working hours are reported in the second and fifth interviews only, quarterly consumption data are aggregated over the previous four quarters (from the second to the fifth interview) for each household to match the annual hours in the fifth interview. I construct the two samples based on the marital status of the household's head. The first sample consists of 10,321 married households, and the second sample consists of 7,212 non-married households. The data contain households whose heads are between 18 and 65 years old.

Annual leisure is calculated as (365 days × 16 hours) – (number of weeks worked) × (average workweek). For married households, the hour is the average of that of the head of the household and that of the spouse. Table 3 shows the summary statistics of the data. For some categories of goods, expenditures are zero or negative values (if the household sold them) for some households so that we cannot take logs in the left-hand side. Following Bils and Klenow (1998), I avoid this problem as follows.

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[9] The households are actually interviewed five times. The data consist of the second to the fifth interviews because the first interview is a background interview and is not reported.

First, I replace negative values with zeros. Second, the percentage deviations from the sample means are used for the approximation of logs of expenditure share.

The OLS estimates of equation (10) for durable goods, non-durable goods and services, entertainment durable goods, food at home, food outside home, and household services are reported in Table 4 (married households) and Table 5 (non-married households). Durable goods are luxury goods.[10] A one percent increase in total expenditure is associated with .34% and .24% increases in its share for married and non-married households, respectively. They are relatively good substitutes for time. A one percent increase in leisure is associated with .13% and .47% decreases of its share for married and non-married households, respectively. However, as we expected, entertainment-related durables (sound and video equipment such as TVs and VCRs, musical instruments, pets, bicycles, boats, campers, camping equipment, hunting and fishing equipment, and other sports equipment) do not show such substitutability for time.

For non-durable goods and service, a one percent increase of leisure is associated with .06% and .11% increases in its share, respectively, for married and non-married households. Food consumption at home and outside home, such as purchased meals shows an interesting contrast. While food consumption at home is relatively complementary with time, food outside home is a very good substitute for time. A one percent increase in leisure is associated with a .72% decrease in its share for both married and non-married households. Household operation services (baby-sitting, housekeeping services, gardening and lawn care services, and repair services) show a very strong substitutability with time. A one percent increase of leisure is associated with .87% and 1.31% decreases of its expenditure share for married and non-married households, respectively.

5. Conclusion

In this paper, two anomalies of investments in aggregate home production are investigated: excess volatility and comovement. The adjustment cost of capital accumulation decreases the volatility and negative correlation as well. Two investments comove if durable goods are better substitutes for time than are non-durables because consumers substitute durable goods for time during booms. According to the Consumer Expenditure Survey, households' expenditure shares on durable goods and leisure show statistically significant negative correlation, indicating substitutability between durable goods and time in consumption.

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[10] The criterion for the durability of a good is service life of longer than one year. Although some clothes last longer than one year, NIPA classifies all apparel as non-durables, and I follow this classification in this paper.

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Table 1: Parameter Values for the Benchmark Case

Parameter	Value	Description
σ	1	Intertemporal substitutability in consumption
ε_D	1	Elasticity of substitution in durable goods consumption
ε_S	1	Elasticity of substitution in non-durable goods consumption
α	2/3	Labor's share in production
α_D	0.81	Labor's share in $Z_D(X, L_D)$
α_S	2/3	Labor's share in $Z_S(C_{S,}, L_S)$
N	1/3	Portion of time spent in the market
γ	1.004	Growth rate of deterministic technological progress
β	0.994	Discount rate
η_K, η_X	∞	Elasticity of i/k and c_D/x to Tobin's q
δ_K, δ_X	0.025	Depreciation rate of capital and consumer durables
τ_K, τ_N	0.2	Tax rate on capital income and labor income

Table 2: Moments of Models **

Statistics	(1) $\eta_k = \eta_x = \infty$, $\varepsilon_D=1$, $\varepsilon_S=1$	(2) $\eta_k = \eta_x = 80$, $\varepsilon_D=1$, $\varepsilon_S=1$	(3) $\eta_k = \eta_x = 80$, $\varepsilon_D=1.50$, $\varepsilon_S=.59$	(4) $\eta_k = \eta_x = 80$, $\varepsilon_D=2.59$, $\varepsilon_S=.34$	Data
σ_Y	1.43	1.40	1.36	1.36	1.72
	(.17)	(.14)	(.14)	(.14)	
σ_{CS}/σ_Y	0.32	0.36	0.25	0.17	0.50
	(.05)	(.05)	(.06)	(.05)	
σ_{CD}/σ_Y	19.5	2.19	2.28	2.85	2.96
	(.08)	(.04)	(.02)	(.02)	
σ_I/σ_Y	5.62	3.14	3.11	3.06	3.05
	(.06)	(.04)	(.04)	(.05)	
cor(C_S,Y)	0.91	0.93	0.89	0.79	0.83
	(.01)	(.01)	(.02)	(.03)	
cor(C_D,Y)	-0.18	-0.04	0.40	0.65	0.83
	(.05)	(.10)	(.08)	(.03)	
cor(I,Y)	0.68	0.98	0.98	0.98	0.71
	(.01)	(.00)	(.00)	(.00)	
cor(C_D,I)	-0.83	-0.24	0.21	0.49	0.47
	(.04)	(.08)	(.07)	(.02)	

** Both data and the generated series are H-P filtered. Statistics are averages and standard deviations in parentheses are based on 50 simulations with 176 observations for each simulation. Data are quarterly for 1954:1 - 1996:4 from the Citibase. *Y*: real GDP in 1987 constant dollars (GDPQ). C_S: non-durables and service consumption (GCNQ+GCSQ). C_D: expenditure on consumer durables (GCDQ) *I*: gross fixed nonresidential investment (GIFQ-GIRQ). *N*: employed man-hours (LPMHU). All series are divided by the population over age 20. σ_{CS}/σ_Y: standard deviation of consumption on non-durables good and services relative to *Y*. $cor(C_D, I)$: correlation of C_D and *I*.

Table 3A: Summary Statistics of CEX for 1990-1994: Married Households

Variables	mean	std.	min	max	obs.
Total expenditure	28,781	18,566	-16,805	293,938	10,321
Age of head	42.55	11.24	18	65	10,321
Schooling of head	13.49	2.8	0	18	10,321
Age of spouse	40.92	11.22	14	83	10,004
Sex of head	0.15	0.36	0	1	10,321
Weeks worked: head	42.77	17.82	0	52	10,321
Hours worked: head	43.92	11.24	1	90	9,168
Weeks worked: spouse	33.67	22.58	0	52	10,004
Hours worked: spouse	37.47	11.91	1	90	7,474
Family size	3.46	1.40	2	15	10,321
Number of children of age < 18	1.15	1.24	0	9	10,321
Number of children of age < 2	0.14	0.37	0	4	10,321
House owned	0.76	0.43	0	1	10,321

Table 3B: Summary Statistics of CEX for 1990-1994: Non-Married Households

Variables	mean	std.	min	max	obs.
Total expenditure	14,764	11,234	-26,324	148,977	7,212
Age of head	38.32	12.91	18	65	7,212
Schooling of head	13.29	2.64	0	18	7,212
Sex of head	0.59	0.49	0	1	7,212
Weeks worked: head	37.31	20.90	0	52	7,212
Hours worked: head	40.28	11.46	2	90	5,934
Family size	1.87	1.27	1	13	7,212
Number of children of age < 18	0.50	0.97	0	8	7,212
Number of children of age < 2	0.05	0.24	0	4	7,212
House owned	0.36	0.48	0	1	7,212

Table 4: Estimation of (10) for Married Households

Category	Durables	Entertainment durables	Non-durables & service	Food at home	Food outside	Household operation
Log (income)	.34	.32	-.15	-.35	-.07	.18
	(36.8)	(9.7)	(-36.8)	(-39.5)	(-4.4)	(5.4)
Log (leisure)	-.13	.18	.06	.08	-.72	-1.31
	(-3.9)	(1.6)	(3.9)	(2.7)	(-13.6)	(-10.8)
Family size	-.04	-.09	.02	.07	-.03	-.25
	(-4.9)	(-3.3)	(4.9)	(9.8)	(-2.1)	(-8.8)
Log (schooling)	.08	-.15	-.03	-.12	.52	1.07
	(3.0)	(-1.5)	(-3.0)	(-4.6)	(11.9)	(10.8)
Log (age)	-.43	-.69	.19	.33	.25	-.27
	(-18.3)	(-8.2)	(18.3)	(14.5)	(6.6)	(-3.2)
Sex of head	-.08	-.27	.03	.03	-.02	.03
	(-5.3)	(-5.2)	(5.3)	(2.1)	(-0.8)	(0.6)
Number of children: age under 18	-.003	.17	.001	.03	-.06	.43
	(-0.3)	(5.2)	(0.3)	(3.1)	(-4.4)	(12.9)
Number of children: age under 2	.03	-.06	-.02	-.09	-.10	.48
	(2.3)	(-1.0)	(-2.3)	(-5.8)	(-4.1)	(8.6)
House owned	.42	.05	-.18	.02	.08	.06
	(30.4)	(1.0)	(-30.4)	(1.9)	(3.7)	(1.2)

t-ratios are in parentheses.

Table 5: Estimation of (10) for Non-Married Households

Category	Durables	entertainment durables	Non-durables & service	food at home	Food outside	household operation
Log (income)	.24	-.13	-.06	-.30	-.37	.07
	(13.8)	(-2.5)	(-13.8)	(-20.2)	(-16.8)	(1.4)
Log (leisure)	-.47	.17	.11	.06	-.72	-.87
	(-8.4)	(1.1)	(8.4)	(1.3)	(-10.1)	(-5.6)
Family size	-.06	.01	.01	.12	-.02	-.22
	(-3.1)	(0.2)	(3.1)	(7.9)	(-0.6)	(-4.4)
Log (schooling)	.29	.18	-.07	-.09	.75	.89
	(4.4)	(0.9)	(-4.4)	(-1.5)	(8.7)	(4.8)
Log (age)	-.47	-1.1	.11	.29	-.16	.11
	(-11.5)	(-8.8)	(11.5)	(8.2)	(-1.5)	(0.9)
Sex of head	-.22	-.67	.04	-.13	-.48	.43
	(-6.9)	(-8.5)	(6.6)	(-5.8)	(-14.7)	(6.0)
Number of children:	.02	.13	-.004	.06	-.09	.76
age under 18	(0.8)	(1.9)	(-0.7)	(2.8)	(-3.0)	(11.4)
Number of children:	.01	-.37	-.003	-.15	-.14	.13
age under 2	(0.1)	(-2.2)	(-0.2)	(-3.1)	(-2.0)	(0.8)
House owned	.81	.20	-.19	.01	.109	.33
	(28.3)	(2.7)	(-28.3)	(0.2)	(2.4)	(4.1)

t-ratios are in parentheses.

Figure 1: Impulse response of investment and capital to 1% increase in productivity in the market when $\eta_k = \eta_x = \infty$, $\varepsilon_D=1$, $\varepsilon_S=1$.

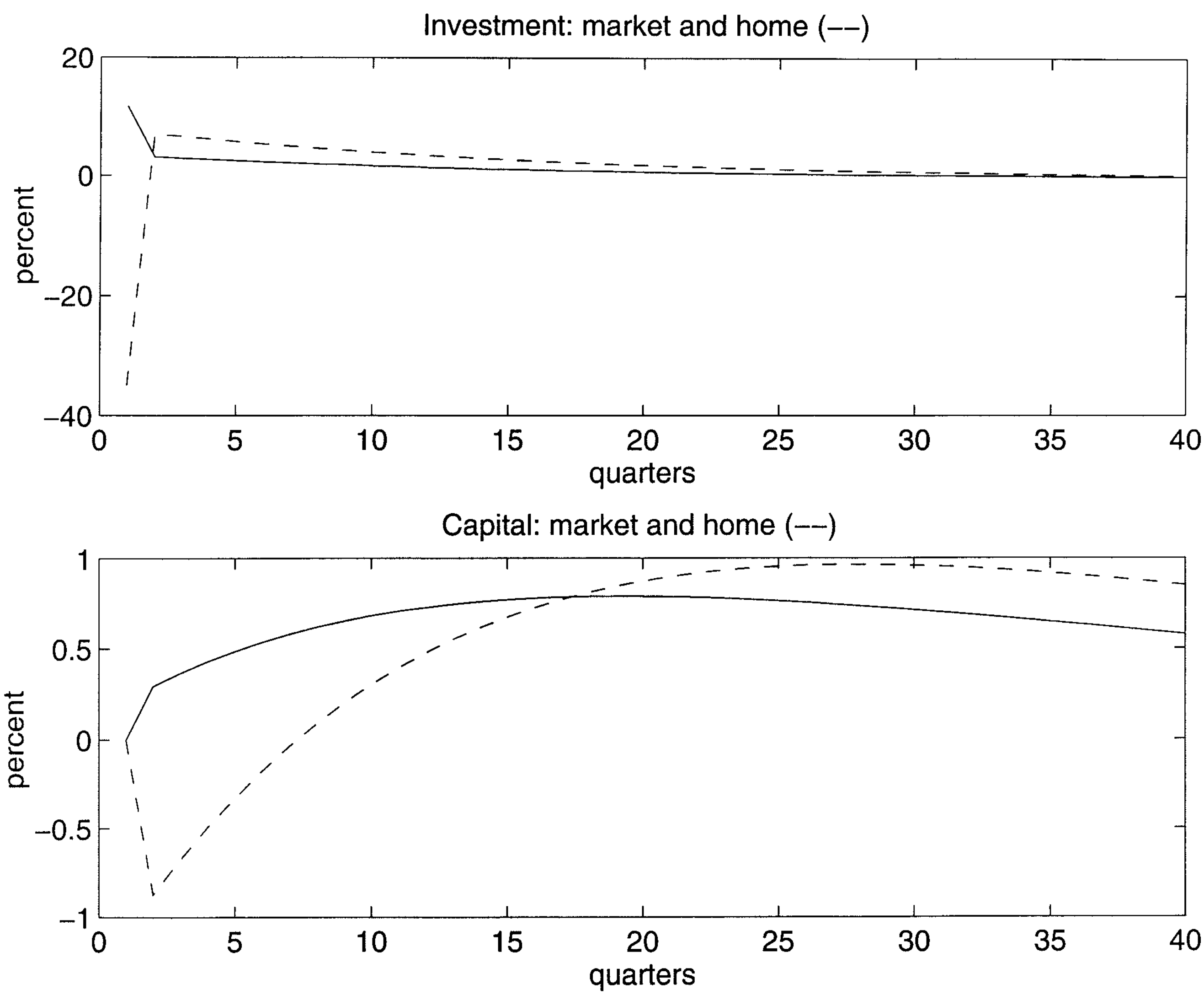

Figure 2: Impulse response of investments and capitals to 1% increase in productivity in the market when $\eta_k = \eta_x = 80$, $\varepsilon_D=1$, $\varepsilon_S=1$

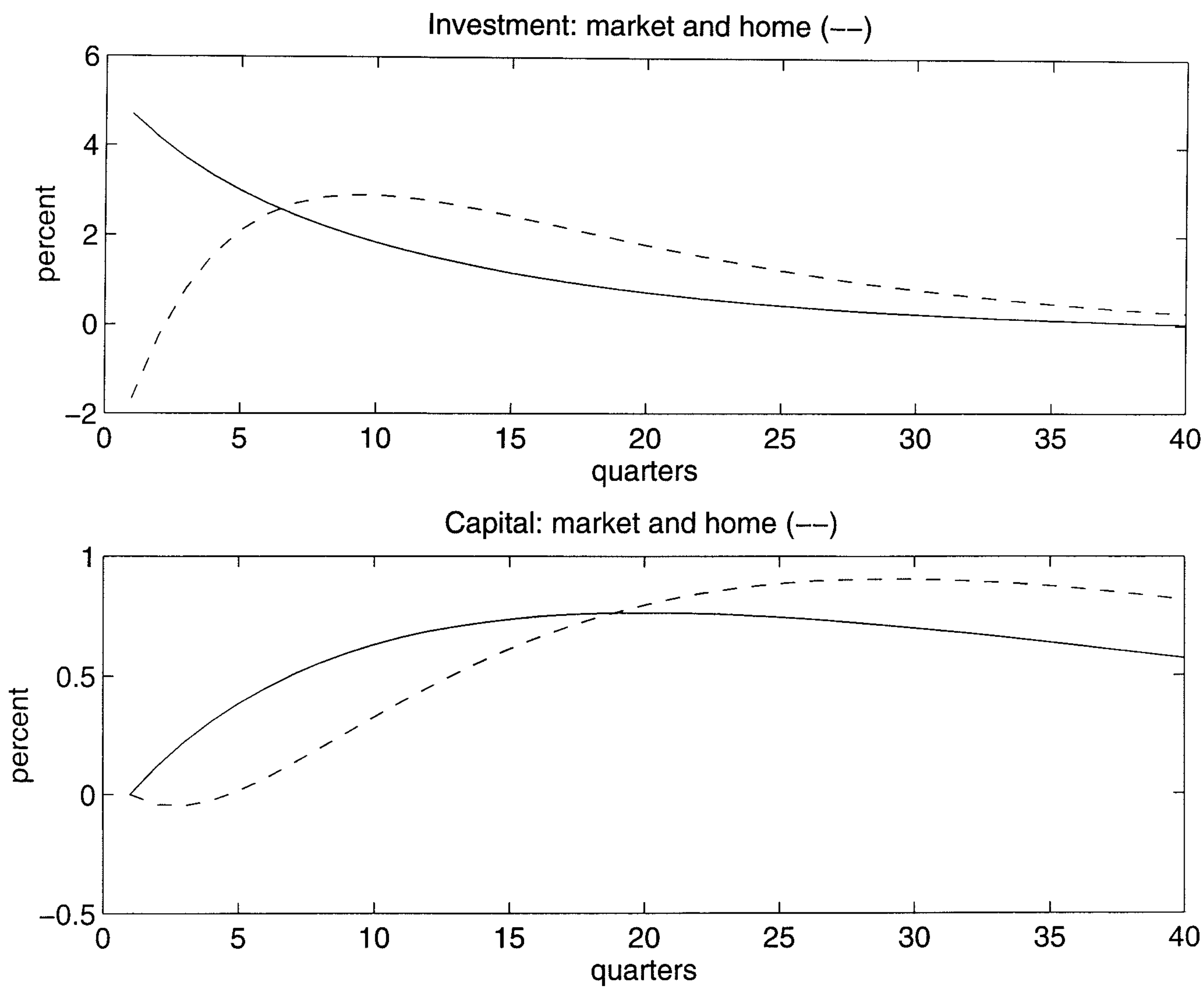

Figure 3: Impulse response of investments and capitals to 1% increase in productivity in the market when $\eta_k = \eta_x = 80$, $\varepsilon_D = 2.59$, $\varepsilon_S = 0.34$