Working Less and Bargain Hunting More: Macro Implications of Sales during Japan’s Lost Decade

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Macro Implications of Sales

- Are sales important for the macroeconomy?
  - How did sales pricing change in Japan’s lost decade and why?
  - Do sales dampen the effect of monetary policy shock?
    - Prices are frequently changed. (e.g. Bils and Klenow (2004), Nakamura and Steinsson (2008), Kehoe and Midrigan (2010), and Eichenbaum, Jaimovich, and Rebelo (2011))
DSGE model with sales

Structure
- Sticky normal-price model with flexible sales
- Households: price-insensitive loyal customers and price-sensitive bargain hunters.

Results
- Firms’ best strategy is holding periodic sales.
- The real effects of monetary policy remain strong, even though sales entail no explicit cost and their prices are perfectly flexible.
DSGE model with sales based on GS

We focus on the fact that bargain hunting is time-consuming.

- We incorporate an endogenous, time-varying fraction of loyal customers (bargain hunters)

Households face tradeoff in bargain hunting.

- Bargain hunting increases utility by optimally purchasing sales goods more and normal-priced goods less.
- Bargain hunting decreases utility. Bargain hunting causes disutility, like labor supply.
What We Find

- Macroeconomic implications are greatly modified when considering sales and endogenous bargain hunting.
  - Trend declines in hours worked account for rises in a sales frequency, rises in the fraction of bargain hunters, and in part, declines in the inflation rate during Japan’s lost decade.
  - Frequently revised sales prices matter for the macroeconomy, dampening the real effects of monetary policy.

- Basic mechanism
  - Hours worked $\uparrow \rightarrow$ Less free time $\rightarrow$ Loyal customers $\uparrow$ (bargain hunters $\downarrow$) $\rightarrow$ Sales frequency $\downarrow$
  - Sales-priced goods are sold more than normal-priced goods in terms of quantity $\rightarrow$ Downward pressure on aggregate demand for goods.
  - Strategic substitutability of sales intensifies.
Evidence for Endogenous Bargain Hunting (Literature)

- GS assume a constant fraction of loyal customers (bargain hunters).

- BUT, Aguiar and Hurst (2007 AER) use scanner data and time diaries to examine households’ substitution between shopping and home production. They find that older households shop the most frequently and pay the lowest price.

- Lach (2007 JPE) analyzes store-level price data following the unexpected arrival of a large number of immigrants from the former Soviet union to Israel. He finds that the immigrants have a higher price elasticity and a lower search cost for goods than the native population.
Evidence for Endogenous Bargain Hunting (Survey on Time Use)

- Statistical Bureau “Survey on Time Use and Leisure Activities”
- Time use in shopping (minutes) is (1) increasing, (2) higher for not-working people, and (3) higher for female.

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<th>Both Not working</th>
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<th>Male Not working</th>
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- Time use in work (including commuting time, minutes) is negatively correlated with time use in shopping.
- It is (1) decreasing, (2) lower for not-working people, and (3) lower for female.

<table>
<thead>
<tr>
<th></th>
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<th>Not working</th>
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Life cycle patterns of time use as of 2006
Working and shopping times are negatively correlated up to a certain age.
Moderate aging increases shopping time.
Evidence for Endogenous Bargain Hunting (POS Data)

- GS Model - Calibration

- Three target variables
  - Ratio of sale price markup to regular price markup $\mu$
  - Ratio of quantities sold at sales price to those sold at regular price $\chi$
  - Frequency of sales $s$

- Three calibrated deep parameters
  - Elasticity of substitution bw product types $\epsilon$ (beer and desserts)
  - Elasticity of substitution bw brands for bargain hunter $\eta$ (Kirin and Asahi): naturally $\eta > \epsilon$
  - Fraction of loyal customers $\lambda$
Target variables including the sales frequency

- Markup ratio $\mu$
- Quantity ratio $\chi$
- Sales frequency $s$

Graphs showing the trend of markup ratio, quantity ratio, and sales frequency over the years 1989 to 2007.
Calibrated deep parameters including the fraction of loyal customers

- Elast bw product types epsilon
- Elast for bargain hunters eta
- Loyal customer fraction lambda

`SUWW (BOJ) Sales model August 7, 2011`
The fraction of loyal customers and labor market indicators

- Hours worked $h$ and the employment ratio $e$ to the pop over 15 (log deviation from mean)
- Price elasticity (cup noodle) in POS
- Price elasticity and labor market indicators
  - Price elasticity is aggregated across goods from the one at the previous page.

![Graph showing price elasticity and labor market indicators]
Model
Consumption in utility

- Two kinds of consumers: loyal customer and bargain hunter
- The fraction of loyal customers $\lambda$ is constant.
- Product type $\tau$ (elast $\epsilon$) and brand $b$ (elast $\eta > \epsilon$)

$$C = \left[ \int c(\tau) \frac{\epsilon-1}{\epsilon} d\tau + \int \left( \int c(\tau, b) \frac{\eta-1}{\eta} db \right) \frac{\eta(\epsilon-1)}{\epsilon(\eta-1)} d\tau \right]^\frac{\epsilon}{\epsilon-1}. \quad (1)$$
Demand function for brand $b$ of type $\tau$ product

- $1 - \lambda$ bargain hunter faces high elast. $\lambda$ loyal customer faces low elast.
- $C^*$ is aggregate consumption (budget constraint)

$$c(\tau, b) = \begin{cases} 
\left( \frac{p(\tau, b)}{p_B(\tau)} \right)^{-\eta} \left( \frac{p_B(\tau)}{P} \right)^{-\epsilon} C^* & \text{for } 1 - \lambda \text{ population} \\
\left( \frac{p(\tau, b)}{P} \right)^{-\epsilon} C^* & \text{for } \lambda \text{ population}
\end{cases}$$ (2)
Sales pricing bears neither cost nor rigidity → flexible

- Sales prices are lower than normal prices.
- Sales prices have constant markup. They reflect their marginal cost.

It is optimal to hold periodic sales with its frequency $s_t$

- Sales are strategic substitutes.
  - Suppose that all other firms do only sales.
  - Suppose that all other firms sell only normal-priced goods.

Sales result in almost no change in macro effects of monetary policy.

- Sales frequency hardly changes.
Endogenous loyal customers’ share $L_t$ with its mean $\lambda$
- $1 - L_t$ is bargain hunters’ share.

$$u(t) = \sum_{j=0}^{\infty} \beta^j E_t \left[ \nu(C_{t+j}) - \nu \left( H_{t+j} + \phi_L \frac{(1 - L_{t+j})^{\theta_L}}{(1 - \lambda)^{\theta_L}} \right) \right],$$  \hspace{1cm} (3)

$$C = \left[ \int \left( \int c(\tau, b) \frac{\eta-1}{\eta} \frac{e}{e-1} \right)^{\frac{\epsilon}{\eta-1}} d\tau \right]^{\frac{e}{\epsilon-1}}. \hspace{1cm} (4)$$

Demand function,

$$c(\tau, b) = \begin{cases} 
\left( \frac{p(\tau, b)}{p_B(\tau)} \right)^{-\eta} \left( \frac{p_B(\tau)}{P} \right)^{-\epsilon} C^* & \text{for } 1 - L_t \text{ population} \\
\left( \frac{p(\tau, b)}{P} \right)^{-\epsilon} C^* & \text{for } L_t \text{ population}, 
\end{cases} \hspace{1cm} (5)$$

is the same as that in GS. It makes firms’ decision almost the same.

The first line is the optimal demand schedule, so an increase in $1 - L_t$ is better. But it worsens the utility directly.
The difference between $C$ and $C^*$ is defined as a consumption wedge $F$:

$$C = F \cdot \left( \frac{P_B}{P} \right)^{-\epsilon} C^*, \quad (6)$$

where

$$F = \left[ \int \left( L \frac{sP_s^{1-\eta}}{(sP_s^{1-\eta}+(1-s)P_N^{1-\eta})^{\frac{\epsilon}{\eta}}} + 1 - L \right) \frac{\frac{\eta(\epsilon-1)}{\epsilon(\eta-1)}}{\frac{\epsilon}{\epsilon-1}} \left( \frac{p_B(\tau)}{P} \right)^{1-\epsilon} d\tau \right] < 1. \quad (7)$$

Tradeoff between disutility from bargain hunting and an increase in consumption wedge.
Basically the same

It is optimal to hold periodic sales with its frequency $s_t$

Firms take account of endogenous $L_t$ in pricing and sales decisions
Monetary policy: the inflation rate omits sales prices.

\[ i_t = \rho i_{t-1} + (1 - \rho) \phi_{\pi_t} \pi_t^N + e_t^i. \] (8)

Resource constraint:

\[ Y_t = C_t^* + Z_t^g. \] (9)
Sales pricing

Sales frequency $s$ decreases with the fraction of loyal customers $l$.

$$s^t = - \frac{1 - \theta_B}{\varphi_B} \frac{1}{1 - \psi} x^t \left( \frac{1 - \theta_B}{\varphi_B} \frac{A}{1 - \psi} + \frac{1}{(\eta - \epsilon)(1 - \lambda)\varphi_B} \right) l^t. \quad (10)$$
The fraction of loyal customers \( l \) increases with output \( y \) (labor supply).

\[
0 = \left( \theta_c^{-1} - 1 + \frac{1}{1 + \gamma \delta} \frac{\theta_h^{-1}}{\alpha} \right) y_t - \frac{\delta}{1 + \gamma \delta} \frac{\theta_h^{-1}}{\alpha} w_t \\
- \frac{\theta_h^{-1}}{\alpha} \epsilon_t^a - (\theta_h^{-1} - 1) \epsilon_t^h - (\theta_c^{-1} - 1) \epsilon_t^g \\
- \left( \frac{1}{1 + \gamma \delta} \frac{\theta_h^{-1}}{\alpha} B + (\theta_L - 1) \frac{\lambda}{1 - \lambda} + \theta_h^{-1} \phi_L \frac{\lambda}{(1 - \lambda) H} \right) l_t \\
+ (\theta_c^{-1} - 1) \left\{ f_t - \epsilon \left( x_t + \frac{1}{(\eta - \epsilon)(1 - \lambda)} l_t \right) \right\} \\
+ \frac{P_{SN}}{1 - P_{SN}} p_{SN,t} + \frac{\eta - 1}{\eta} f_t. \tag{11}
\]
The inflation rate $\pi$ increases with the fraction of loyal customers $l$.

$$\pi_t = \beta E_t \pi_{t+1} + \frac{1}{1 - \psi} \left\{ \kappa x_t + \psi (\Delta x_t - \beta E_t \Delta x_{t+1}) + \kappa A l_t + A (\Delta l_t - \beta E_t \Delta l_{t+1}) \right\}.$$

(12)
Simulation Results: IRFs
## GS’s Calibration from POS

### Target variables

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Description</th>
<th>Value</th>
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<tbody>
<tr>
<td>$\mu$</td>
<td>Price ratio of sales to normal</td>
<td>0.883</td>
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<tr>
<td>$\chi$</td>
<td>Quantity ratio of sales to normal</td>
<td>2.657</td>
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<tr>
<td>$s$</td>
<td>Sales frequency</td>
<td>0.276</td>
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### Parameters

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Description</th>
<th>Value</th>
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<tbody>
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<td>$\epsilon$</td>
<td>Elasticity bw product types</td>
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<td>$\eta$</td>
<td>Elasticity bw brands</td>
<td>26.820</td>
</tr>
<tr>
<td>$\lambda$</td>
<td>Fraction of loyal customers</td>
<td>0.833</td>
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</table>
IRFs to an Accom MP Shock and Positive Tech Shock in the GS Model

- Sales result in almost no change in real effects.

![Graphs showing IRFs](image-url)
IRFs to an Accom MP Shock in Our Model

- **Demand Y**: Comparison between GS model, Our model (theta_l = 100), and Our model (theta_l = 3).
- **Inflation (incl sales) pi**: Graph showing inflation changes with sales included.
- **Inflation (excl sales) pi_N**: Graph showing inflation changes without sales included.
- **Hours worked h**: Graph showing the impact on hours worked over time.
- **Loyal customers' fraction l**: Graph showing the fraction of loyal customers over time.
- **Sales frequency s**: Graph showing sales frequency changes over time.
- **Real wage w**: Graph showing the change in real wage over time.
- **Real marginal cost x**: Graph showing the change in real marginal cost over time.
- **Nominal interest rate i**: Graph showing nominal interest rate changes over time.
Why is the Real Effect of Mon Policy Small?

- Basic mechanism
  - Accom mon shock $\rightarrow$ Goods demand $\uparrow$ $\rightarrow$ Hours worked $\uparrow$ $\rightarrow$ Less free time $\rightarrow$ Loyal customers $\uparrow$ (bargain hunters $\downarrow$)
  - For firms, sales frequency $\downarrow$
  - Sales-priced goods are sold more than normal-priced goods in terms of quantity $\rightarrow$ Downward pressure on goods demand
Intensified strategic substitutability of sales can also explain this.

- Suppose that all firms but firm A raise their sales frequency.
- As in GS, it loses an incentive for firm A to raise its sales frequency, because its decreases the marginal revenue from sales.
- In our model, additional channel emerges.
  - When all firms but firm A raise their sales frequency, an aggregate price falls.
  - That increases aggregate demand for goods, and in turn, aggregate demand for labor.
  - Households supply more labor and lose time in bargain hunting.
  - The fraction of loyal customers (bargain hunters) increases (decreases).
  - By observing this, firm A lowers its sales frequency.

Such intensified strategic substitutability of sales mitigates the real effect of monetary policy.
IRFs to a Positive TFP Shock in Our Model

- Demand Y
- Inflation (incl sales) pi
- Inflation (excl sales)
- Loyal customers' fraction l
- Sales frequency s
- Hours worked h
- Nominal interest rate i
- Real wage w
- Real marginal cost x

GS model
Our model (theta_l = 100)
Our model (theta_l = 3)
IRFs to a Positive Gov Shock in Our Model

- Demand Y
- Inflation (incl sales) pi
- Inflation (excl sales) pi_N
- Hours worked h
- Loyal customers' fraction l
- Nominal interest rate i
- Real wage w
- Real marginal cost x

GS model
Our model (theta_l = 100)
Our model (theta_l = 3)
IRFs to a Labor Supply Shock in Our Model

- **Demand Y**
  - GS model
  - Our model (θ_l = 100)
  - Our model (θ_l = 3)

- **Inflation (incl sales) π**

- **Inflation (excl sales)**

- **Loyal customers' fraction l**

- **Sales frequency s**

- **Labor input h+eh**

- **Nominal interest rate i**

- **Real wage w**

- **Real marginal cost x**
Simulation Results: Japan’s Lost Decade
The sales frequency continues to rise during Japan’s lost decade.

Its reason and macroeconomic implications.

- Particular focus on the trend fall in hours worked.
**Approach**

- Match the actual time-series path of hours worked in Japan.
  - Sample ranges from 1981Q1 to 2008Q4.

- Assume that only the technology shock drives the economy.
  - Obtain the time-series path of the technology shock.
Use calibrated parameters, except that we estimate the persistence of the technology shock.

- Use two models: the GS model and our model characterized by $\theta_L = 3$.

- From the time-series path of the technology shock, we calculate the time-series paths of key economic variables.
Simulation Results

- Sales frequency

Sales frequency

Sales frequency s

Our model
(theta_l = 3)

GS model

data

SUWW (BOJ)
Sales model
August 7, 2011
40 / 51
Fraction of loyal customers
Inflation rate
Inflation rate 2

Inflation rate (aggregate - normal)

- Our model (theta_l=3)
- GS model
- POS CPI

[Graph showing inflation rate from 1981 to 2009]
Alternative Explanations

- Other shocks than the technology shock drive the economy.
- Hours worked changes in their steady state.
- Innovations in bargain hunting technology influences bargain hunting in steady state.
Alternative Explanations 1

Sales frequency

Benchmark (Tech shock, theta_l=3)
Gov shock, theta_l=10
Labor shock, theta_l=3
data

SUWW (BOJ)
Fraction of loyal customers

- Benchmark (Tech shock, $\theta_l=3$)
- Gov shock, $\theta_l=10$
- Labor shock, $\theta_l=3$
Inflation rate (aggregate - normal)

- POS CPI
- Benchmark (Tech shock, \( \theta_l = 3 \))
- Gov shock, \( \theta_l = 10 \)
- Labor shock, \( \theta_l = 3 \)
• Steady state change in hours worked, instead of the transitory shock.
Innovations in bargain hunting technology $\phi_L$

Brown and Goolsbee (2002) argue that the internet lowers search cost for customers.
Thank you