Supplementary Appendix for the Paper "Demand Shocks as Technology Shocks"

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This appendix presents the equilibrium and calibration of the model with storable goods. It also includes a robustness check on the Bayesian estimation with an alternative definition of storable goods and alternative specification of shocks.

1 A Shopping Model with Storable Goods and Services

We consider an economy with storable consumption goods, services and investment. There are search frictions in goods and services but not in investment. Goods can be stored by both households and firms with depreciation δ_f for firms and δ_h for households. Investment can be stored with depreciation rate of δ by both firms and households. Without loss of generosity, we assume that households accumulate capital.

Goods yield utility to the households that hold them. Services can only be produced when a shopper is present. An unmatched services location produces zero output. An unmatched goods location yields goods that add, subject to depreciation, to the stock of inventories the following period. Goods are produced in two stages. First, the production of goods involves a manufacturing stage where a physical object is produced using labor. The following period this object becomes available in a location where it may or may not match with a shopper. If there is a match, then a sale is produced that adds to output. If not the physical object is added to the stock of inventories. Output or GDP is the sum of the sales of goods, services, investment, and changes of inventories.

The aggregate state of the economy is $\Lambda = (\theta, G, X, K)$ where G denotes households' stocks of goods, X firms' inventories, and K the set of capital stock for each sector $K = (K_g, K_s, K_i)$.

Markets are differentiated by what is traded, and by price, tightness, and quantity. We label goods markets by (p_g, q_g, F_g) and services markets by (P_s, q_s, F_s) where P is the price, $Q = D/T$ is market tightness, and F is the capacity in a market. The price of investment is given by P_i and the price of inventory investment is P_x. The measure of location for goods is T_g, for service is T_s, and for investment is 1.

We pose again the determination of which markets are active by having firms choose which market to go to among those that guarantee households a certain level of utility $V(\Lambda)$. Households take the existing markets as given. We pose all prices and later choose a numeraire.

1.1 Households

Households choose purchases of goods c, and of services s, shopping effort for goods d_g, and for services d_s, hours worked n, and investments (i_g, i_s, i_i), taking as given the wage w, rental return r_k, and the dividend income π to maximize

$$V(\Lambda, g, k) = \max_{c,s,d^c,d^s,n,a',I,k'} u(c + (1-\delta_h)g, s, d_g + d_s, n; \theta) + \beta\, E\{V(\Lambda', c + (1-\delta_h)g, k')\}$$

subject to

$$\begin{aligned} c\, p_g(\Lambda) + &s\, p_s(\Lambda) + p_i(\Lambda)(i_g + i_s + i_i) \\ &\leq \pi(\Lambda) + n\, w(\Lambda) + R_g(\Lambda)k_g + R_s(\Lambda)k_s + R_i(\Lambda)k_i \\ c &= d_g\ \Psi_{d,g}\left[q_g(\Lambda)\right]\ F_g(\Lambda), \\ s &= d_s\ \Psi_{d,s}\left[q_s(\Lambda)\right]\ F_s(\Lambda) \\ k_g' &= (1-\delta)k_g + i_g \\ k_s' &= (1-\delta)k_s + i_s \\ k_i' &= (1-\delta)k_i + i_i \end{aligned}$$

and the law of motion for Λ.

The equilibrium value is given by $v(\Lambda, G, K)$ that is what we denote $V(\Lambda)$. We write cumbersomely $V^s(\Lambda, g, k, \hat{p}_s, \hat{q}_s, \hat{F}_s)$ and $V^g(\Lambda, g, k, \hat{p}_g, \hat{q}_g, \hat{F}_g)$ to denote the utility attained by households if the market available where the one specified rather than the equilibrium market.

Let λ^h be the multiplier on the budget constraint. We derive the following first order conditions for the household's problem

$$
\begin{aligned}
v_g(\Lambda) &= (1-\delta_h)\left\{u_c + \beta E[v_g(\Lambda')]\right\} \\
\lambda^h &= \frac{1}{P_s}\left(u_s + \frac{u_d}{\Psi_d(Q^s)F_s}\right) \\
\frac{P_g}{P_s}\left(u_s + \frac{u_d}{\Psi_{d.s}(Q_s)F_s}\right) &= u_c + \frac{u_d}{\Psi_{d,g}(Q_g)F_g} + \beta E[v_g(\Lambda')] \\
-\frac{u_n}{u_s + \frac{u_d}{\Psi_{d,s}(Q_s)F_s}} &= \frac{w}{P_s} \\
\frac{P_i}{P_s}\left(u_s + \frac{u_d}{\Psi_{d,s}(Q_s)F_s}\right) &= \beta E\left\{\frac{P_i(\Lambda')(1-\delta)+R_g(\Lambda')}{P_s(\Lambda')}\left(u_s(\Lambda') + \frac{u_d(\Lambda')}{\Psi_{d,s}(Q_s(\Lambda'))F_s(\Lambda')}\right)\right\} \\
\frac{P_i}{P_s}\left(u_s + \frac{u_d}{\Psi_{d,s}(Q_s)F_s}\right) &= \beta E\left\{\frac{P_i(\Lambda')(1-\delta)+R_s(\Lambda')}{P_s(\Lambda')}\left(u_s(\Lambda') + \frac{u_d(\Lambda')}{\Psi_{d,s}(Q_s(\Lambda'))F_s(\Lambda')}\right)\right\} \\
\frac{P_i}{P_s}\left(u_s + \frac{u_d}{\Psi_{d,s}(Q_s)F_s}\right) &= \beta E\left\{\frac{P_i(\Lambda')(1-\delta)+R_i(\Lambda')}{P_s(\Lambda')}\left(u_s(\Lambda') + \frac{u_d(\Lambda')}{\Psi_{d,s}(Q_s(\Lambda'))F_s(\Lambda')}\right)\right\}.
\end{aligned}
$$

We now derive the marginal utility of p, Q, F using the envelope theorem. The objective function of the household can be rewritten as

$$
\begin{aligned}
V(\Lambda, g, k) = \max_{d_g, d_s, n, k'} \; & u\left(d_g\Psi_{d,g}(q_s)F_g + (1-\delta_h)g, d_s\Psi_{d,s}(q_s)F_s, d_g + d_s, n\right) \\
& + \beta \; E\{V(\Lambda', d_g\Psi_{d,g}(q_g)F_g + (1-\delta_h)g, k')\}
\end{aligned}
$$

subject to

$$
\begin{aligned}
d_g\Psi_{d,g}(q_g)F_g p_g(\Lambda) + & d_s\Psi_{d,s}(q_s)F_s\, p_s(\Lambda) + p_i(\Lambda)(k'_g + k'_s + k'_i) \\
\leq & \pi(\Lambda) + n\, w(\Lambda) + [R_g(\Lambda) + p_i(\Lambda)(1-\delta)]k_g \\
& + [R_s(\Lambda) + p_i(\Lambda)(1-\delta)]k_s + [R_i(\Lambda) + p_i(\Lambda)(1-\delta)]k_i
\end{aligned}
$$

Using the definition of $\Psi_d(q_g) = (q_g)^{1-\varphi}$ and the envelope theorem, we get the following derivatives

$$
\begin{aligned}
V_{p_g} &= -\lambda^h d_g(q_g)^{1-\varphi}F_g \\
V_{q_g} &= (1-\varphi)d_g(q_g)^{-\varphi}F_g(u_c + \beta E V_g(\Lambda') - \lambda^h p^g) \\
V_{F_g} &= d_g(q_g)^{1-\varphi}(u_c + \beta E V_g(\Lambda') - \lambda^h p^g) \\
V_{p_s} &= -\lambda^h d_s(q_s)^{1-\varphi}F_s \\
V_{q_s} &= (1-\varphi)d_s(q_s)^{-\varphi}F_s(u_s - \lambda^h p_s) \\
V_{F_s} &= d_s(q_s)^{1-\varphi}(u_s - \lambda^h p_s)
\end{aligned}
$$

These derivatives will be useful when we characterize firms' optimal problem.

1.2 Firms in the Services Sector

The production function of a firm in the services sector is $z_s\, f_s(n_s, k_s)$. The firm chooses labor and which market to go to subject to that market providing enough utility to the household, *i.e.* $V^s(\Lambda, p_s, q_s, F_s) \geq V(\Lambda)$. The problem of these firms is static, but we write it dynamically to compare it with the good producing firms.

$$\max_{p_s, F_s, q_s, n_s, k_s} \; p_s\, \Psi_{T,s}(q_s)\, F_s - w(\Lambda) n_s - R_s(\Lambda) k_s$$

subject to

$$\begin{aligned} z_s f(n_s, k_s) &\geq F_s \qquad (\lambda^s) \\ V^s(\Lambda, p_s, q_s, F_s) &\geq V(\Lambda) \qquad (\gamma^s) \end{aligned}$$

and to the equilibrium law of motion, $\Lambda' = H(\Lambda)$.

The following conditions characterize the service firm's problem,

$$\begin{aligned} \frac{w}{R_s} &= \frac{f_n(n_s, k_s)}{f_k(n_s, k_s)} \\ w &= \frac{1}{1-\varphi} P_s \Psi_{T,s}(q_s) z_s f_n(n_s, k_s) \\ -u_d &= \varphi u_s \Psi_{d,s}(Q_s) F_s \\ F_s &= z_s f(n_s, k_s). \end{aligned}$$

1.3 Firms in the Goods Sector

There are two activities that goods producing firms undertake, production and sales. Each period, a firm in the goods sector can send inventories x plus the newly produced goods to a market. Firms first choose their inputs n_g and k_g for the next period's production. They then choose which market to search for customers. After the matching, firms choose how much extra investment of inventory to purchase from the frictionless inventory market with price $p_x(\Lambda)$. The unmatched firms choose i_n^x and the matched firms choose i_m^x. This in turn gives the next period's inventory for the unmatched firms,

$$x_n' = z_g f(n_g, k_g) + (1 - \delta_f) x + i_n^x$$

and for the matched firms

$$x_m' = z_g f(n_g, k_g) + (1 - \delta_f) x - F_g + i_m^x$$

We will show below that firms with identical initial inventory choose the same holdings of next period's inventory, i.e.

$$x_n'(x, \Lambda) = x_m'(x, \Lambda).$$

Specifically, firms in the goods sector choose how many workers and capital to hire/rent, how much inventory to use, which market to search (p_g, F_g, Q_g) among those available for goods F_g and how much is held for next period, taking as given the market prices w, R_g, and the stochastic discount factor Υ. Then a goods producer chooses $\{n_g, k_g, p_g, F_g, Q_g, i_n^x, i_m^x, x'_m, x'_n\}$ to solve the following problem

$$\begin{aligned}\Omega(x, \Lambda) = \max \;\; -w(\Lambda)n_g - R_g(\Lambda)k_g + &\Psi_{T,g}(q_g)\left\{p_g F_g - p_x(\Lambda)i_m^x + E\Upsilon(\Lambda, \Lambda')\Omega^g(x'_m, \Lambda')\right\} \\ &+ (1 - \Psi(q_g))\left\{-p_x(\Lambda)i_n^x + E\Upsilon(\Lambda, \Lambda')\Omega(x'_n, \Lambda')\right\}\end{aligned}$$

subject to

$$\begin{aligned} F_g &\le z_g f(n_g, k_g) + (1 - \delta_f)x, \\ x'_m &\le z_g f(n_g, k_g) + (1 - \delta_f)x - F_g + i_m^x, \\ x'_n &\le z_g f(n_g, k_g) + (1 - \delta_f)x + i_n^x, \\ V^g(\Lambda, p_g, q_g, F_g) &\ge V(\Lambda). \end{aligned}$$

We can show that consumption goods producers with identical initial inventory choose the same holdings of next period's inventory, i.e.

$$x'_n(\Lambda, x) = x'_m(\Lambda, x). \tag{1}$$

Taking the first order conditions on $i_{x,u}, i_{x,m}, x'_m, x'_n$, we have

$$\begin{aligned} \Psi_{T,g}(q_g)p_x(\Lambda) &= \mu_m, \qquad (1 - \Psi_{T,g}(q_g))p_x(\Lambda) = \mu_n \\ \Psi_{T,g}(q_g)E[\Upsilon(\Lambda, \Lambda')\Omega_x(\Lambda', x'_m)] &= \mu_m, \qquad (1 - \Psi_{T,g}(q_g))E[\Upsilon(\Lambda, \Lambda')\Omega_x(\Lambda', x'_n)] = \mu_n \end{aligned}$$

Combining these four equations, we have

$$\frac{\Psi_{T,g}(q_g)E[\Upsilon(\Lambda, \Lambda')\Omega_x(\Lambda', x'_m)]}{(1 - \Psi_{T,g}(q_g))E[\Upsilon(\Lambda, \Lambda')\Omega_x(\Lambda', x'_n)]} = \frac{\mu_m}{\mu_n} = \frac{\Psi_{T,g}(q_g)p_x(\Lambda)}{(1 - \Psi_{T,g}(q_g))p_x(\Lambda)}$$

which implies

$$\frac{E[\Upsilon(\Lambda, \Lambda')\Omega_x(\Lambda', x'_m)]}{E[\Upsilon(\Lambda, \Lambda')\Omega_x(\Lambda', x'_n)]} = 1.$$

It is therefore $x'_m = x'_n$.

We can characterize the firm's problem with the following equations,

$$
\begin{aligned}
w(\Lambda) &= \left[\frac{1}{1-\varphi}A(q_g)^{-\varphi}(p_g - p_x) + p_x\right] z_g f_n^g, \\
\frac{w(\Lambda)}{R_g(\Lambda)} &= \frac{f_n^g}{f_k^g}, \\
-u_d &= \frac{\varphi(p_g - p_x)}{p_g - \varphi p_x}\left[u_c + \beta E V_g(\Lambda')\right] \Psi_{d,g}(q_g) F_g, \\
p_x = \beta(1-\delta_f)\sum &\left[p_x(\Lambda') + \frac{1}{1-\varphi}(q_g(\Lambda'))^{-\varphi}(p_g(\Lambda') - p_x(\Lambda'))\right]\frac{u_s(\Lambda')p_s(\Lambda)}{u_s(\Lambda)p_s(\Lambda')}, \\
F_g &= z_g f(k_g, n_g) + (1-\delta_f)x.
\end{aligned}
$$

1.4 Firms in the Investment Good Sector

The production function of a firm in the investment sector is $z_i f(n_i, k_i)$. Investment good does not subject to search friction. Thus standard conditions apply,

$$
\begin{aligned}
w(\Lambda) &= p_i z z_i f_n(n_i, k_i), \\
R_i(\Lambda) &= p_i z z_i f_k(n_i, k_i).
\end{aligned}
$$

1.5 Equilibrium

We normalize the price of consumption good as 1, i.e. $p_g = 1$.

The competitive equilibrium consists of allocations $\{C, S,\ G,\ D_g,\ D_s,\ I_g,\ I_s,\ I_i,\ N,\ N_g,\ N_s,$ $N_i, n_g, n_s,\ k_g, k_s,\ x',\ K_g',\ K_s',\ K_i',\ X'\}$, values V and Ω, prices $\{w, R_g, R_s, R_i, p_x, p_i\}$, market tightness and capacity $p_g, p_s, q_g, q_s, F_g, F_s$ and dividend π such that

1. Households choose $\{C,\ S,\ D_g,\ D_s,\ I_g,\ I_s,\ I_i,\ N,\ K_g',\ K_s',\ K_i',\ V\}$ solve their problem taking as given prices $\{w, R_g, R_s, R_i, p_i\}$ and dividend π. The stochastic discount factor satisfies $\Upsilon(\Lambda, \Lambda') = \beta u_s(\Lambda')/u_s(\Lambda)$.
2. Investment producers choose $\{N_i, K_i\}$ solve their problem taking as given $\{w, R_i, p_i\}$.
3. Goods producers choose $\{p_g, q_g, F_g, n_g, k_g, x'\}$ to their problem taking as given $\{w, R_g, p_x\}$.
4. Service producers choose $\{p_s, q_s, F_s, n_s, k_s\}$ to their problem taking as given $\{w, R_s\}$.

5. Market clearing conditions are satisfied

$$
\begin{aligned}
C &= T_g \Psi_{T,g}(q_g) F_g \\
S &= T_s \Psi_{T,s}(q_s) z_s f(k_s, n_s) \\
z_i f(N_i, K_i) &= (K_g' - (1-\delta_k)K_g) + (K_s' - (1-\delta_k)K_s) + (K_i' - (1-\delta_k)K_i) \\
N &= N_g + N_s + N_i \\
x' &= [1 - \Psi_{T,g}(q_g)] F_g \\
F_g &= z_g f(k_g, n_g) + (1-\delta_f)\frac{X}{T_g} \\
X' &= T_g x' \\
K_g &= T_g k_g \\
N_g &= T_g n_g \\
K_s &= T_s k_s \\
N_s &= T_s n_s
\end{aligned}
$$

The equilibrium can be characterized with the following equations.

$$V_g(\Lambda) = (1-\delta_h)\left\{u_c + \beta E[V_g(\Lambda')]\right\} \tag{2}$$

$$\frac{1}{p_s}u_s = \frac{1}{1-\varphi p_x}\left\{u_c + \beta E[V_g(\Lambda')]\right\} \tag{3}$$

$$-\frac{u_n}{u_s} = (1-\varphi)\frac{w}{p_s} \tag{4}$$

$$\frac{p_i}{p_s}u_s = \beta E\left\{\frac{p_i(\Lambda')(1-\delta) + R_g(\Lambda')}{p_s(\Lambda')}u_s(\Lambda')\right\} \tag{5}$$

$$\frac{p_i}{p_s}u_s = \beta E\left\{\frac{p_i(\Lambda')(1-\delta) + R_s(\Lambda')}{p_s(\Lambda')}u_s(\Lambda')\right\} \tag{6}$$

$$\frac{p_i}{p_s}u_s = \beta E\left\{\frac{p_i(\Lambda')(1-\delta) + R_i(\Lambda')}{p_s(\Lambda')}u_s(\Lambda')\right\} \tag{7}$$

$$w(\Lambda) = \left[\frac{1}{1-\varphi}\Psi_{T,g}(q_g)(1-p_x) + p_x\right] z_g f_n^g \tag{8}$$

$$w(\Lambda)/R_g(\Lambda) = f_n^g / f_k^g \tag{9}$$

$$\frac{u_d}{\Psi_{d,g}(q_g)F_g} = -\frac{\varphi(1-p_x)}{1-\varphi p_x}\left[u_c + \beta E V_g(\Lambda')\right] \tag{10}$$

$$p_x = \beta(1-\delta_f)\sum\left[p_x(\Lambda') + \frac{1}{1-\varphi}\Psi_{T,g}(q_g(\Lambda'))(1-p_x(\Lambda'))\right]\frac{u_s(\Lambda')p_s(\Lambda)}{u_s(\Lambda)p_s(\Lambda')} \tag{11}$$

$$w(\Lambda) = p_i z_i f_n^i(n_i, k_i) \tag{12}$$

$$R_i(\Lambda) = p_i z_i f_k^i(n_i, k_i) \tag{13}$$

$$w/R_s = f_n^s/f_k^s \tag{14}$$
$$(1-\varphi)w = p_s \Psi_{T,s}(q_s) z_s f_n^s \tag{15}$$
$$\frac{u_d}{\Psi_{d,s}(q^s)F_s} = -\varphi u_s \tag{16}$$
$$F_s = z_s f(k_s, n_s) \tag{17}$$
$$F_g = z_g f(k_g, n_g) + (1-\delta_f)X/T_g \tag{18}$$
$$C = T_g \Psi_{T,g}(q_g) F_g \tag{19}$$
$$S = T_s \Psi_{T,s}(q_s) F_s \tag{20}$$
$$z_i f(N_i, K_i) = T_g(k_g' - (1-\delta)k_g) + T_s(k_s' - (1-\delta)k_s) + (K^{i\prime} - (1-\delta)K_i) \tag{21}$$
$$N = T_g n_g + T_s n_s + N_i \tag{22}$$
$$X' = T_g[1 - \Psi_T^g(q_g)]F_g \tag{23}$$
$$q_g = D_g/T_g \tag{24}$$
$$q_s = D^s \tag{25}$$
$$G' = (1-\delta_h)G + C \tag{26}$$

1.6 Steady state

The steady state includes twenty variables $\{C, G, S, D^g, D^s, N, N_g, N_s, N_i, K_g, K_s, K_i, k_g, n_g, X\}$, prices $\{w, R, p_x, p_i\}$, market tightness and capacity p_s, q_g, q_s which satisfy the following twenty equations:

$$\frac{1}{p_s}u_s = \frac{1}{1-\varphi p_x}\frac{1}{1-\beta(1-\delta_h)}u_c \tag{27}$$
$$-\frac{u_n}{u_s} = (1-\varphi)\frac{w}{p_s} \tag{28}$$
$$R = \left(\frac{1}{\beta} - 1 + \delta\right) p_i \tag{29}$$

$$\frac{u_d}{\Psi_{d,g}(Q_g)F_g} = -\frac{\varphi(1-p_x)}{1-\varphi p_x}\frac{1}{1-\beta(1-\delta_h)}u_c \tag{30}$$
$$\frac{u_d}{\Psi_{d,s}(Q_s)F_s} = -\varphi u_s \tag{31}$$
$$w = \left[\frac{1}{1-\varphi}\Psi_{T,g}(q_g)(1-p_x) + p_x\right] z_g f_n\left(\frac{K_g}{T_g}, \frac{N_g}{T_g}\right) \tag{32}$$

$$w = \frac{1}{1-\varphi}p_s \Psi_{T,s}(q_s) z z_s f_n\left(\frac{K_s}{T_s}, \frac{N_s}{T_s}\right) \tag{33}$$

$$w = p_i z z_i f_n(K_i, N_i) = p_i \gamma_n \frac{I}{N_i} \tag{34}$$

$$r_k = p_i zz_i f_k(K_i, N_i) = p_i \gamma_k \frac{I}{K_i} \tag{35}$$

$$\frac{w}{r_k} = \frac{f_n(K_s/T_s, N_s/T_s)}{f_k(K_s/T_s, N_s/T_s)} \tag{36}$$

$$\frac{K_g}{N_g} = \frac{K_s}{N_s} = \frac{K_i}{N_i} \tag{37}$$

$$p_x = \frac{\beta(1-\delta_f)\Psi_{T,g}(q_g)}{(1-\varphi)(1-\beta(1-\delta_f)) + \beta(1-\delta_f)\Psi_{T,g}(q_g)} \tag{38}$$

$$C = T_g \Psi_{T,g}(q_g)\left[zf\left(\frac{K_g}{T_g}, \frac{N_g}{T_g}\right) + (1-\delta_f)X\right] \tag{39}$$

$$S = T_s \Psi_{T,s}(q_s) zz_s f\left(\frac{K_s}{T_s}, \frac{N_s}{T_s}\right) \tag{40}$$

$$\delta K = zz_i f(K_i, N_i) \tag{41}$$

$$N = N_g + N_s + N_i \tag{42}$$

$$\frac{[1-(1-\delta_f)(1-\Psi_{T,g}(q_g)]}{1-\Psi_{T,g}(q_g)} X = T_g \, zf\left(\frac{K_g}{T_g}, \frac{N_g}{T_g}\right) \tag{43}$$

$$q_g = D_g/T_g \tag{44}$$

$$q_s = D_s/T_s \tag{45}$$

where $\Psi_{T,g}(q_g) = A_g(q_g)^{\varphi}$, $\Psi_{d,g}(q_g) = A_g(q_g)^{\varphi-1}$, $\Psi_{T,s}(q_s) = (q_s)^{\varphi}$, and $\Psi_{g,s}(q_s) = (q_s)^{\varphi-1}$.

2 Calibration

We now describe the calibration. We consider the following functional form for preference

$$u(g, s, d_c, d_s, n) = \frac{1}{1-\gamma}\left\{\left[\mu[c + (1-\delta_h)g]^{\frac{\omega-1}{\omega}} + (1-\mu)s^{\frac{\omega-1}{\omega}}\right]^{\frac{\omega}{\omega-1}} - \chi_d \frac{(d_c + d_s)^{1+1/\eta}}{1+1/\eta}\right\}^{1-\gamma} - \chi_n \frac{n^{1+1/\nu}}{1+1/\nu}.$$

Table 1 summarizes the moments and parameters values. Under the same relevant moments as the benchmark, the shopping parameters η and φ take the benchmark values.

Depreciation δ. Let the investment share of output be $\kappa = p_I I/Y = 20\%$ and the size of the aggregate capital-output ratio $p_I K/Y = 2.75$. This allows us to pin down the depreciation rate from the steady-state relation $\delta K = I$, so

$$\delta = \frac{p_I I/Y}{p_I K/Y} = \frac{0.2}{2.75} = 7.3\%$$

Finding capacity utilization of goods sector We use the inventory-sale ratio in the goods sector to get the probability of matching in goods sector $\Psi_{T,g}$ in steady state. In the model the inventory-to-sale ratio equals $X/C = (1-\Psi_{T,g})F_g/\Psi_{T,g}F_g$. Thus, with the observed quarterly ratio of 0.46, we obtain $\Psi_{T,g} = 0.68$. We can then calculate $p_x = 0.93$ with equaiton (38) using the quarterly depreciation rate of inventory $\delta_f = 0.05$, and $\beta = 1/1.01$. Combining equation (27), (30), and (31), we can get

$$D_g = \frac{(1-p_x)C}{Sp_s} = \frac{(1-p_x)(1-\kappa_s)}{\kappa_s} D_s,$$

where $1-\kappa_s$ is the share of storable good purchases aggregate consumption. From $\Psi_{T,s} = D_s^{\varphi} = 0.81$, we know $D_s = 0.4$. We can therefore calculate the corresponding D_g.

Calibration of T_g It can be calculated directly from the definition of matching probability for firms $T_g = D_g/\Psi_{T,g}^{1/\varphi}$.

Calibration of labor share The aggregate labor share is given by,

$$\begin{aligned}\frac{WN}{Y} &= \theta_n \left[\frac{(1-p_x)\Psi_{T,g}}{1-\varphi} + p_x\right] \frac{1-(1-\delta_f)(1-\Psi_{T,g})}{\Psi_{T,g}} (1-\kappa)(1-\kappa_s) \\ &+ \frac{\theta_n}{1-\varphi}(1-\kappa)\kappa_s + \theta_n \kappa\end{aligned}$$

where three terms of the right-hand side are the labor share in the good sector WN_g/Y, in the service sector WN_s/Y, and in the investment sector WN_i/Y respectively. We solve θ_n from the above equation with $WN/Y = 0.67$, $p_x = 0.9338$, $\Psi_{T,g} = 0.6865$, $\delta_f = 0.05$, $\kappa = 0.2$, $\kappa_s = 0.92$, and $\varphi = 0.23$. Note that given θ_n, we know the labor share in each sector.

Calibration of capital share

$$\frac{RK}{Y} = \frac{WN_g}{Y}\frac{\theta_k}{\theta_n} + \frac{WN_s}{Y}\frac{\theta_k}{\theta_n} + \theta_k \kappa.$$

The left-hand side of the above equation is given by

$$\frac{RK}{Y} = \left(\frac{1}{\beta} - 1 + \delta\right)\frac{\kappa}{\delta}.$$

We can therefore solve θ_k.

Calibration for consumption share parameter μ in the utility function Taking the ratio of the household's first order conditions (30) and (31), we have

$$\frac{D_g}{D_s} = \frac{\mu}{(1-\mu)}\frac{C}{S}(S/G)^{-\frac{1}{\omega}}\frac{(1-p_x)}{1-\varphi p_x}\frac{1}{1-\beta(1-\delta_h)}.$$

where the stock of good $G = C/\delta_h$. We solve μ from the above equation with the quarterly household depreciation rate $\delta_h = 0.05$ and other endogenous values solved above.

Calibration of T_g Note that

$$\frac{T_g f^g}{S/\mu_p} = \frac{T_g f^g}{F_s} = \frac{T_g z_g (k_g)^{\gamma_k}(n_g)^{\gamma_n}}{z_s(K_s)^{\gamma_k}(N_s)^{\gamma_n}} = \frac{z_g T_g^{1-\gamma_k-\gamma_n}(K_g)^{\gamma_k}(N_g)^{\gamma_n}}{z_s(K_s)^{\gamma_k}(N_s)^{\gamma_n}}$$

with $z_g = z_s$, we have

$$\frac{T_g f^g}{S/\mu_p} = \frac{T_g^{1-\gamma_k-\gamma_n}(K_g)^{\gamma_k}(N_g)^{\gamma_n}}{(K_s)^{\gamma_k}(N_s)^{\gamma_n}}.$$

Thus

$$T_g = \left(\frac{T_g f^g}{S/\mu_p}\right)^{\frac{1}{1-\gamma_k-\gamma_n}} \left(\frac{K_s}{K_g}\right)^{\frac{\gamma_k+\gamma_n}{1-\gamma_k-\gamma_n}}$$

We can get the ratio of K_s/K_g from firms' first order conditions.

Calibration of weight on search effort χ_d. It is easy to show that equation (31) can be rewritten as

$$\chi_d(D_g + D_s)^{\frac{1}{\eta_d}} D_S = (1-\mu)(M/S)^{\frac{1}{\omega}} \varphi S$$

with M given by $M = \left[\mu G^{\frac{\omega-1}{\omega}} + (1-\mu)s^{\frac{\omega-1}{\omega}}\right]^{\frac{\omega}{\omega-1}}$. This implies $\chi_d = 740$.

Others The mean TFP $E(z)$ and $E(z_i)$ are calibrated in a similar fashion as in the benchmark case.

[Table 1 about here.]

3 Robustness of Estimation: alternative shock specifications

We conduct sensitivity analysis over alternative shock specifications. In Table 2 to Table 6, we use five data series in the estimation, output Y, labor productivity Y/N, investment Inv, investment price P_i, and the ratio of goods to service C/S. In all the specifications, shocks are independent and follow AR(1) processes. Table 2 reports our benchmark estimation together with the corresponding business cycle statistics and variance decomposition. There are five shocks, θ_d on shopping disutility, θ_n on leisure, and three productivity shocks $\{z_s, z_g, z_i\}$. Service firms face productivity shock z_s, goods producing firms have $z_s z_g$, and investment firms produce with $z_s z_i$. The persistence parameters for these shocks are $\{\rho_d, \rho_n, \rho_{z_s}, \rho_{z_g}, \rho_{z_i}\}$ and the standard deviations are $\{\sigma_d, \sigma_n, \sigma_{z_s}, \sigma_{z_g}, \sigma_{z_i}\}$.

Table 3 presents the estimation with two types of shopping disutility shocks, θ_d^g goods and θ_d^s on service. Shocks also include the usual leisure shock θ_n and two types of productivity shocks z_s

and z_i. The productivity shock on the service and goods sector is z_s and on the investment sector is $z_s z_i$. Table 4 and Table 5 have the same five shocks as in the benchmark. However, in Table 4 the productivity shock on the service sector is $z_g z_s$, on goods is z_g, and on investment is $z_g z_i$. In Table 5 the productivity shock on the service sector is z_s, on goods is z_g, and on investment is z_i. Table 6 has the same shock specification as our benchmark in Table 2, but it has an calibration of higher household's depreciation of 0.99.

Table 7 and 8 estimate without the ratio of goods to service C/S and includes only four data series. They both have four shocks, θ_d on shopping disutility, θ_n on leisure, productivity shocks of $\{z_s, z_i\}$. Firms in service and goods sector produce with z_s and firms in investment sector face shocks of $z_s z_i$. The difference between these two tables is that Table 7 has the benchmark calibration and Table 8 has a high household's depreciation rate.

The demand shock θ_d on the disutility of shopping plays significant role in generating aggregate fluctuations. Its contribution varies from 18 percent to 34 percent for output, 30 percent to 44 percent for TFP, and 39 percent to 61 percent for consumption.

Here we focus on two business cycle facts that are unique to our model with storable goods and service. One is the relative goods volatility to service. The other one is the cyclicality of inventory to sales ratio. In the data, the variance of durable goods purchases is 27 times larger than the variance of services plus non-durable consumption, and inventory to sales ratio is countercyclical with a correlation of -0.46. All models have a countercyclical inventory to sales except for Table 6.

In all estimations except for Table 8, goods are more volatile than services, consistent with the data. The benchmark economy in Table 2 has the highest likelihood and also matches better the excess variance of goods. It is easy to understand the intuition when we compare the results with those in Table 8, which assumes that goods is almost nondurable with a depreciation rate of 0.99 and estimates without the ratio of goods to service. In this case, firms in goods sector can store unmatched goods as inventory, but service firms cannot. Hence, search frictions have more impact on the service sector than on the goods sector. Service sector responds more to shocks and becomes more volatile than goods sector. Table 6 also assumes a high depreciation rate of households. It, however, includes an extra shock on goods sector z_g and forces the model to match the highly volatile goods. The estimated z_g is more volatile and more persistent than the neutral shock z_s in this case. It turns out that the estimated goods is more volatile than service. However, the variance of goods is just twice as large as the variance of servcices – a much smaller difference than in the data. The high persistence of z_g also leads to an acyclical inventory to sales, opposite to the data.

[Table 2 about here.]

[Table 3 about here.]

[Table 4 about here.]

[Table 5 about here.]

[Table 6 about here.]

[Table 7 about here.]

[Table 8 about here.]

4 Robustness of estimation: nondurable goods

In this section, we report the robustness estimation for an alternative calibration with goods including both durable and nondurable goods in the data. Compared to the benchmark calibration in Table 1, the new calibration in Table 9 leads to more bias to consumption good in preference, i.e. a higher μ, and a larger measure of goods producer firms T_g.

Table 10-13 report the estimation results for the shock structures as in the benchmark case in Table 2-5. We used the same data series of output, labor productivity, investment, and investment price as in the benchmark case. For the ratio of goods to service, we reclassify nondurable goods from service to goods. Hence goods is the sum of durable and nondurable goods, and service is as in NIPA. Since nondurable goods is less volatile than durable but more volatile than service. The variance of goods drops from 19.13 in the benchmark to about 4.27. The variance of service decreases from 0.7 to 0.6.

Demand shock account for less of aggregate fluctuations but still significant. Its contribution varies from 6.5% to 18% for output, 16% to 32% for TFP, and 22 % to 38% for consumption. Demand shock Similarly as in the high service share case, the shock specification of neutral service productivity has the highest likelihood and the excess goods volatility most close to the data. Inventory to sales are countercyclical and the level of the correlations are close to the data.

[Table 9 about here.]

[Table 10 about here.]

[Table 11 about here.]

[Table 12 about here.]

[Table 13 about here.]

Table 1: Calibration of the Shopping Model with Storable Goods and Services

Targets	Value	Parameter	Value
First Group: Parameters Set Exogenously			
Risk aversion	2.	γ	2
Real interest rate	4%	β	0.99
Frisch elasticity	0.72	$\frac{1}{\nu}$	0.72
Elasticity of substitution	0.85	ω	0.85
Households depreciation	0.19	δ_h	0.19
Households depreciation	0.19	δ_f	0.19
Second Group: Standard Targets			
Fraction of time spent working	30%	χ_n	10.68
Labor share of income	0.67	α_n	0.55
Consumption share	0.80	α_k	0.25
Capital-output ratio	2.75	δ	0.07
Storable goods share in cons.	0.08	μ	0.07
Inventory-sale ratio	11.5%	T_g	0.018
Third Group: Normalization			
Steady-state output	1	$E(z)$	1.74
p_i	1	$E(z_i)$	0.09
Capacity utilization of services	0.81	χ_d	2339
Fourth Group: Targets Specific to This Economy			
Price dispersion	0.21	φ	0.23
Shopping elasticity	0.075	η_d	0.11

Table 2: Economy BM1: z_s on service, $z_s z_g$ on goods, $z_s z_i$ on investment

Priors and Posteriors for the Shock Parameters (Likelihood = 2570.57)
Data used: Y, Y/N, Inv, P_i, C/S

Parameter	Density	Para(1)	Para(2)	Mean	90% Intv.
ρ_d	Beta	0.930	0.05	0.9958	[0.9918, 0.9995]
ρ_{z_g}	Beta	0.930	0.05	0.5634	[0.5327, 0.6001]
ρ_{z_i}	Beta	0.930	0.05	0.9946	[0.9909, 0.9988]
ρ_{z_s}	Beta	0.930	0.05	0.8799	[0.8569, 0.8996]
ρ_n	Beta	0.930	0.05	0.9825	[0.9742, 0.9899]
σ_d	Inv Gamma	0.150	Inf	0.5631	[0.5152, 0.6179]
σ_{z_g}	Inv Gamma	0.002	Inf	0.0274	[0.0250, 0.0302]
σ_{z_i}	Inv Gamma	0.002	Inf	0.0111	[0.0100, 0.0122]
σ_{z_s}	Inv Gamma	0.002	Inf	0.0125	[0.0114, 0.0137]
σ_n	Inv Gamma	0.020	Inf	0.0176	[0.0162, 0.0189]

	Data (1967Q1-2013Q4)			Model			Var Decomposition				
	var(x)	$\frac{var(x)}{var(Y)}$	Corr	var(x)	$\frac{var(x)}{var(Y)}$	Corr	θ_d	z_g	z_i	z_s	θ_n
Y	4.68	1.00	1.00	4.39	1.00	1.00	19.71	2.09	3.61	68.51	6.08
Y/N	1.47	0.31	0.50	5.22	1.19	0.88	41.26	0.46	1.22	54.45	2.62
Investment	48.48	10.36	0.95	29.25	6.66	0.77	1.43	2.05	23.13	69.45	3.93
P_i	0.70	0.15	-0.01	1.18	0.27	0.23	0.02	21.76	62.69	14.70	0.83
Goods/service	14.14	3.02	0.82	63.80	14.53	0.31	2.89	87.31	0.60	8.94	0.26
Labor	3.52	0.75	0.83	1.14	0.26	0.07	25.26	2.04	2.05	2.14	68.51
TFP	2.05	0.44	0.79	4.73	1.08	0.94	35.04	0.86	1.92	62.07	0.11
Consumption	1.58	0.34	0.93	3.27	0.74	0.88	51.67	7.32	0.89	35.61	4.51
Goods	19.13	4.09	0.87	66.73	15.20	0.48	2.15	81.06	0.81	15.17	0.81
Services	0.70	0.15	0.88	2.85	0.65	0.82	65.15	0.41	0.53	29.47	4.44
$\frac{Inventory}{sale}$	2.44	0.52	-0.42	57.64	13.13	-0.58	29.13	59.16	0.49	10.66	0.57
$\frac{P_{goods}}{P_{service}}$	1.47	0.31	-0.19	4.24	0.97	0.69	62.02	9.95	0.51	26.81	0.72

This table reports Bayesian estimation and the corresponding business cycle statistics and variance decomposition for the model with storable goods and services. There are five shocks, θ_d on shopping disutility, θ_n on leisure, productivity shock z_s on the service sector, $z_s z_g$ on the goods sector, and $z_s z_i$ on the investment sector. Shocks are independent and follow AR(1) processes with persistence parameters of $\{\rho_d, \rho_n, \rho_{z_s}, \rho_{z_g}, \rho_{z_i}\}$ and standard deviations of $\{\sigma_d, \sigma_n, \sigma_{z_s}, \sigma_{z_g}, \sigma_{z_i}\}$ respectively. We use five data series in the estimation, output Y, labor productivity Y/N, investment Inv, investment price P_i, and the ratio of goods to service C/S. "Beta" denotes Beta distribution, "Inv Gamma" denotes inverse Gamma distribution, "Para(1)" is the prior mean, "Para(2)" is the prior standard deviation, "Mean" is the posterior mean, and "90% Intv." is short for 90 percentile interval.

Table 3: Economy BM2: shock on d_g and d_s, z_s on service and goods, $z_s z_i$ on investment

Priors and Posteriors for the Shock Parameters (Likelihood = 2553.36)
Data used: Y, Y/N, Inv, P_i, C/S

Parameter	Density	Para(1)	Para(2)	Mean	90% Intv.
ρ_{d_g}	Beta	0.930	0.05	0.9475	[0.9364, 0.9588]
ρ_{d_s}	Beta	0.930	0.05	0.9948	[0.9898, 0.9996]
ρ_{z_s}	Beta	0.930	0.05	0.8317	[0.7939, 0.8718]
ρ_{z_i}	Beta	0.930	0.05	0.9984	[0.9971, 0.9998]
ρ_n	Beta	0.930	0.05	0.9815	[0.9742, 0.9890]
σ_{d_g}	Inv Gamma	0.150	Inf	0.2509	[0.2302, 0.2712]
σ_{d_s}	Inv Gamma	0.150	Inf	0.0500	[0.0450, 0.0542]
σ_{z_s}	Inv Gamma	0.002	Inf	0.0118	[0.0107, 0.0129]
σ_{z_i}	Inv Gamma	0.002	Inf	0.0101	[0.0091, 0.0110]
σ_n	Inv Gamma	0.020	Inf	0.0175	[0.0162, 0.0189]

	Data (1967Q1-2013Q4)			Model			Var Decomposition				
	var(x)	$\frac{var(x)}{var(Y)}$	Corr	var(x)	$\frac{var(x)}{var(Y)}$	Corr	θ_{dg}	θ_{ds}	z_s	z_i	θ_n
Y	4.68	1.00	1.00	3.67	1.00	1.00	0.04	18.84	70.35	3.52	7.26
Y/N	1.47	0.31	0.50	4.31	1.17	0.87	0.03	39.72	55.79	1.30	3.16
Investment	48.48	10.36	0.95	27.48	7.49	0.77	12.98	0.34	63.06	19.42	4.19
P_i	0.70	0.15	-0.01	0.93	0.25	0.14	8.65	0.37	13.40	76.52	1.07
Goods/service	14.14	3.02	0.82	42.45	11.58	0.20	82.02	3.88	13.05	0.67	0.39
Labor	3.52	0.75	0.83	1.05	0.29	0.10	0.00	21.70	2.18	1.57	74.54
TFP	2.05	0.44	0.79	3.90	1.06	0.94	0.03	33.82	64.03	1.99	0.13
Consumption	1.58	0.34	0.93	2.63	0.72	0.86	8.21	47.31	38.12	0.80	5.56
Goods	19.13	4.09	0.87	45.12	12.31	0.39	76.96	0.01	20.95	0.89	1.19
Services	0.70	0.15	0.88	2.33	0.64	0.84	0.01	63.65	30.50	0.46	5.38
$\frac{Inventory}{sale}$	2.44	0.52	-0.42	336.00	91.63	-0.13	98.09	0.01	1.74	0.06	0.10
$\frac{P_{goods}}{P_{service}}$	1.47	0.31	-0.19	3.63	0.99	0.77	2.22	64.49	32.01	0.44	0.84

This table reports Bayesian estimation and the corresponding business cycle statistics and variance decomposition for the model with storable goods and services. There are five shocks, θ_d^g on the shopping disutility of goods, θ_d^s on the shopping disutility of service, θ_n on leisure, productivity shock z_s on the service and goods sector, and $z_s z_i$ on the investment sector. Shocks are independent and follow AR(1) processes with persistence parameters of $\{\rho_{d_g}, \rho_{d_s}, \rho_n, \rho_{z_s}, \rho_{z_i}\}$ and standard deviations of $\{\sigma_{d_g}, \sigma_{d_s}, \sigma_n, \sigma_{z_s}, \sigma_{z_i}\}$ respectively. We use five data series in the estimation, output Y, labor productivity Y/N, investment Inv, investment price P_i, and the ratio of goods to service C/S. "Beta" denotes Beta distribution, "Inv Gamma" denotes inverse Gamma distribution, "Para(1)" is the prior mean, "Para(2)" is the prior standard deviation, "Mean" is the posterior mean, and "90% Intv." is short for 90 percentile interval.

Table 4: Economy BM3: $z_g z_s$ on service, z_g on goods, $z_g z_i$ on investment goods

Priors and Posteriors for the Shock Parameters (Likelihood = 2511.71)
Data used: Y, Y/N, Inv, P_i, C/S

Parameter	Density	Para(1)	Para(2)	Mean	90% Intv.
ρ_d	Beta	0.930	0.05	0.9995	[0.9990, 0.9999]
ρ_{z_g}	Beta	0.930	0.05	0.8377	[0.8095, 0.8658]
ρ_{z_i}	Beta	0.930	0.05	0.9917	[0.9873, 0.9968]
ρ_{z_s}	Beta	0.930	0.05	0.9630	[0.9560, 0.9699]
ρ_n	Beta	0.930	0.05	0.9887	[0.9819, 0.9954]
σ_d	Inv Gamma	0.150	Inf	1.0381	[0.9519, 1.1263]
σ_{z_g}	Inv Gamma	0.002	Inf	0.0151	[0.0137, 0.0163]
σ_{z_i}	Inv Gamma	0.002	Inf	0.0097	[0.0087, 0.0106]
σ_{z_s}	Inv Gamma	0.002	Inf	0.0294	[0.0268, 0.0319]
σ_n	Inv Gamma	0.020	Inf	0.0176	[0.0162, 0.0189]

	Data (1967Q1-2013Q4)			Model			Var Decomposition				
	var(x)	$\frac{var(x)}{var(Y)}$	Corr	var(x)	$\frac{var(x)}{var(Y)}$	Corr	θ_d	z_g	z_i	z_s	θ_n
Y	4.68	1.00	1.00	13.22	1.00	1.00	21.57	32.75	1.02	42.73	1.92
Y/N	1.47	0.31	0.50	22.56	1.71	0.96	32.57	17.92	0.22	48.69	0.60
Investment	48.48	10.36	0.95	39.48	2.99	0.57	4.46	73.83	15.08	4.28	2.35
P_i	0.70	0.15	-0.01	0.86	0.06	0.42	0.14	25.49	61.68	12.03	0.66
Goods/service	14.14	3.02	0.82	23.53	1.78	-0.19	27.02	38.64	1.52	32.23	0.58
Labor	3.52	0.75	0.83	2.75	0.21	-0.55	37.98	1.38	0.83	32.30	27.51
TFP	2.05	0.44	0.79	18.93	1.43	0.98	29.63	22.17	0.39	47.78	0.03
Consumption	1.58	0.34	0.93	15.02	1.14	0.94	38.75	11.18	0.18	48.86	1.03
Goods	19.13	4.09	0.87	21.44	1.62	0.61	22.22	72.88	2.37	0.16	2.36
Services	0.70	0.15	0.88	16.35	1.24	0.92	39.28	7.31	0.09	52.50	0.83
$\frac{Inventory}{sale}$	2.44	0.52	-0.42	67.45	5.10	-0.62	84.38	14.25	0.39	0.52	0.46
$\frac{P_{goods}}{P_{service}}$	1.47	0.31	-0.19	28.28	2.14	0.90	31.18	6.67	0.07	61.99	0.09

This table reports Bayesian estimation and the corresponding business cycle statistics and variance decomposition for the model with storable goods and services. There are five shocks, θ_d on shopping disutility, θ_n on leisure, productivity shock $z_g z_s$ on the service sector, z_g on the goods sector, and $z_g z_i$ on the investment sector. Shocks are independent and follow AR(1) processes with persistence parameters of $\{\rho_d, \rho_n, \rho_{z_s}, \rho_{z_g}, \rho_{z_i}\}$ and standard deviations of $\{\sigma_d, \sigma_n, \sigma_{z_s}, \sigma_{z_g}, \sigma_{z_i}\}$ respectively. We use five data series in the estimation, output Y, labor productivity Y/N, investment Inv, investment price P_i, and the ratio of goods to service C/S. "Beta" denotes Beta distribution, "Inv Gamma" denotes inverse Gamma distribution, "Para(1)" is the prior mean, "Para(2)" is the prior standard deviation, "Mean" is the posterior mean, and "90% Intv." is short for 90 percentile interval.

Table 5: Economy BM4: z^s on service, z^g on goods, z^i on investment

Priors and Posteriors for the Shock Parameters (Likelihood = 2452.48)
Data used: Y, Y/N, Inv, P_i, C/S

Parameter	Density	Para(1)	Para(2)	Mean	90% Intv.
ρ_d	Beta	0.930	0.05	0.9997	[0.9994, 1.0000]
ρ_{z_g}	Beta	0.930	0.05	0.8894	[0.8788, 0.9052]
ρ_{z_i}	Beta	0.930	0.05	0.9603	[0.9539, 0.9647]
ρ_{z_s}	Beta	0.930	0.05	0.9461	[0.9402, 0.9539]
ρ_n	Beta	0.930	0.05	0.9887	[0.9830, 0.9941]
σ_d	Inv Gamma	0.150	Inf	1.0317	[0.9475, 1.1175]
σ_{z_g}	Inv Gamma	0.002	Inf	0.0183	[0.0166, 0.0198]
σ_{z_i}	Inv Gamma	0.002	Inf	0.0207	[0.0191, 0.0224]
σ_{z_s}	Inv Gamma	0.002	Inf	0.0251	[0.0227, 0.0272]
σ_n	Inv Gamma	0.020	Inf	0.0179	[0.0164, 0.0195]

	Data (1967Q1-2013Q4)			Model			Var Decomposition				
	var(x)	$\frac{var(x)}{var(Y)}$	Corr	var(x)	$\frac{var(x)}{var(Y)}$	Corr	θ_d	z_g	z_i	z_s	θ_n
Y	4.68	1.00	1.00	8.38	1.00	1.00	34.46	0.65	9.56	52.23	3.10
Y/N	1.47	0.31	0.50	15.99	1.91	0.94	46.66	0.11	1.34	51.03	0.86
Investment	48.48	10.36	0.95	44.73	5.34	0.33	4.05	0.92	88.52	4.38	2.13
P_i	0.70	0.15	-0.01	2.38	0.28	-0.03	0.06	43.69	51.62	4.38	0.24
Goods/service	14.14	3.02	0.82	53.85	6.42	-0.33	12.00	72.57	6.00	9.17	0.26
Labor	3.52	0.75	0.83	2.65	0.32	-0.53	40.20	0.44	7.74	22.41	29.21
TFP	2.05	0.44	0.79	12.89	1.54	0.97	44.15	0.21	2.85	52.75	0.04
Consumption	1.58	0.34	0.93	11.88	1.42	0.89	49.78	1.42	2.05	45.42	1.33
Goods	19.13	4.09	0.87	47.97	5.72	0.12	10.07	79.16	9.51	0.18	1.08
Services	0.70	0.15	0.88	13.05	1.56	0.90	50.00	0.06	0.98	47.91	1.06
$\frac{Inventory}{sale}$	2.44	0.52	-0.42	79.77	9.52	-0.49	72.42	23.75	2.99	0.44	0.40
$\frac{P_{goods}}{P_{service}}$	1.47	0.31	-0.19	24.06	2.87	0.86	37.19	5.36	0.77	56.59	0.10

This table reports Bayesian estimation and the corresponding business cycle statistics and variance decomposition for the model with storable goods and services. There are five shocks, θ_d on shopping disutility, θ_n on leisure, productivity shock z_s on the service sector, z_g on the goods sector, and z_i on the investment sector. Shocks are independent and follow AR(1) processes with persistence parameters of $\{\rho_d,\ \rho_n,\ \rho_{z_s},\rho_{z_g},\ \rho_{z_i}\}$ and standard deviations of $\{\sigma_d,\ \sigma_n,\ \sigma_{z_s},\ \sigma_{z_g},\ \sigma_{z_i}\}$ respectively. We use five data series in the estimation, output Y, labor productivity Y/N, investment Inv, investment price P_i, and the ratio of goods to service C/S. "Beta" denotes Beta distribution, "Inv Gamma" denotes inverse Gamma distribution, "Para(1)" is the prior mean, "Para(2)" is the prior standard deviation, "Mean" is the posterior mean, and "90% Intv." is short for 90 percentile interval.

Table 6: Economy BM5: $\delta_h = 0.99$, z_s on service, $z_s z_g$ on goods, and $z_s z_i$ on investment

Priors and Posteriors for the Shock Parameters (Likelihood = 2023.92)
5 Data used: Y, Y/N, Inv, P_i, C/S

Parameter	Density	Para(1)	Para(2)	Mean	90% Intv.
ρ_d	Beta	0.930	0.05	0.9995	[0.9989, 0.9999]
ρ_{z_g}	Beta	0.930	0.05	0.9965	[0.9932, 0.9998]
ρ_{z_i}	Beta	0.930	0.05	0.9997	[0.9995, 1.0000]
ρ_{z_s}	Beta	0.930	0.05	0.7694	[0.7651, 0.7754]
ρ_n	Beta	0.930	0.05	0.9986	[0.9972, 0.9999]
σ_d	Inv Gamma	0.150	Inf	1.0059	[0.9253, 1.0897]
σ_{z_g}	Inv Gamma	0.002	Inf	0.0426	[0.0393, 0.0459]
σ_{z_i}	Inv Gamma	0.002	Inf	0.0434	[0.0397, 0.0472]
σ_{z_s}	Inv Gamma	0.002	Inf	0.0237	[0.0216, 0.0258]
σ_n	Inv Gamma	0.020	Inf	0.0216	[0.0201, 0.0231]

	Data (1967Q1-2013Q4)			Model			Var Decomposition				
	var(x)	$\frac{var(x)}{var(Y)}$	Corr	var(x)	$\frac{var(x)}{var(Y)}$	Corr	θ_d	z_g	z_i	z_s	θ_n
Y	4.68	1.00	1.00	14.35	1.00	1.00	18.31	0.59	16.49	62.32	2.29
Y/N	1.47	0.31	0.50	17.36	1.21	0.93	40.13	0.91	5.68	52.19	1.09
Investment	48.48	10.36	0.95	164.51	11.47	0.79	0.72	0.04	53.28	45.45	0.52
P_i	0.70	0.15	-0.01	51.42	3.58	0.09	0.36	57.26	32.73	9.63	0.03
Goods/service	14.14	3.02	0.82	27.00	1.88	-0.17	18.24	79.50	0.09	2.16	0.01
Labor	3.52	0.75	0.83	2.46	0.17	-0.05	42.23	0.50	13.56	2.42	41.29
TFP	2.05	0.44	0.79	15.98	1.11	0.96	33.02	0.82	8.68	57.41	0.06
Consumption	1.58	0.34	0.93	8.56	0.60	0.75	61.37	1.43	2.45	31.98	2.78
Goods	19.13	4.09	0.87	23.50	1.64	0.28	0.93	90.51	0.82	6.83	0.92
Services	0.70	0.15	0.88	9.42	0.66	0.74	64.59	0.01	2.26	30.60	2.54
$\frac{Inventory}{sale}$	2.44	0.52	-0.42	82.28	5.73	-0.03	54.25	16.63	2.57	26.43	0.13
$\frac{P_{goods}}{P_{service}}$	1.47	0.31	-0.19	38.06	2.65	0.19	18.99	78.35	0.12	2.53	0.01

This table reports Bayesian estimation and the corresponding business cycle statistics and variance decomposition for the model with storable goods and services. The economy is calibrated under high household depreciation rate in inventory, $\delta_h = 0.99$. All other moments are the same as the benchmark calibration. There are five shocks, θ_d on shopping disutility, θ_n on leisure, productivity shock z_s on the service sector, $z_s z_g$ on the goods sector, and $z_s z_i$ on the investment sector. Shocks are independent and follow AR(1) processes with persistence parameters of $\{\rho_d,\ \rho_n,\ \rho_{z_s}, \rho_{z_g},\ \rho_{z_i}\}$ and standard deviations of $\{\sigma_d,\ \sigma_n,\ \sigma_{z_s},\ \sigma_{z_g},\ \sigma_{z_i}\}$ respectively. We use five data series in the estimation, output Y, labor productivity Y/N, investment Inv, investment price P_i, and the ratio of goods to service C/S. "Beta" denotes Beta distribution, "Inv Gamma" denotes inverse Gamma distribution, "Para(1)" is the prior mean, "Para(2)" is the prior standard deviation, "Mean" is the posterior mean, and "90% Intv." is short for 90 percentile interval.

Table 7: Economy BM6: z_s on service and goods, $z_s z_i$ on investment, 4 data series

Priors and Posteriors for the Shock Parameters (Likelihood = 2335.44)
4 Data used: Y, Y/N, Inv, p_i

Parameter	Density	Para(1)	Para(2)	Mean	90% Intv.
ρ_d	Beta	0.930	0.05	0.9966	[0.9933, 0.9997]
ρ_{z_s}	Beta	0.930	0.05	0.8948	[0.8652, 0.9269]
ρ_{z_i}	Beta	0.930	0.05	0.9651	[0.9536, 0.9752]
ρ_n	Beta	0.930	0.05	0.9924	[0.9871, 0.9985]
σ_d	Inv Gamma	0.150	Inf	0.4961	[0.4474, 0.5385]
σ_{z_s}	Inv Gamma	0.002	Inf	0.0111	[0.0100, 0.0122]
σ_{z_i}	Inv Gamma	0.002	Inf	0.0128	[0.0115, 0.0143]
σ_n	Inv Gamma	0.020	Inf	0.0183	[0.0168, 0.0198]

	Data (1967Q1-2013Q4)			Model			Var Decomposition			
	var(x)	$\frac{var(x)}{var(Y)}$	Corr	var(x)	$\frac{var(x)}{var(Y)}$	Corr	θ_d	z_i	z_s	θ_n
Y	4.68	1.00	1.00	3.54	1.00	1.00	18.34	9.19	65.07	7.41
Y/N	1.47	0.31	0.50	4.11	1.16	0.86	39.91	2.13	54.49	3.47
Investment	48.48	10.36	0.95	32.49	9.18	0.76	1.07	49.22	47.19	2.52
P^i	0.70	0.15	-0.01	0.68	0.19	0.13	0.00	76.70	22.81	0.48
Labor	3.52	0.75	0.83	1.11	0.31	0.14	20.27	7.37	1.48	70.88
TFP	2.05	0.44	0.79	3.70	1.05	0.93	33.96	4.05	61.82	0.17
Consumption	1.58	0.34	0.93	2.46	0.70	0.81	52.39	3.97	36.60	7.05
Goods	4.27	0.91	0.92	10.34	2.92	0.67	10.43	17.60	66.87	5.09
Services	0.60	0.13	0.81	2.30	0.65	0.79	61.90	2.22	29.20	6.68
Goods/service	2.43	0.52	0.82	6.48	1.83	0.38	21.80	19.89	56.28	2.03
$\frac{Inventory}{sale}$	2.44	0.52	-0.42	18.17	5.13	-0.66	70.18	5.24	22.82	1.76
$\frac{P_{goods}}{P_{service}}$	1.47	0.31	-0.19	2.78	0.79	0.68	71.35	2.63	25.22	0.79

This table reports Bayesian estimation and the corresponding business cycle statistics and variance decomposition for the model with storable goods and services. There are four shocks, θ_d on shopping disutility, θ_n on leisure, productivity shock z_s on the service and goods sector, and $z_s z_i$ on the investment sector. Shocks are independent and follow AR(1) processes with persistence parameters of $\{\rho_d, \rho_n, \rho_{z_s}, \rho_{z_i}\}$ and standard deviations of $\{\sigma_d, \sigma_n, \sigma_{z_s}, \sigma_{z_i}\}$ respectively. We use four data series in the estimation, output Y, labor productivity Y/N, investment Inv, and investment price P_i. "Beta" denotes Beta distribution, "Inv Gamma" denotes inverse Gamma distribution, "Para(1)" is the prior mean, "Para(2)" is the prior standard deviation, "Mean" is the posterior mean, and "90% Intv." is short for 90 percentile interval.

Table 8: Economy BM7: $\delta_h = 0.99$, z_s on service and goods, $z_s z_i$ on investment, 4 data series

Priors and Posteriors for the Shock Parameters (Likelihood = 2322.48)
4 Data used: Y, Y/N, Inv, p_i

Parameter	Density	Para(1)	Para(2)	Mean	90% Intv.
ρ_d	Beta	0.930	0.05	0.9988	[0.9977, 0.9999]
ρ_{z_s}	Beta	0.930	0.05	0.8927	[0.8758, 0.9124]
ρ_{z_i}	Beta	0.930	0.05	0.9006	[0.8848, 0.9169]
ρ_{z^n}	Beta	0.930	0.05	0.9967	[0.9939, 0.9996]
σ_d	Inv Gamma	0.150	Inf	0.4372	[0.3945, 0.4727]
σ_{z_s}	Inv Gamma	0.002	Inf	0.0080	[0.0073, 0.0086]
σ_{z_i}	Inv Gamma	0.002	Inf	0.0154	[0.0140, 0.0165]
σ_n	Inv Gamma	0.020	Inf	0.0188	[0.0174, 0.0204]

	Data (1967Q1-2013Q4)			Model			Var Decomposition			
	var(x)	$\frac{var(x)}{var(Y)}$	Corr	var(x)	$\frac{var(x)}{var(Y)}$	Corr	θ_d	z_i	z_s	θ_n
Y	4.68	1.00	1.00	2.42	1.00	1.00	20.61	20.22	48.62	10.55
Y/N	1.47	0.31	0.50	2.78	1.15	0.78	47.16	3.59	44.02	5.23
Investment	48.48	10.36	0.95	32.23	13.34	0.76	0.64	67.20	29.89	2.26
P^i	0.70	0.15	-0.01	1.46	0.60	0.17	2.46	56.59	39.90	1.05
Labor	3.52	0.75	0.83	1.15	0.47	0.24	16.86	14.03	0.71	68.41
TFP	2.05	0.44	0.79	2.43	1.00	0.89	41.04	8.15	50.52	0.29
Consumption	1.58	0.34	0.93	1.63	0.67	0.68	60.71	5.72	22.68	10.89
Goods	19.13	4.09	0.87	0.56	0.23	0.56	7.30	15.25	48.61	28.84
Services	0.70	0.15	0.88	1.80	0.74	0.68	63.63	5.26	21.17	9.94
Goods/service	2.43	0.52	0.82	0.98	0.40	-0.50	94.80	1.05	3.99	0.16
$\frac{Inventory}{sale}$	2.44	0.52	-0.42	10.69	4.42	-0.19	78.55	11.12	9.63	0.71
$\frac{P_{goods}}{P_{service}}$	1.47	0.31	-0.19	1.45	0.60	0.51	94.11	1.31	4.42	0.16

This table reports Bayesian estimation and the corresponding business cycle statistics and variance decomposition for the model with storable goods and services. The economy is calibrated under high household depreciation rate in inventory, $\delta_h = 0.99$. All other moments are the same as the benchmark calibration. There are four shocks, θ_d on shopping disutility, θ_n on leisure, productivity shock z_s on the service and goods sector, and $z_s z_i$ on the investment sector. Shocks are independent and follow AR(1) processes with persistence parameters of $\{\rho_d, \rho_n, \rho_{z_s}, \rho_{z_i}\}$ and standard deviations of $\{\sigma_d, \sigma_n, \sigma_{z_s}, \sigma_{z_i}\}$ respectively. We use four data series in the estimation, output Y, labor productivity Y/N, investment Inv, and investment price P_i. "Beta" denotes Beta distribution, "Inv Gamma" denotes inverse Gamma distribution, "Para(1)" is the prior mean, "Para(2)" is the prior standard deviation, "Mean" is the posterior mean, and "90% Intv." is short for 90 percentile interval.

Table 9: Calibration of the Shopping Model with Storable Goods and Services

Targets	Value	Parameter	Value
First Group: Parameters Set Exogenously			
Risk aversion	2.	γ	2
Real interest rate	4%	β	0.99
Frisch elasticity	0.72	$\frac{1}{\nu}$	0.72
Elasticity of substitution	0.85	ω	0.85
Households depreciation	0.19	δ_h	0.19
Households depreciation	0.19	δ_f	0.19
Second Group: Standard Targets			
Fraction of time spent working	30%	χ_n	6.84
Labor share of income	0.67	α_n	0.58
Consumption share	0.80	α_k	0.27
Capital-output ratio	2.75	δ	0.07
Services share over consumption	0.60	μ	0.48
Inventory-sale ratio	11.5%	T_g	0.09
Third Group: Normalization			
Steady-state output	1	$E(z)$	1.44
p_i	1	$E(z_i)$	0.93
Capacity utilization of services	0.81	χ_d	1748
Fourth Group: Targets Specific to This Economy			
Price dispersion	0.21	φ	0.23
Shopping elasticity	0.075	η_d	0.11

Table 10: Durable plus nondurable goods (ND1), z_s on service, $z_s z_g$ on goods, $z_s z_i$ on investment

Priors and Posteriors for the Shock Parameters (Likelihood = 2835.17)
Data used: Y, Y/N, Inv, P_i, C/S

Parameter	Density	Para(1)	Para(2)	Mean	90% Intv.
ρ_d	Beta	0.930	0.05	0.9940	[0.9891, 0.9988]
ρ_{z_g}	Beta	0.930	0.05	0.6682	[0.6344, 0.7067]
ρ_{z_i}	Beta	0.930	0.05	0.9983	[0.9969, 0.9998]
ρ_{z_s}	Beta	0.930	0.05	0.9270	[0.9146, 0.9401]
ρ_n	Beta	0.930	0.05	0.9776	[0.9708, 0.9855]
σ_d	Inv Gamma	0.150	Inf	0.4171	[0.3815, 0.4576]
σ_{z_g}	Inv Gamma	0.002	Inf	0.0112	[0.0102, 0.0120]
σ_{z_i}	Inv Gamma	0.002	Inf	0.0088	[0.0079, 0.0096]
σ_{z_s}	Inv Gamma	0.002	Inf	0.0100	[0.0092, 0.0108]
σ_n	Inv Gamma	0.020	Inf	0.0166	[0.0152, 0.0180]

	Data (1967Q1-2013Q4)			Model			Var Decomposition				
	var(x)	$\frac{var(x)}{var(Y)}$	Corr	var(x)	$\frac{var(x)}{var(Y)}$	Corr	θ_d	z_g	z_i	z_s	θ_n
Y	4.68	1.00	1.00	3.27	1.00	1.00	6.51	10.82	2.71	70.38	9.57
Y/N	1.47	0.31	0.50	2.53	0.78	0.83	21.27	4.48	1.71	67.61	4.93
Investment	48.48	10.36	0.95	23.76	7.26	0.61	11.81	14.30	23.89	45.20	4.80
P_i	0.70	0.15	-0.01	0.79	0.24	0.27	0.29	11.15	75.49	12.10	0.97
Goods/service	2.43	0.52	0.82	12.76	3.90	0.49	8.08	79.21	1.67	10.25	0.79
Labor	3.52	0.75	0.83	1.04	0.32	0.48	7.19	6.71	0.81	5.11	80.18
TFP	2.05	0.44	0.79	2.57	0.79	0.93	16.07	6.79	2.18	74.88	0.08
Consumption	1.58	0.34	0.93	3.26	1.00	0.84	22.18	33.49	2.06	36.46	5.82
Goods	4.27	0.91	0.92	13.31	4.07	0.71	6.39	65.48	2.15	23.11	2.87
Services	0.60	0.13	0.81	1.66	0.51	0.63	63.08	3.15	0.39	27.26	6.11
$\frac{Inventory}{sale}$	2.44	0.52	-0.42	16.61	5.08	-0.63	56.79	29.38	0.86	11.54	1.43
$\frac{P_{goods}}{P_{service}}$	1.47	0.31	-0.19	2.08	0.64	0.31	70.42	16.71	0.25	11.74	0.88

This table reports Bayesian estimation and the corresponding business cycle statistics and variance decomposition for the model with storable goods and services. The economy is calibrated with goods including both durable and nondurable goods. All other moments are the same as the benchmark calibration. There are five shocks, θ_d on shopping disutility, θ_n on leisure, productivity shock z_s on the service sector, $z_s z_g$ on the goods sector, and $z_s z_i$ on the investment sector. Shocks are independent and follow AR(1) processes with persistence parameters of $\{\rho_d,\ \rho_n,\ \rho_{z_s}, \rho_{z_g},\ \rho_{z_i}\}$ and standard deviations of $\{\sigma_d,\ \sigma_n,\ \sigma_{z_s},\ \sigma_{z_g},\ \sigma_{z_i}\}$ respectively. We use five data series in the estimation, output Y, labor productivity Y/N, investment Inv, investment price P_i, and the ratio of goods to service C/S. "Beta" denotes Beta distribution, "Inv Gamma" denotes inverse Gamma distribution, "Para(1)" is the prior mean, "Para(2)" is the prior standard deviation, "Mean" is the posterior mean, and "90% Intv." is short for 90 percentile interval.

Table 11: Durable plus nondurable goods (ND2), shock on d_g and d_s, z_s on service and goods, $z_s z_i$ on investment

Priors and Posteriors for the Shock Parameters (Likelihood = 2820.89)
Data used: Y, Y/N, Inv, P_i, C/S

Parameter	Density	Para(1)	Para(2)	Mean	90% Intv.
ρ_{d_g}	Beta	0.930	0.05	0.9745	[0.9622, 0.9879]
ρ_{d_s}	Beta	0.930	0.05	0.9913	[0.9852, 0.9972]
ρ_{z_s}	Beta	0.930	0.05	0.9108	[0.8981, 0.9232]
ρ_{z_i}	Beta	0.930	0.05	0.9993	[0.9987, 0.9999]
ρ_n	Beta	0.930	0.05	0.9750	[0.9686, 0.9817]
σ_{d_g}	Inv Gamma	0.150	Inf	0.0913	[0.0831, 0.0990]
σ_{d_s}	Inv Gamma	0.150	Inf	0.0373	[0.0341, 0.0408]
σ_{z_s}	Inv Gamma	0.002	Inf	0.0089	[0.0081, 0.0096]
σ_{z_i}	Inv Gamma	0.002	Inf	0.0086	[0.0078, 0.0093]
σ_n	Inv Gamma	0.020	Inf	0.0165	[0.0152, 0.0180]

	Data (1967Q1-2013Q4)			Model			Var Decomposition				
	var(x)	$\frac{var(x)}{var(Y)}$	Corr	var(x)	$\frac{var(x)}{var(Y)}$	Corr	θ_{dg}	θ_{ds}	z_s	z_i	θ_n
Y	4.68	1.00	1.00	2.38	1.00	1.00	0.14	6.97	75.91	3.54	13.45
Y/N	1.47	0.31	0.50	1.89	0.79	0.78	0.22	21.62	69.21	2.24	6.70
Investment	48.48	10.36	0.95	26.34	11.07	0.65	43.06	0.08	32.07	20.14	4.65
P_i	0.70	0.15	-0.01	0.70	0.29	0.15	2.60	0.01	10.54	85.57	1.29
Goods/service	2.43	0.52	0.82	6.70	2.82	0.27	65.19	13.35	16.91	2.93	1.62
Labor	3.52	0.75	0.83	0.96	0.40	0.48	0.01	5.61	5.07	0.79	88.53
TFP	2.05	0.44	0.79	1.86	0.78	0.91	0.21	16.94	79.83	2.92	0.11
Consumption	1.58	0.34	0.93	2.15	0.90	0.75	31.50	13.52	43.36	2.85	8.77
Goods	4.27	0.91	0.92	7.47	3.14	0.55	57.73	0.01	33.54	3.51	5.21
Services	0.60	0.13	0.81	1.28	0.54	0.72	0.02	65.74	26.12	0.46	7.65
$\frac{Inventory}{sale}$	2.44	0.52	-0.42	44.38	18.65	-0.21	95.61	0.03	3.52	0.30	0.55
$\frac{P_{goods}}{P_{service}}$	1.47	0.31	-0.19	1.57	0.66	0.49	0.98	84.01	13.43	0.30	1.28

This table reports Bayesian estimation and the corresponding business cycle statistics and variance decomposition for the model with storable goods and services. The economy is calibrated with goods including both durable and nondurable goods. All other moments are the same as the benchmark calibration. There are five shocks, θ_d^g on the shopping disutility of goods, θ_d^s on the shopping disutility of service, θ_n on leisure, productivity shock z_s on the service and goods sector, and $z_s z_i$ on the investment sector. Shocks are independent and follow AR(1) processes with persistence parameters of $\{\rho_{d_g}, \rho_{d_s}, \rho_n, \rho_{z_s}, \rho_{z_i}\}$ and standard deviations of $\{\sigma_{d_g}, \sigma_{d_s}, \sigma_n, \sigma_{z_s}, \sigma_{z_i}\}$ respectively. We use five data series in the estimation, output Y, labor productivity Y/N, investment Inv, investment price P_i, and the ratio of goods to service C/S. "Beta" denotes Beta distribution, "Inv Gamma" denotes inverse Gamma distribution, "Para(1)" is the prior mean, "Para(2)" is the prior standard deviation, "Mean" is the posterior mean, and "90% Intv." is short for 90 percentile interval.

Table 12: Durable plus nondurable goods (ND3), $z_g z_s$ on service, z_g on goods, $z_g z_i$ on investment

Priors and Posteriors for the Shock Parameters (Likelihood = 2680.90)
Data used: Y, Y/N, Inv, P_i, C/S

Parameter	Density	Para(1)	Para(2)	Mean	90% Intv.
ρ_d	Beta	0.930	0.05	0.9997	[0.9994, 1.0000]
ρ_{z_g}	Beta	0.930	0.05	0.8197	[0.8176, 0.8215]
ρ_{z_i}	Beta	0.930	0.05	0.9981	[0.9968, 0.9994]
ρ_{z_s}	Beta	0.930	0.05	0.9557	[0.9522, 0.9580]
ρ_n	Beta	0.930	0.05	0.8532	[0.8511, 0.8554]
σ_d	Inv Gamma	0.150	Inf	0.5502	[0.5047, 0.5932]
σ_{z_g}	Inv Gamma	0.002	Inf	0.0102	[0.0093, 0.0111]
σ_{z_i}	Inv Gamma	0.002	Inf	0.0082	[0.0075, 0.0090]
σ_{z_s}	Inv Gamma	0.002	Inf	0.0160	[0.0146, 0.0174]
σ_n	Inv Gamma	0.020	Inf	0.0245	[0.0226, 0.0265]

	Data (1967Q1-2013Q4)			Model			Var Decomposition				
	var(x)	$\frac{var(x)}{var(Y)}$	Corr	var(x)	$\frac{var(x)}{var(Y)}$	Corr	θ_d	z_g	z_i	z_s	θ_n
Y	4.68	1.00	1.00	4.34	1.00	1.00	7.97	53.85	1.77	17.49	18.92
Y/N	1.47	0.31	0.50	4.15	0.96	0.71	22.88	36.16	0.90	33.04	7.01
Investment	48.48	10.36	0.95	23.81	5.49	0.67	20.82	41.46	20.74	1.82	15.16
P^i	0.70	0.15	-0.01	0.62	0.14	0.27	0.13	9.51	83.44	2.94	3.98
Labor	3.52	0.75	0.83	2.43	0.56	0.40	6.15	4.21	0.30	3.77	85.57
TFP	2.05	0.44	0.79	3.70	0.85	0.87	19.28	48.24	1.31	31.10	0.07
Consumption	1.58	0.34	0.93	4.00	0.92	0.89	31.88	32.04	1.46	23.65	10.97
Goods	4.27	0.91	0.92	7.07	1.63	0.78	20.37	57.04	3.53	0.07	18.99
Services	0.60	0.13	0.81	4.99	1.15	0.72	37.86	7.12	0.11	52.34	2.56
Goods/service	2.43	0.52	0.82	7.57	1.75	0.17	23.83	29.91	2.46	34.21	9.59
$\frac{Inventory}{sale}$	2.44	0.52	-0.42	20.05	4.62	-0.57	81.93	12.99	0.62	0.21	4.25
$\frac{P_{goods}}{P_{service}}$	1.47	0.31	-0.19	8.09	1.86	0.66	31.13	5.58	0.06	61.52	1.72

This table reports Bayesian estimation and the corresponding business cycle statistics and variance decomposition for the model with storable goods and services. The economy is calibrated with goods including both durable and nondurable goods. All other moments are the same as the benchmark calibration. There are five shocks, θ_d on shopping disutility, θ_n on leisure, productivity shock $z_g z_s$ on the service sector, z_g on the goods sector, and $z_g z_i$ on the investment sector. Shocks are independent and follow AR(1) processes with persistence parameters of $\{\rho_d,\ \rho_n,\ \rho_{z_s}, \rho_{z_g},\ \rho_{z_i}\}$ and standard deviations of $\{\sigma_d,\ \sigma_n,\ \sigma_{z_s},\ \sigma_{z_g},\ \sigma_{z_i}\}$ respectively. We use five data series in the estimation, output Y, labor productivity Y/N, investment Inv, investment price P_i, and the ratio of goods to service C/S. "Beta" denotes Beta distribution, "Inv Gamma" denotes inverse Gamma distribution, "Para(1)" is the prior mean, "Para(2)" is the prior standard deviation, "Mean" is the posterior mean, and "90% Intv." is short for 90 percentile interval.

Table 13: Durable plus nondurable goods (ND4), z_s on service, z_g on goods, z_i on investment

Priors and Posteriors for the Shock Parameters (Likelihood = 2699.52)
Data used: Y, Y/N, Inv, P_i, C/S

Parameter	Density	Para(1)	Para(2)	Mean	90% Intv.
ρ_d	Beta	0.930	0.05	0.9997	[0.9995, 1.0000]
ρ_{z_g}	Beta	0.930	0.05	0.9911	[0.9848, 0.9980]
ρ_{z_i}	Beta	0.930	0.05	0.9885	[0.9861, 0.9911]
ρ_{z_s}	Beta	0.930	0.05	0.9527	[0.9455, 0.9609]
ρ_n	Beta	0.930	0.05	0.9713	[0.9637, 0.9799]
σ_d	Inv Gamma	0.150	Inf	0.5682	[0.5162, 0.6189]
σ_{z_g}	Inv Gamma	0.002	Inf	0.0106	[0.0096, 0.0115]
σ_{z_i}	Inv Gamma	0.002	Inf	0.0152	[0.0138, 0.0164]
σ_{z_s}	Inv Gamma	0.002	Inf	0.0162	[0.0149, 0.0178]
σ_n	Inv Gamma	0.020	Inf	0.0165	[0.0151, 0.0178]

	Data (1967Q1-2013Q4)			Model			Var Decomposition				
	var(x)	$\frac{var(x)}{var(Y)}$	Corr	var(x)	$\frac{var(x)}{var(Y)}$	Corr	θ_d	z_g	z_i	z_s	θ_n
Y	4.68	1.00	1.00	2.02	1.00	1.00	18.03	12.59	15.44	37.90	16.03
Y/N	1.47	0.31	0.50	2.81	1.39	0.77	35.70	6.32	4.42	49.03	4.53
Investment	48.48	10.36	0.95	31.33	15.48	0.32	16.72	4.96	72.80	1.44	4.09
P_i	0.70	0.15	-0.01	2.34	1.15	-0.00	0.04	39.51	59.23	0.81	0.42
Goods/service	2.43	0.52	0.82	11.37	5.62	-0.21	16.77	50.86	8.62	22.74	1.01
Labor	3.52	0.75	0.83	1.16	0.57	0.12	13.62	1.02	3.87	7.80	73.68
TFP	2.05	0.44	0.79	2.29	1.13	0.88	32.89	8.82	7.64	50.57	0.08
Consumption	1.58	0.34	0.93	3.54	1.75	0.71	38.04	20.76	9.03	26.88	5.29
Goods	4.27	0.91	0.92	8.55	4.22	0.31	17.79	61.90	15.64	0.06	4.61
Services	0.60	0.13	0.81	4.75	2.35	0.74	41.97	0.24	0.71	55.08	2.01
$\frac{Inventory}{sale}$	2.44	0.52	-0.42	20.83	10.29	-0.49	83.33	12.05	3.24	0.21	1.18
$\frac{P_{goods}}{P_{service}}$	1.47	0.31	-0.19	9.06	4.48	0.55	29.37	14.76	0.26	55.38	0.23

This table reports Bayesian estimation and the corresponding business cycle statistics and variance decomposition for the model with storable goods and services. The economy is calibrated with goods including both durable and nondurable goods. All other moments are the same as the benchmark calibration. There are five shocks, θ_d on shopping disutility, θ_n on leisure, productivity shock z_s on the service sector, z_g on the goods sector, and z_i on the investment sector. Shocks are independent and follow AR(1) processes with persistence parameters of $\{\rho_d, \rho_n, \rho_{z_s}, \rho_{z_g}, \rho_{z_i}\}$ and standard deviations of $\{\sigma_d, \sigma_n, \sigma_{z_s}, \sigma_{z_g}, \sigma_{z_i}\}$ respectively. We use five data series in the estimation, output Y, labor productivity Y/N, investment Inv, investment price P_i, and the ratio of goods to service C/S. "Beta" denotes Beta distribution, "Inv Gamma" denotes inverse Gamma distribution, "Para(1)" is the prior mean, "Para(2)" is the prior standard deviation, "Mean" is the posterior mean, and "90% Intv." is short for 90 percentile interval.