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))

Guimaraes and Sheedy "Sales and Monetary Policy" (AER 2011, hereafter GS)

- 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.

What We Do

- 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 $\uparrow \longrightarrow$ Less free time $\longrightarrow$ Loyal customers $\uparrow$ (bargain hunters $\downarrow$) $\longrightarrow$ Sales frequency $\downarrow$
  - Sales-priced goods are sold more than normal-priced goods in terms of quantity $\longrightarrow$ 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)

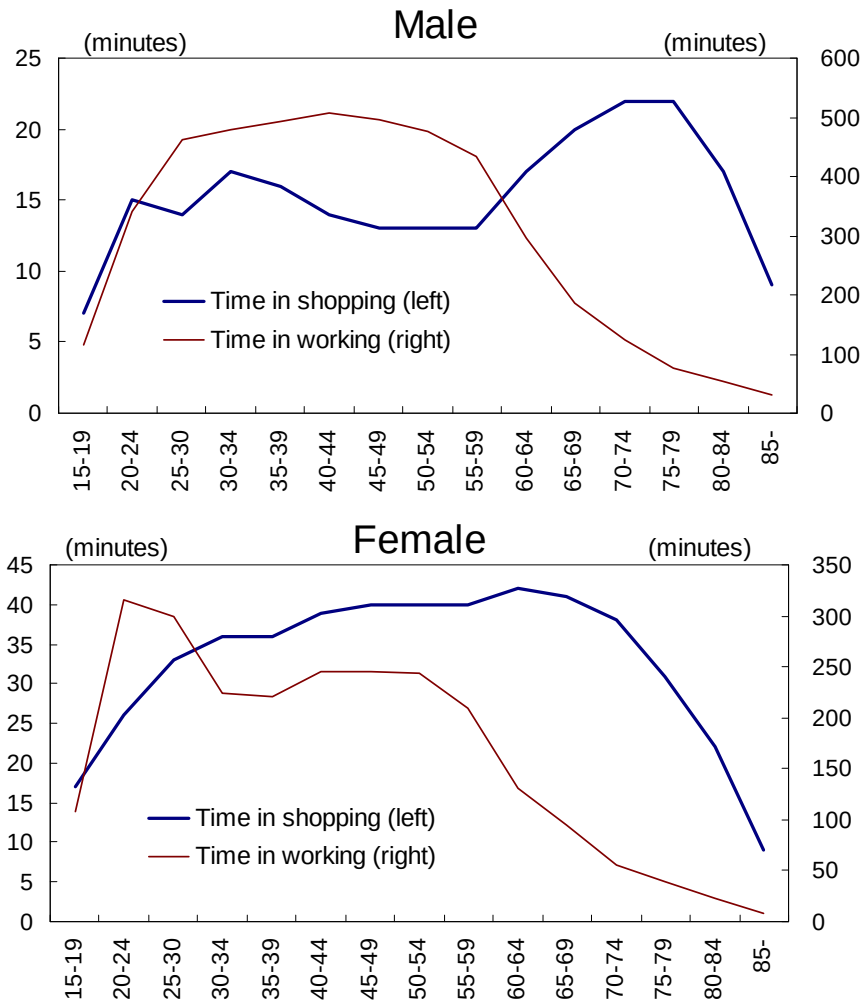
- Statistical Bureau "Survey on Time Use and Leisure Activities"
- Time use in shopping (minutes) is (1) increasing, (2) higher for not-working people, and (3) higher for female.

	Both		Male		Female	
	Working	Not working	Working	Not working	Working	Not working
1986	15	29	6	9	27	37
1991	17	30	9	12	30	38
1996	19	32	11	15	30	39
2001	21	32	13	18	31	39
2006	21	33	14	20	31	39

- 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.

	Both		Male		Female	
	Working	Not working	Working	Not working	Working	Not working
1986	383	28	493	42	371	21
1991	370	26	481	41	358	19
1996	358	22	469	35	345	17
2001	401	17	456	26	324	13
2006	412	16	470	25	335	12

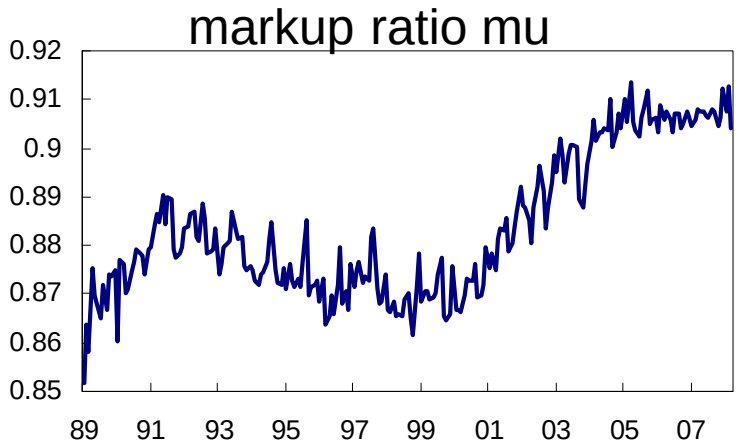
- Life cycle patterns of time use as of 2006
- Working and shopping times are negatively correlated up to a certain age.
- Modereate aging increases shopping time.

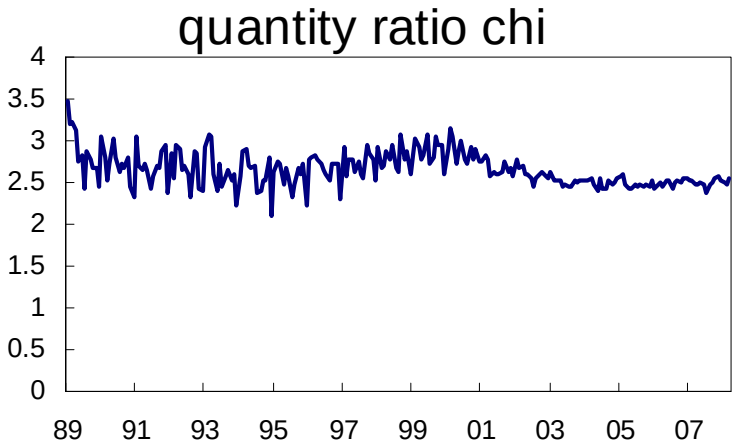


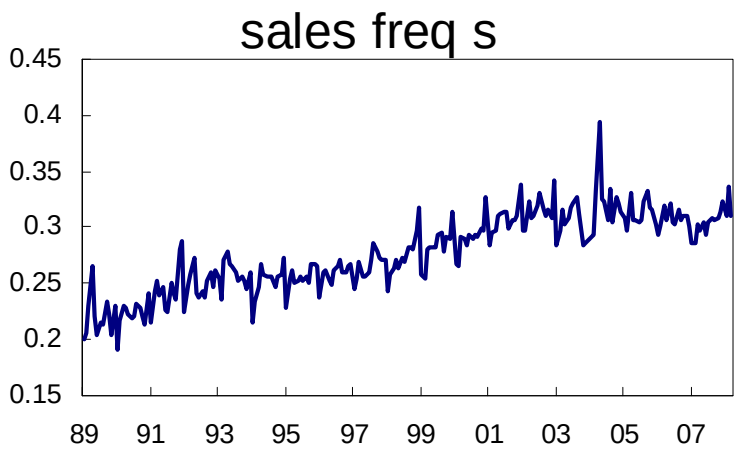
Evidence for Endogenous Bargain Hunting (POS Data)

- GS Model - Calibration
- Three target variables
  - Ratio of sale price markup to regular price markup μ
  - Ratio of quantities sold at sales price to those sold at regular price χ
  - Frequency of sales s
- Three calibrated deep parameters
  - Elasticity of substitution bw product types ϵ (beer and desserts)
  - Elasticity of substitution bw brands for bargain hunter η (Kirin and Asahi): naturally $\eta > \epsilon$
  - Fraction of loyal customers λ

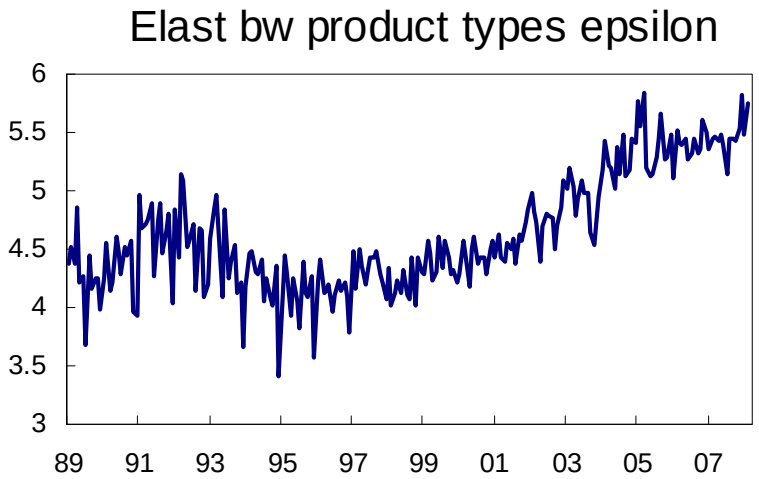
- Target variables including the sales frequency

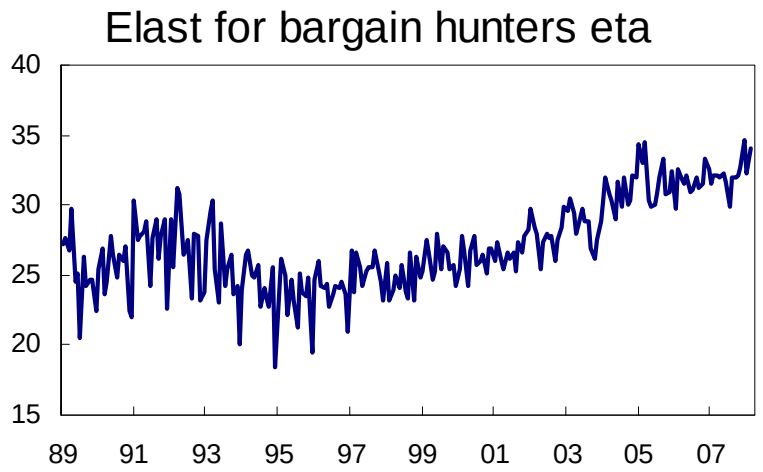


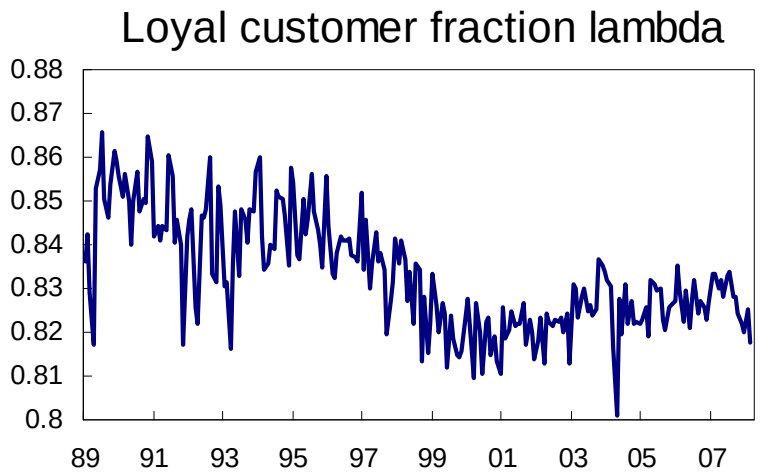




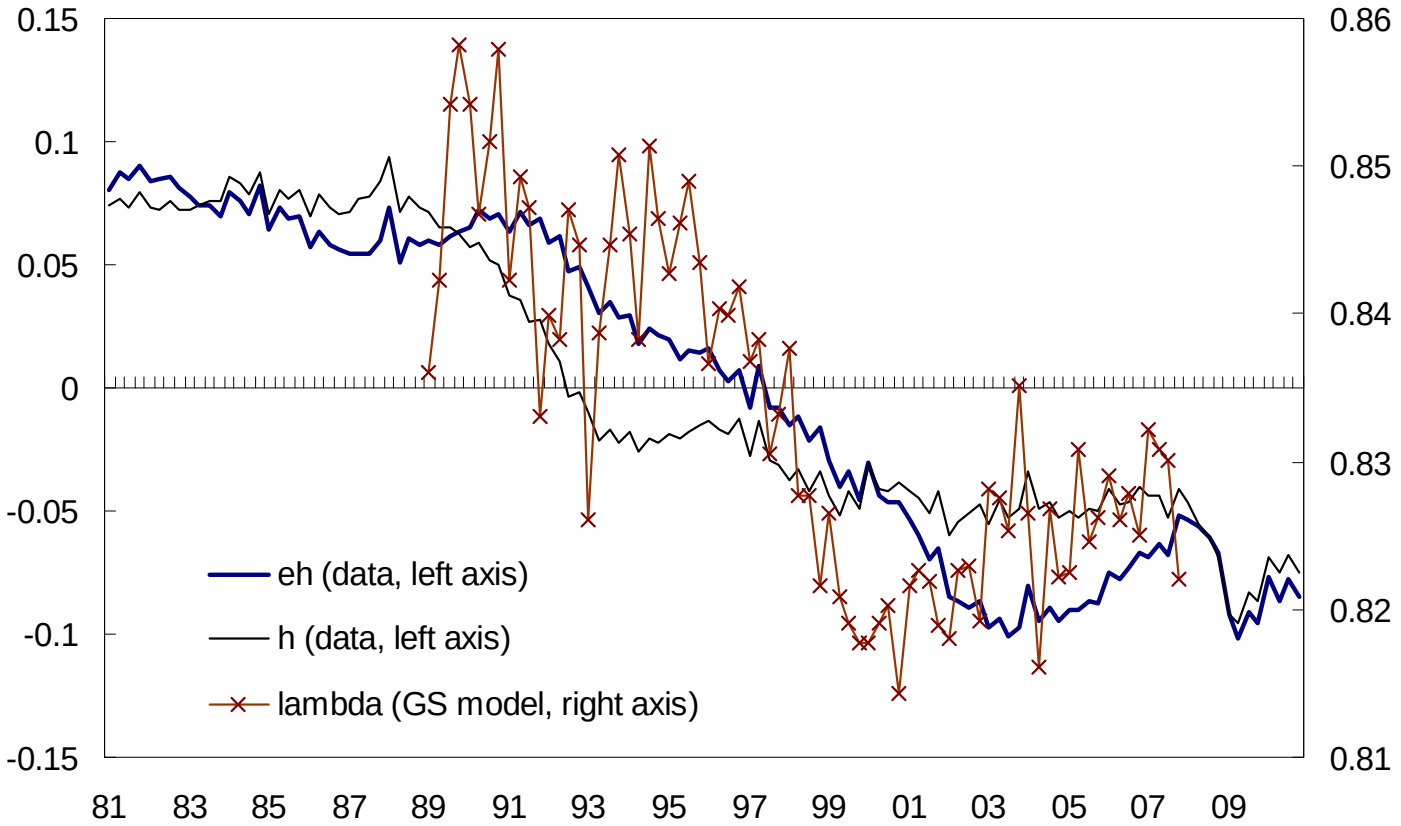
- Calibrated deep parameters including the fraction of loyal customers



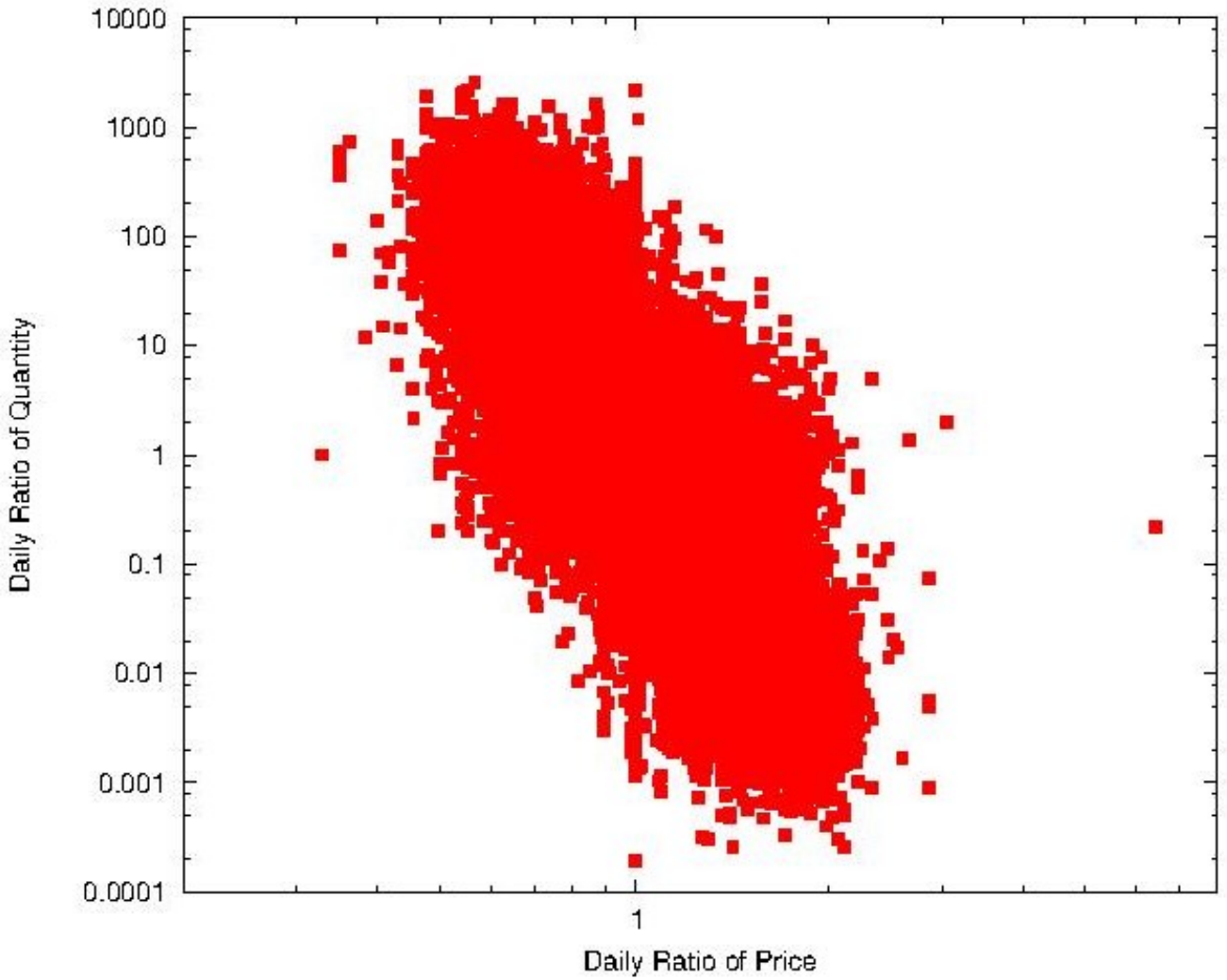




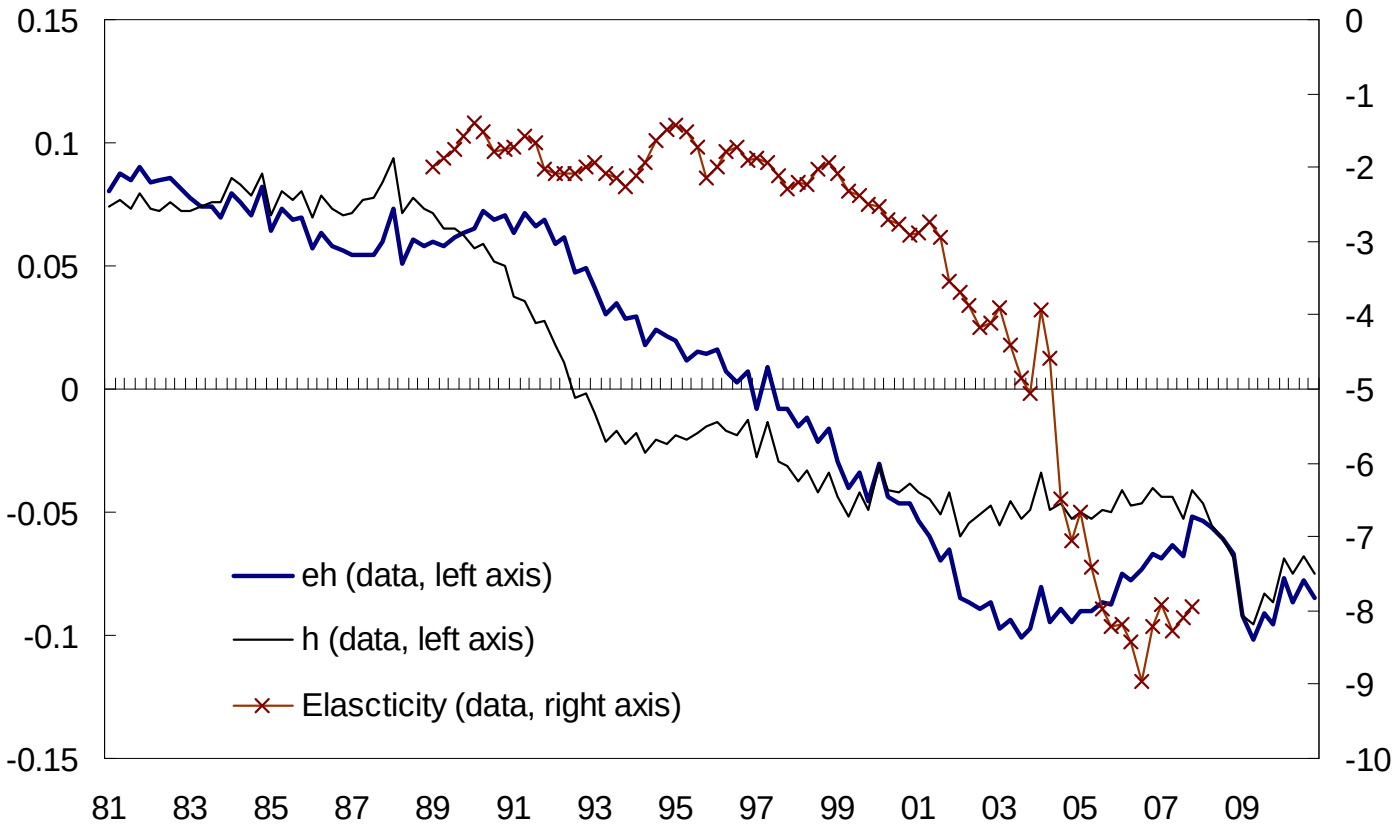
- The fraction of loyal customers and labor market indicators
  - Hours worked h and the employment ratio e to the pop over 15 (log deviation from mean)



- 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.



Model

GS Model - Consumers

- Consumption in utility
  - Two kinds of consumers: loyal customer and bargain hunter
  - The fraction of loyal customers λ is constant.
  - Product type τ (elast ϵ) and brand b (elast $\eta > \epsilon$)

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

GS Model - Consumers 2

- Demand function for brand b of type τ product
  - $1-\lambda$ bargain hunter faces high elast. λ loyal customer faces low elast.
  - C^* is aggregate consumption (budget constraint)

$$c(\tau,b)=\begin{cases}\left(\frac{p(\tau,b)}{p_B(\tau)}\right)^{-\eta}\left(\frac{p_B(\tau)}{P}\right)^{-\epsilon}C^* & \text{for } 1-\lambda \text{ population}\\ \left(\frac{p(\tau,b)}{P}\right)^{-\epsilon}C^* & \text{for } \lambda \text{ population}\end{cases} \tag{2}$$

GS Model - Firms

- Sales pricing bears neither cost nor rigidity $\longrightarrow$ 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.

Our Model (Modified GS Model) - Consumers 1

- Endogenous loyal customers' share L_t with its mean λ
  - $1 - L_t$ is bargain hunters' share.

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

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

- Demand function,

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

  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.

Modified GS Model - Consumers 2

- The difference between C and C^* is defined as a consumption wedge F :

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

where

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

- Tradeoff between disutility from bargain hunting and an increase in consumption wedge.

Modified GS Model - Firms

- 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

GS Model - Other Parts

- Monetary policy: the inflation rate omits sales prices.

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

- Resource constraint:

$$Y_t = C_t^* + Z_t^g. \tag{9}$$

Key Log-Linearized Equations 1

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

$$ss_t = -\frac{1-\theta_B}{\varphi_B}\frac{1}{1-\psi}x_t - \underline{\left(\frac{1-\theta_B}{\varphi_B}\frac{A}{1-\psi} + \frac{1}{(\eta-\epsilon)(1-\lambda)\varphi_B}\right) l_t}. \quad (10)$$

Key Log-Linearized Equations 2

- The fraction of loyal customers l increases with output y (labor supply).

$$
\begin{aligned}
0 = & \left(\theta_c^{-1} - 1 + \frac{1}{1+\gamma\delta} \frac{\theta_h^{-1}}{\alpha} \right) y_t - \frac{\delta}{1+\gamma\delta} \frac{\theta_h^{-1}}{\alpha} w_t \\
& - \frac{\theta_h^{-1}}{\alpha} \varepsilon_t^a - (\theta_h^{-1} - 1)\varepsilon_t^h - (\theta_c^{-1} - 1)\varepsilon_t^g \\
& - \left(\frac{1}{1+\gamma\delta} \frac{\theta_h^{-1}}{\alpha} B + (\theta_L - 1) \frac{\lambda}{1-\lambda} + \theta_h^{-1} \phi_L \frac{\lambda}{(1-\lambda)H} \right) l_t \\
& + (\theta_c^{-1} - 1) \left\{ f_t - \epsilon \left(x_t + \frac{1}{(\eta-\epsilon)(1-\lambda)} l_t \right) \right\} \\
& + \frac{P_{SN}}{1-P_{SN}} p_{SN,t} + \frac{\eta - 1}{\eta} f_t. \qquad (11)
\end{aligned}
$$

Key Log-Linearized Equations 3

- The inflation rate π increases with the fraction of loyal customers I.

$$\pi_t = \beta E_t \pi_{t+1} + \frac{1}{1-\psi}\left\{\kappa x_t + \psi(\Delta x_t - \beta E_t \Delta x_{t+1}) \underline{+\kappa A I_t + A(\Delta I_t - \beta E_t \Delta I_{t+1})}\right\}. \tag{12}$$

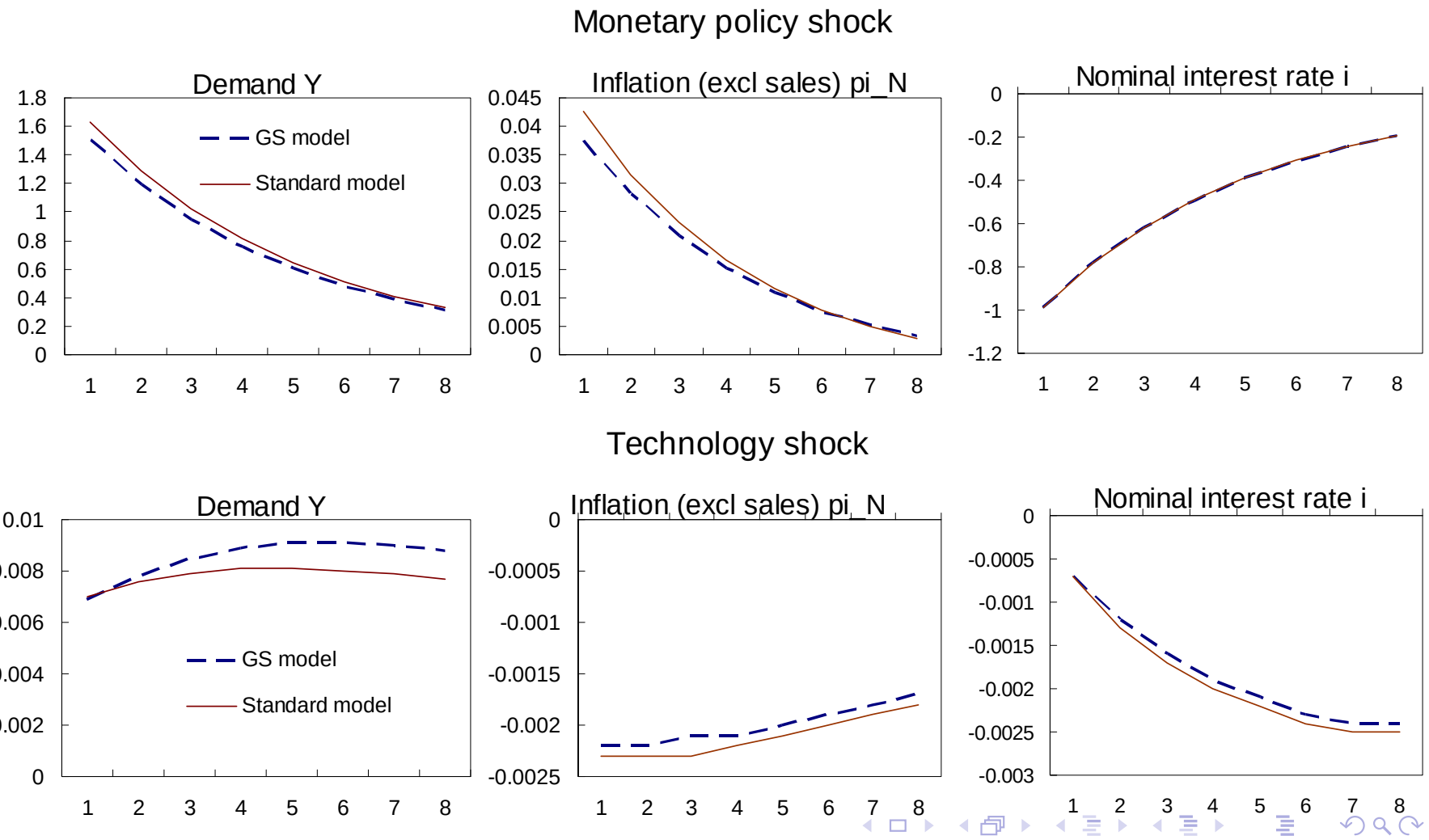
Simulation Results: IRFs

GS's Calibration from POS

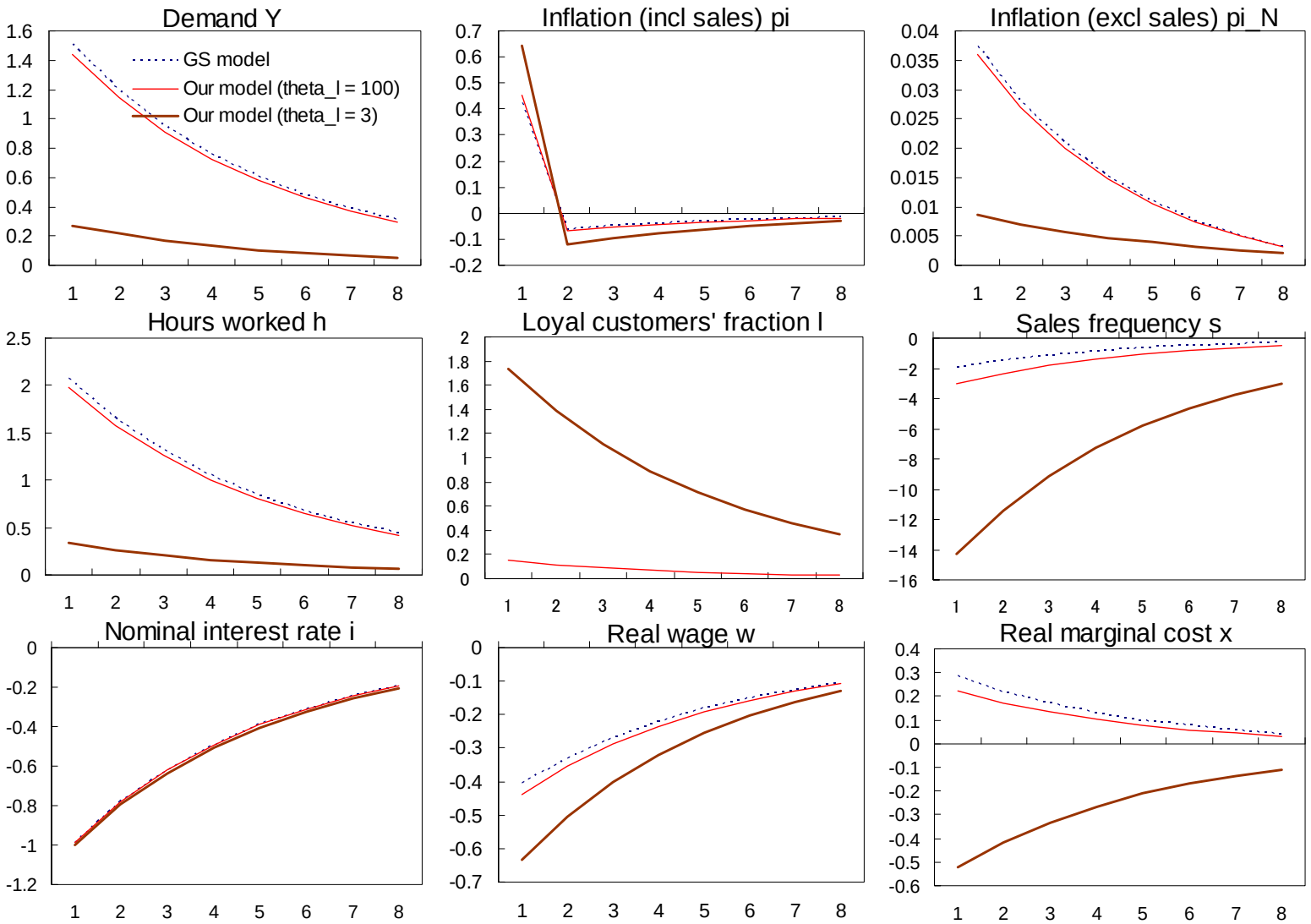
Target variables		
μ	Price ratio of sales to normal	0.883
χ	Quantity ratio of sales to normal	2.657
s	Sales frequency	0.276
Parameters		
ϵ	Elasticity bw product types	4.586
η	Elasticity bw brands	26.820
λ	Fraction of loyal customers	0.833

IRFs to an Accom MP Shock and Positive Tech Shock in the GS Model

- Sales result in almost no change in real effects.



IRFs to an Accom MP Shock in Our Model

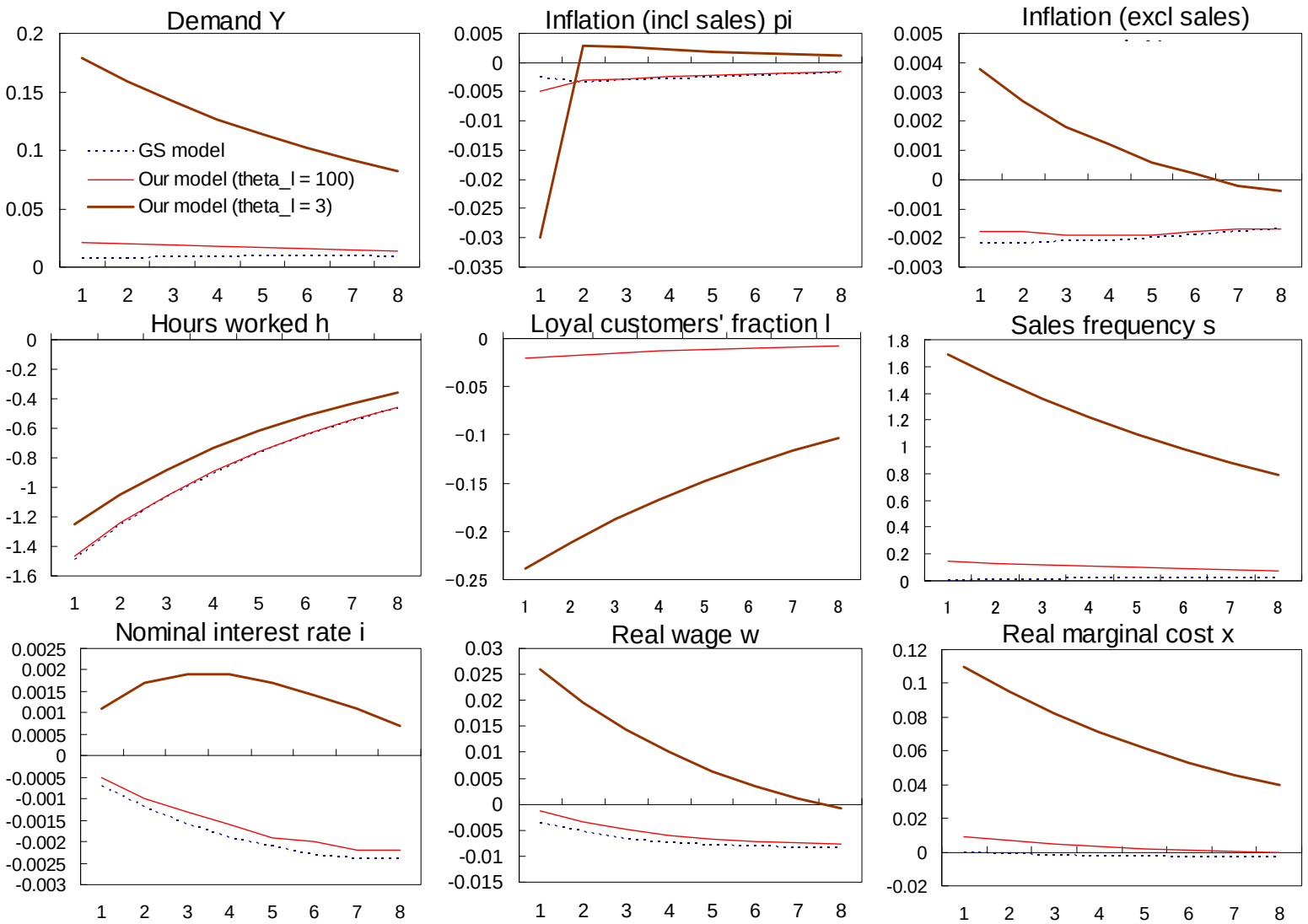


Why is the Real Effect of Mon Policy Small?

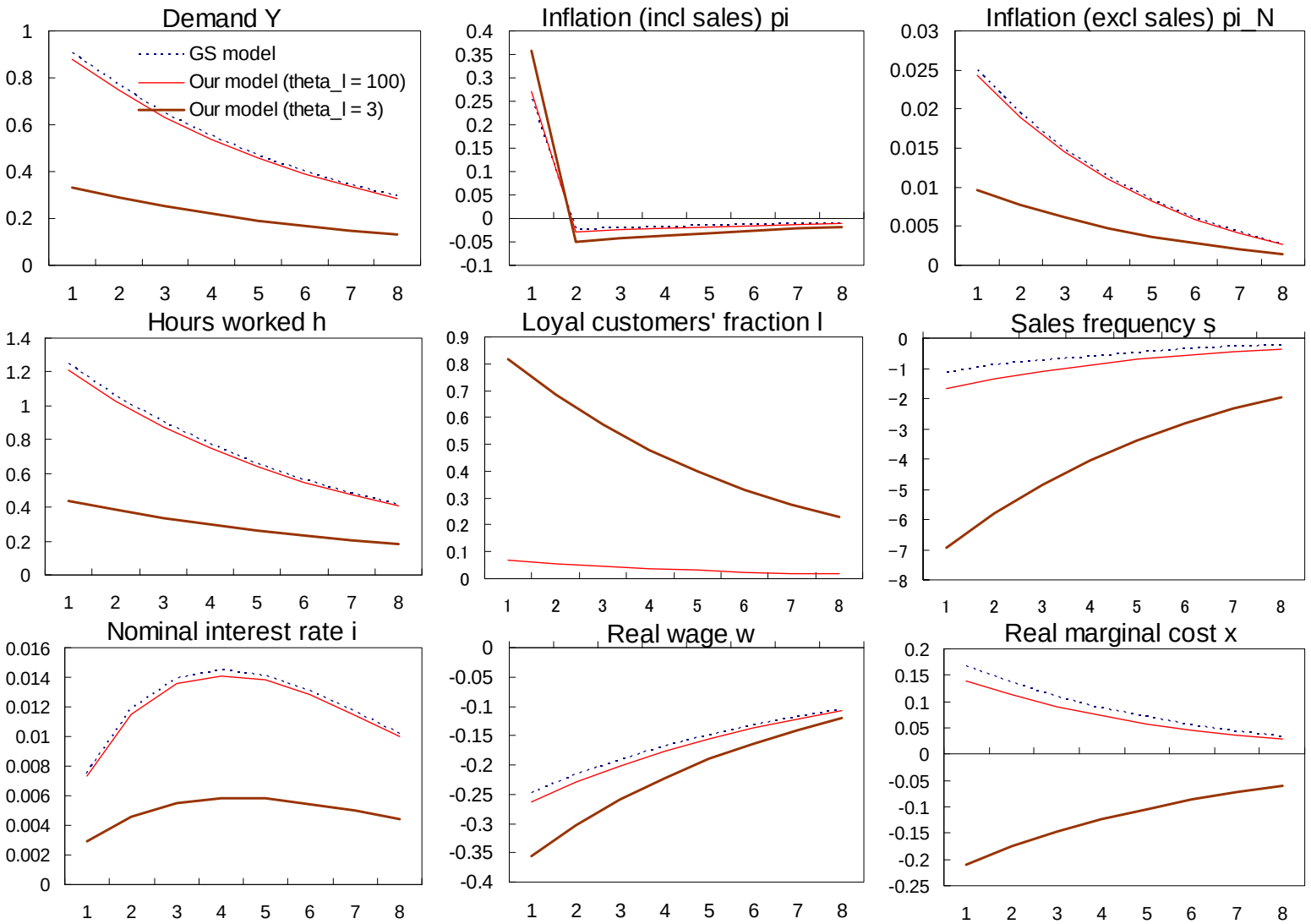
- Basic mechanism
  - Accom mon shock $\longrightarrow$ Goods demand $\uparrow$ $\longrightarrow$ Hours worked $\uparrow$ $\longrightarrow$ Less free time $\longrightarrow$ Loyal customers $\uparrow$ (bargain hunters $\downarrow$)
  - For firms, sales frequency $\downarrow$
  - Sales-priced goods are sold more than normal-priced goods in terms of quantity $\longrightarrow$ 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.

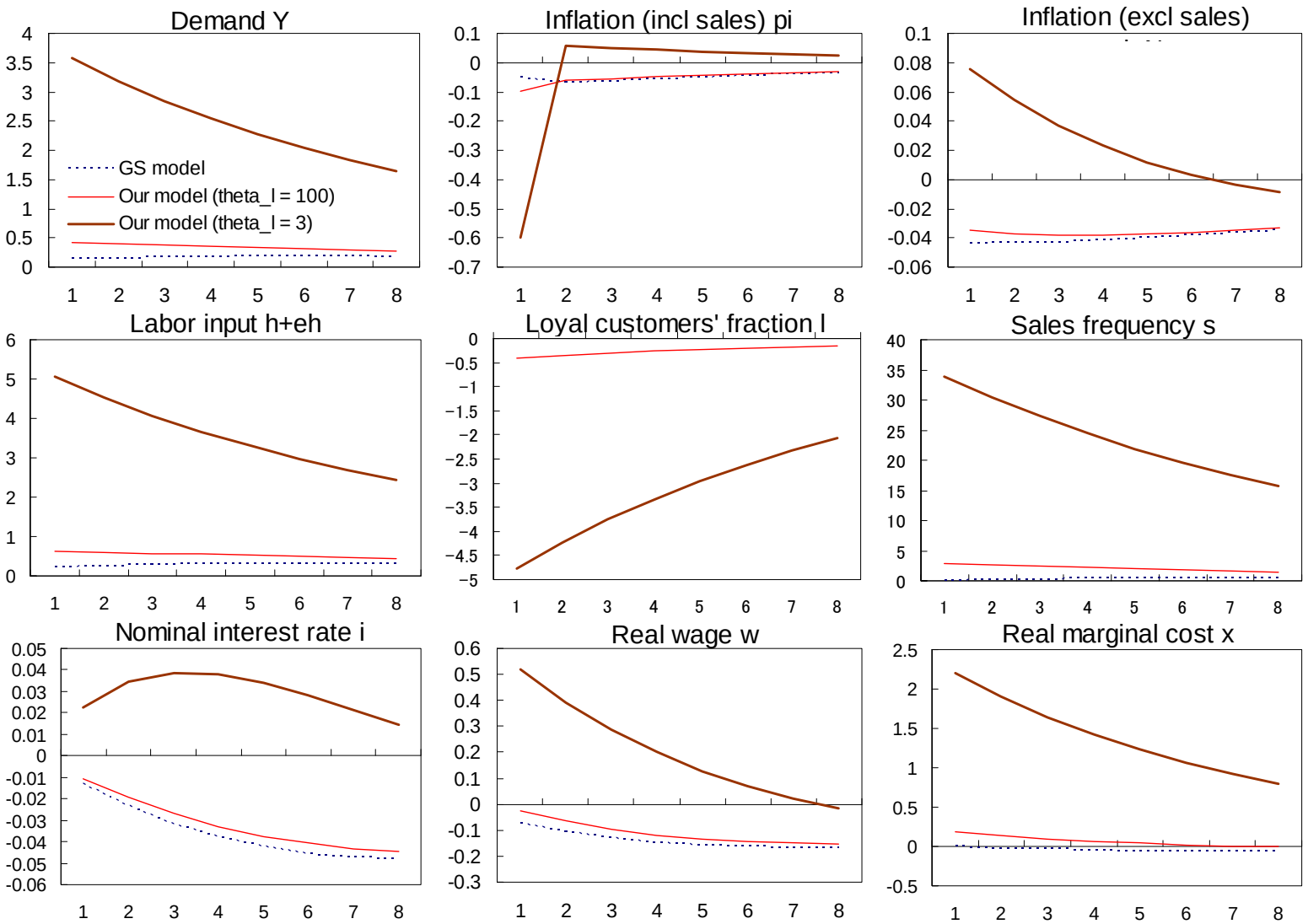
IRFs to a Positive TFP Shock in Our Model



IRFs to a Positive Gov Shock in Our Model



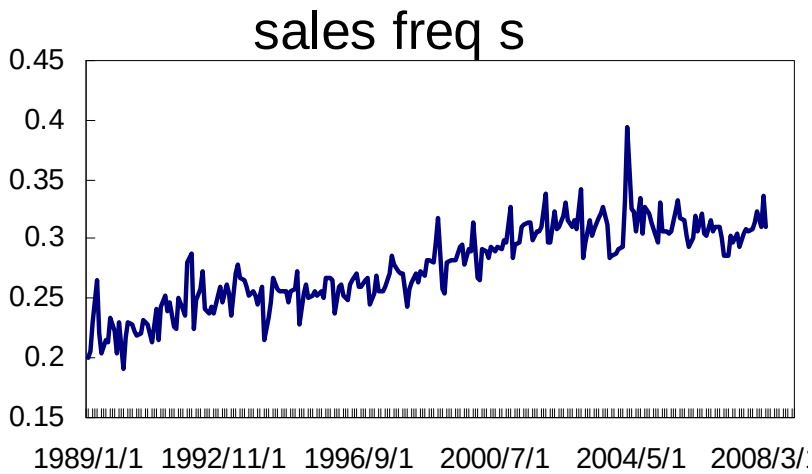
IRFs to a Labor Supply Shock in Our Model



Simulation Results: Japan's Lost Decade

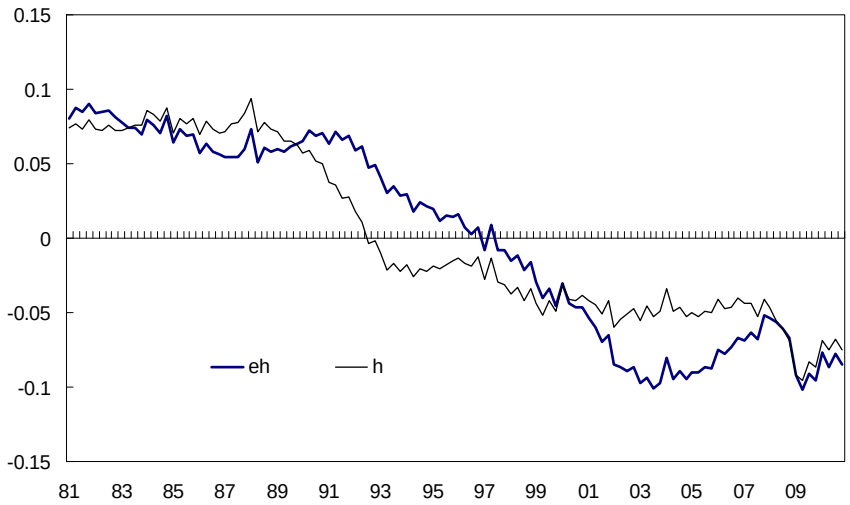
Motivation

- The sales frequency s 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.

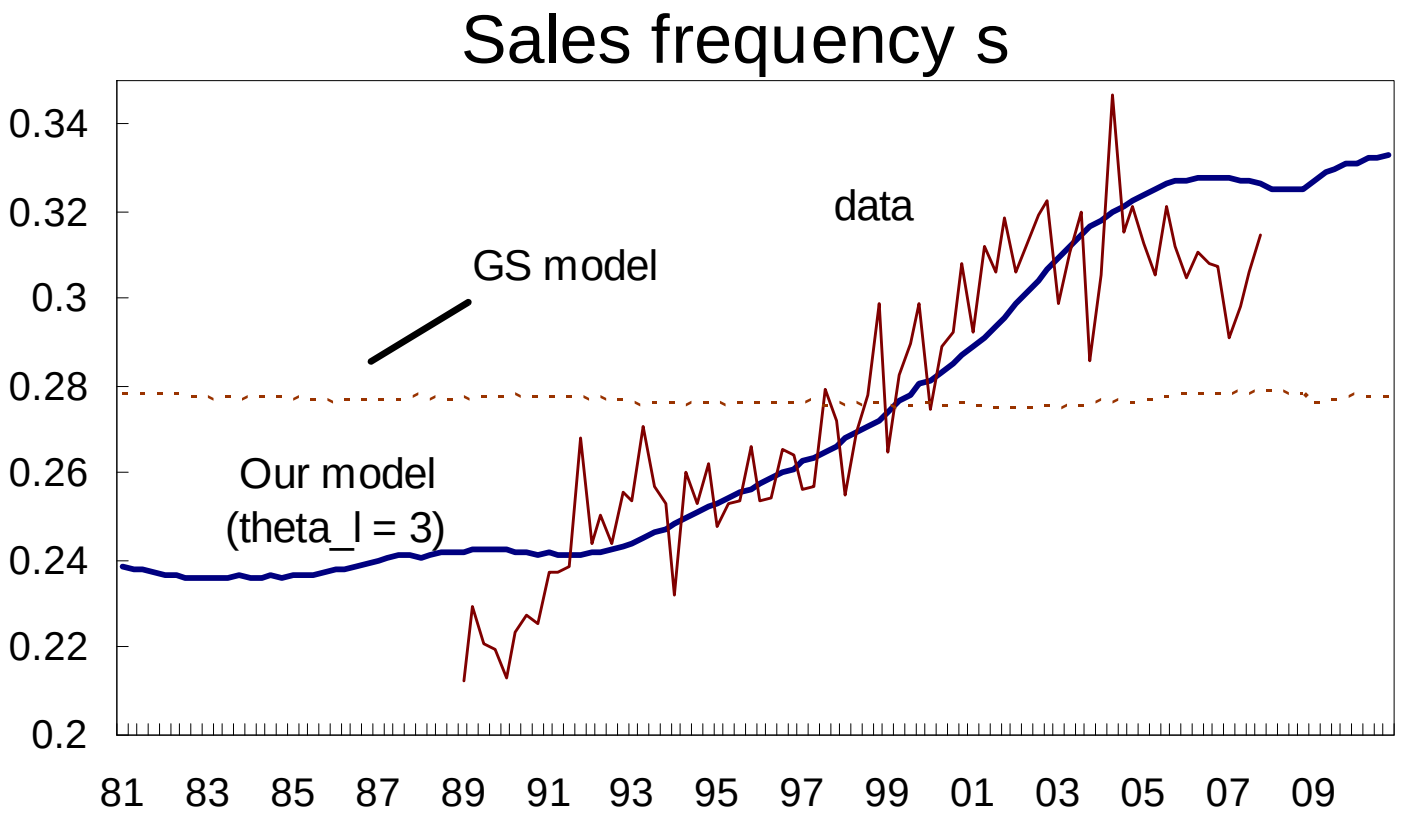


- Assume that only the technology shock drives the economy.
  - Obtain the time-series path of the technology shock.

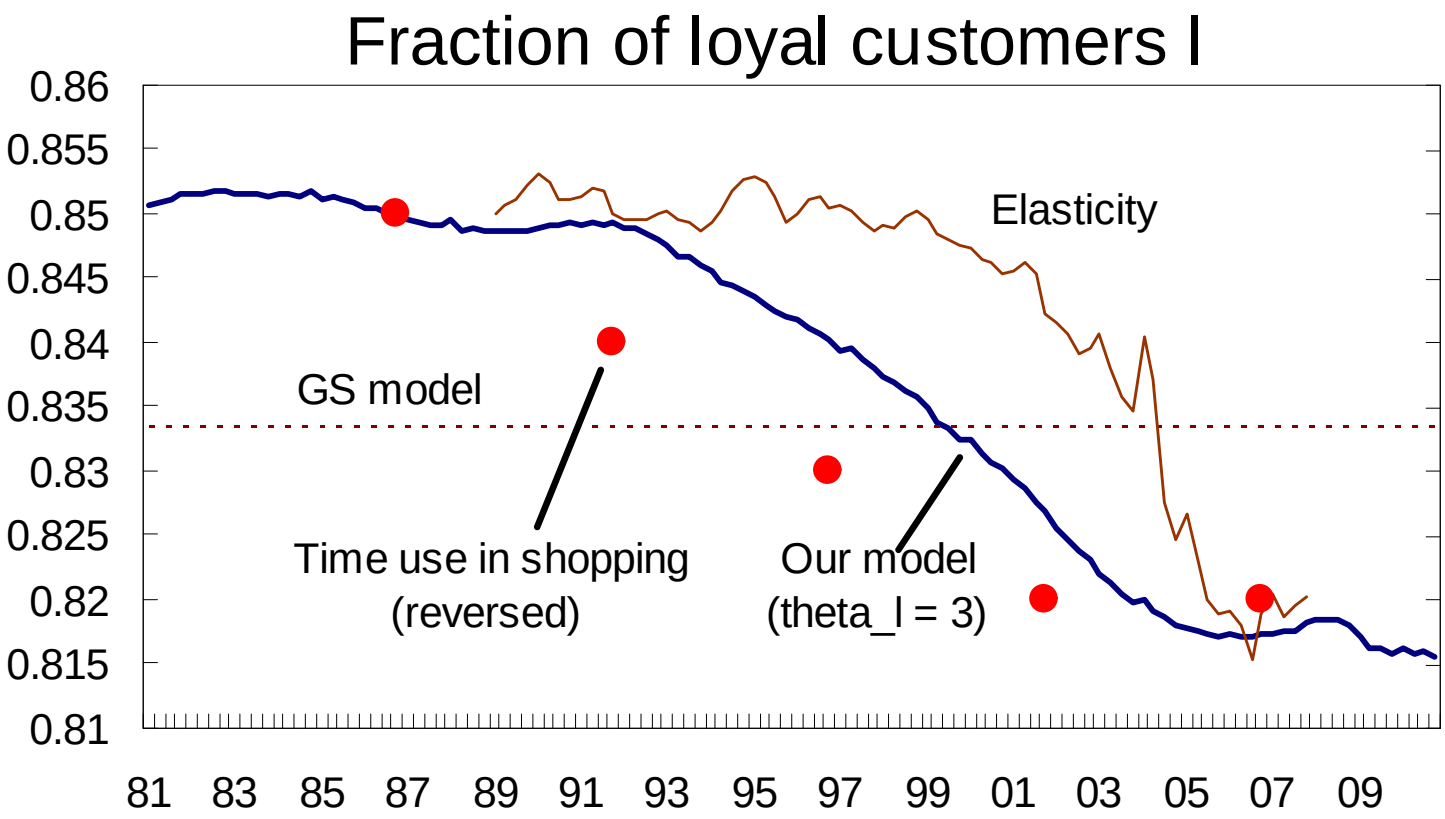
- Use calibrated parameters, except that we estimate the persistence of the technology shock.
  - Use two models: the GS model and our model characterized by $\theta_L = 3$.
- From the time-series path of the technology shock, we calculate the time-series paths of key economic variables.

Simulation Results

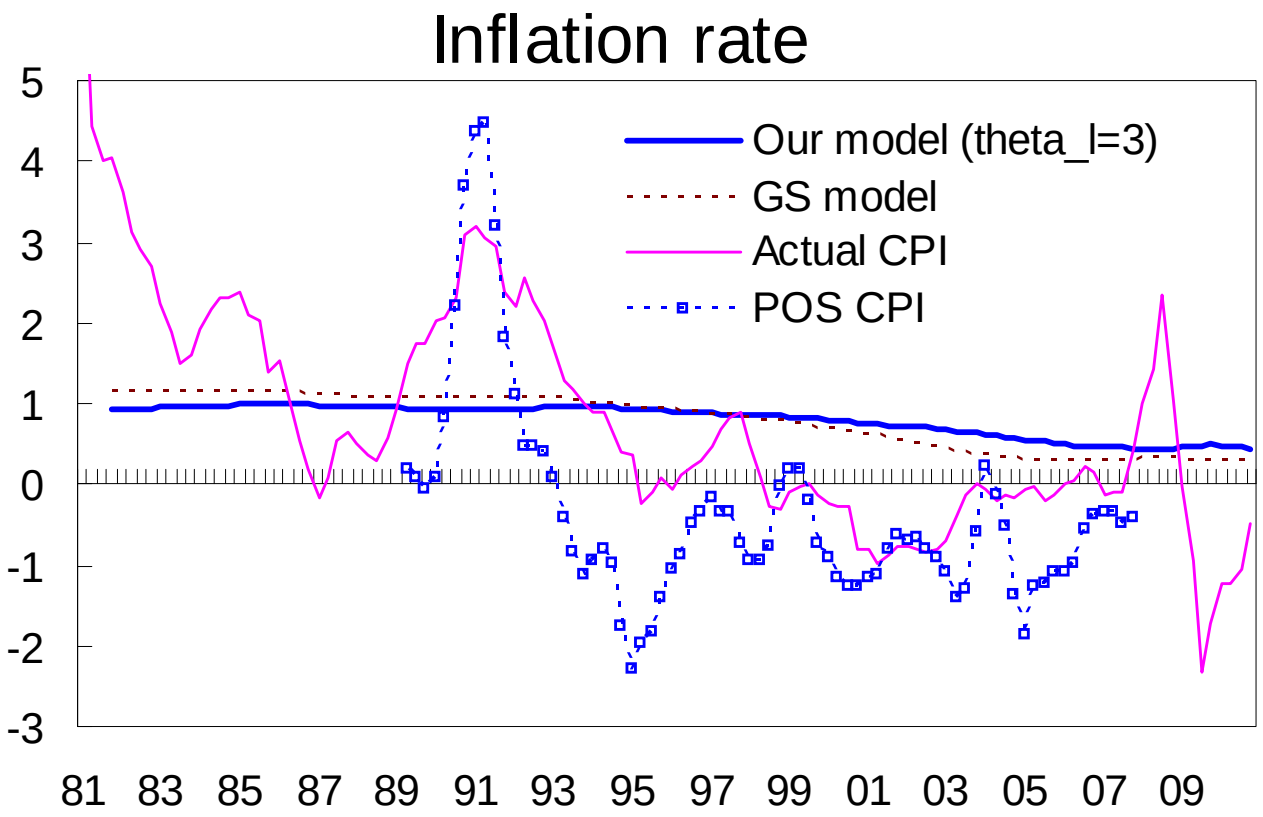
- Sales frequency



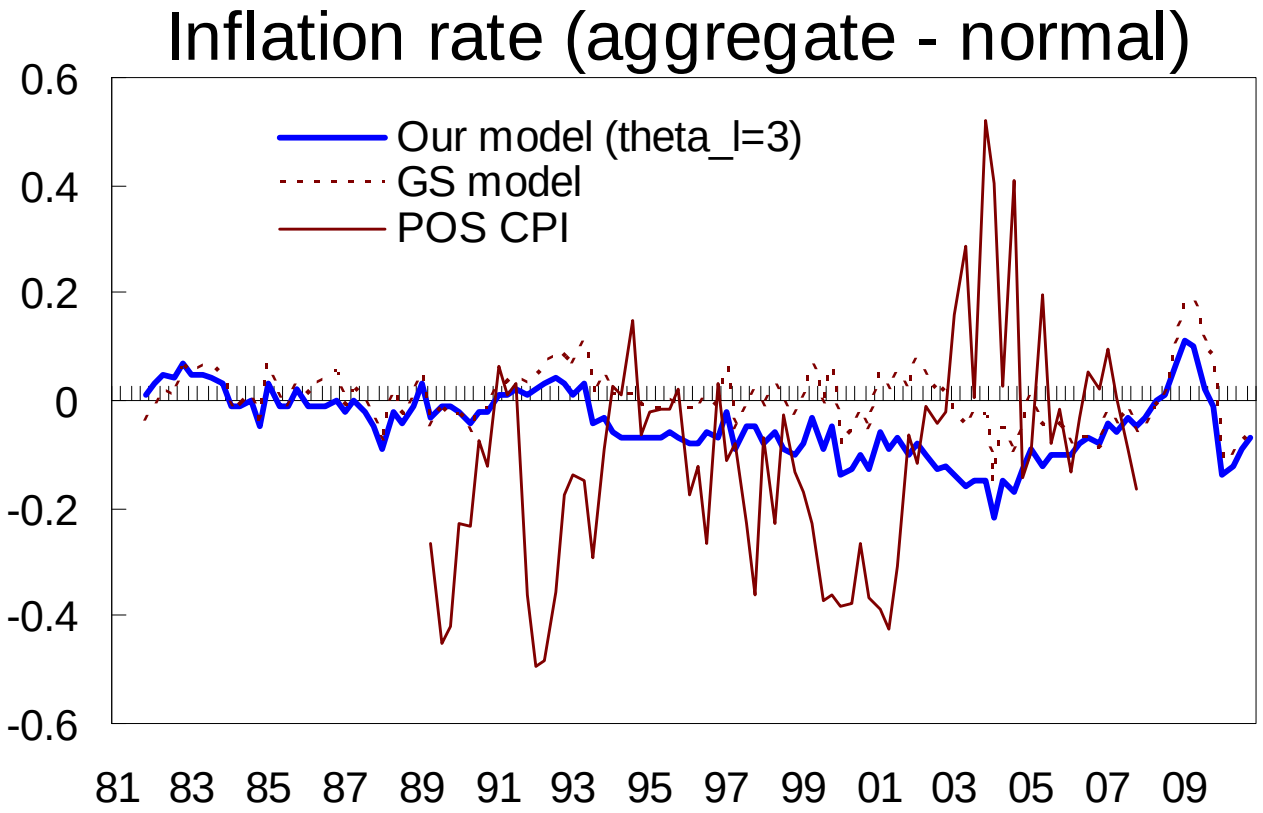
- Fraction of loyal customers



- Inflation rate



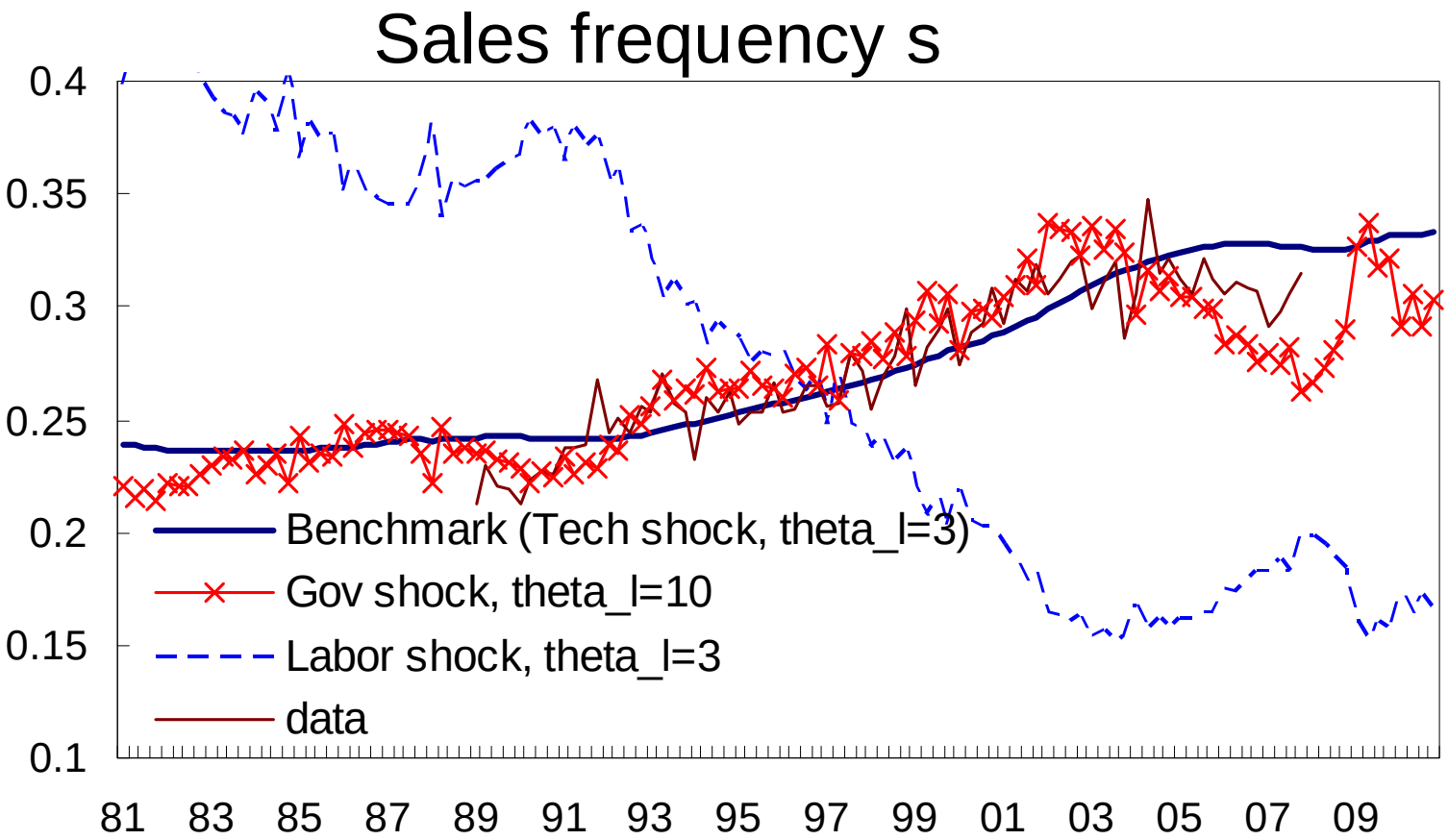
- Inflation rate 2



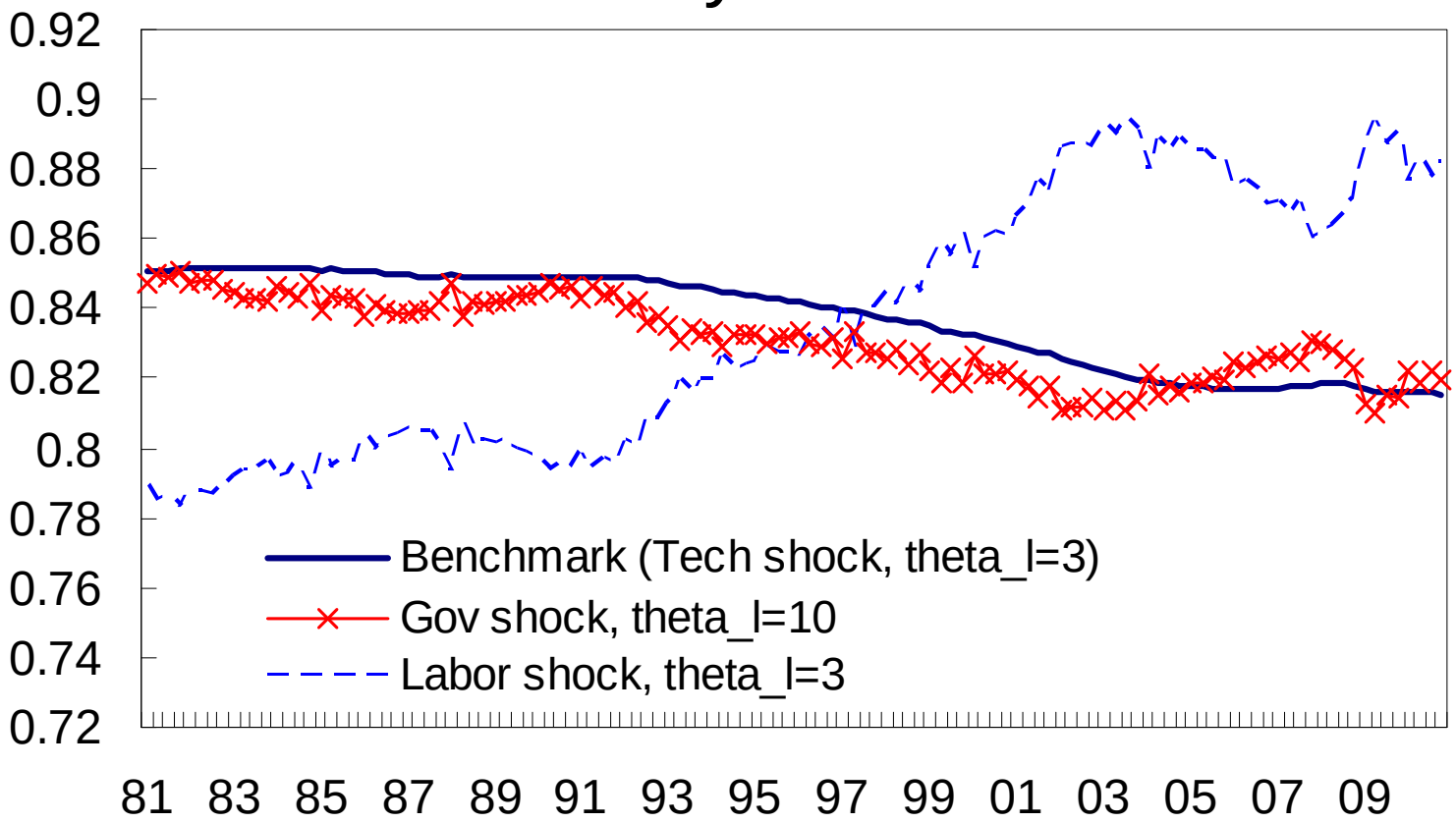
Alternative Explanations

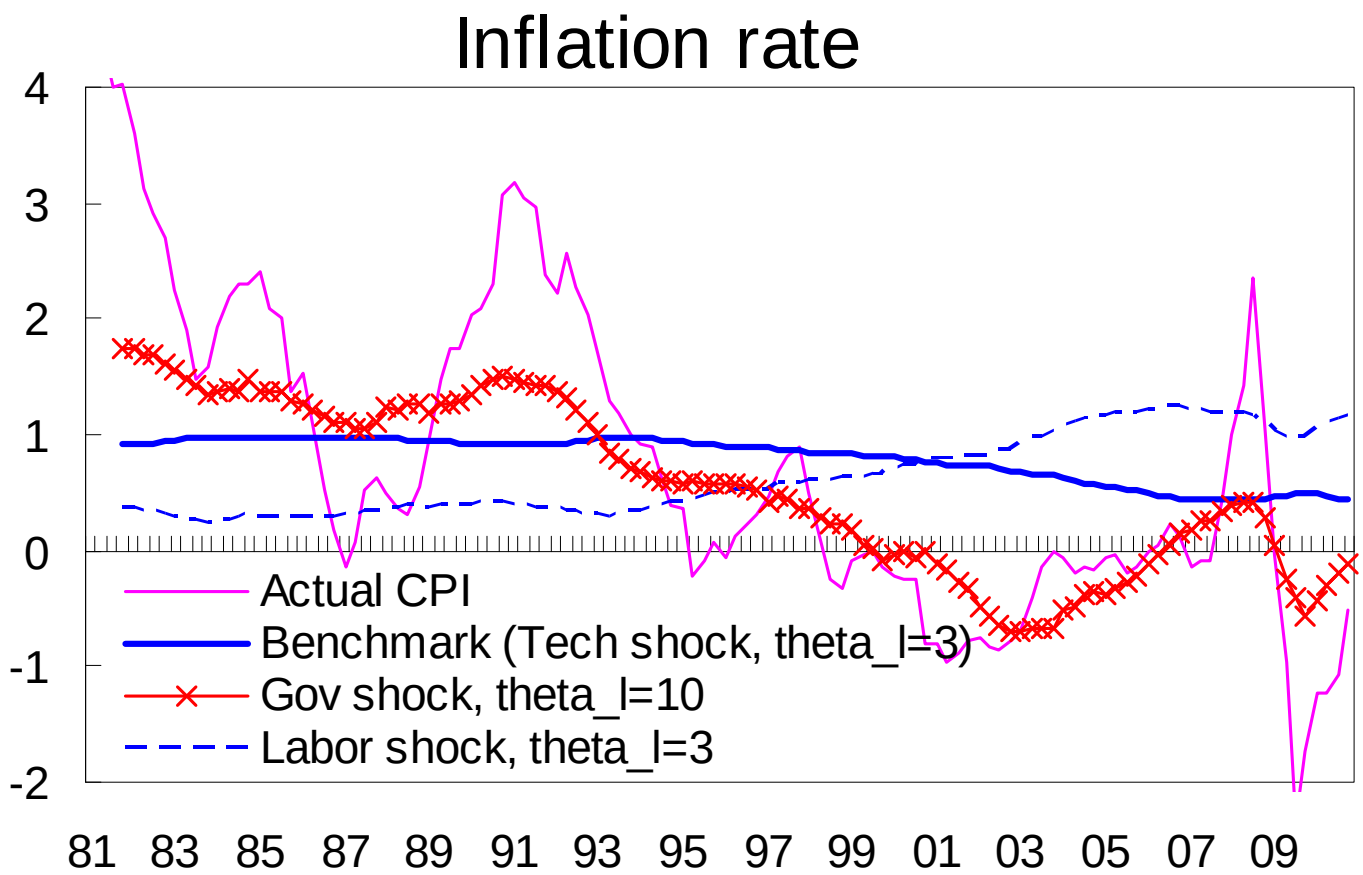
- Other shocks than the technology shock drive the economy.
- Hours worked changes in their steady state.
- Innovations in bargain hunting technology influences bargain hunting in steady state.

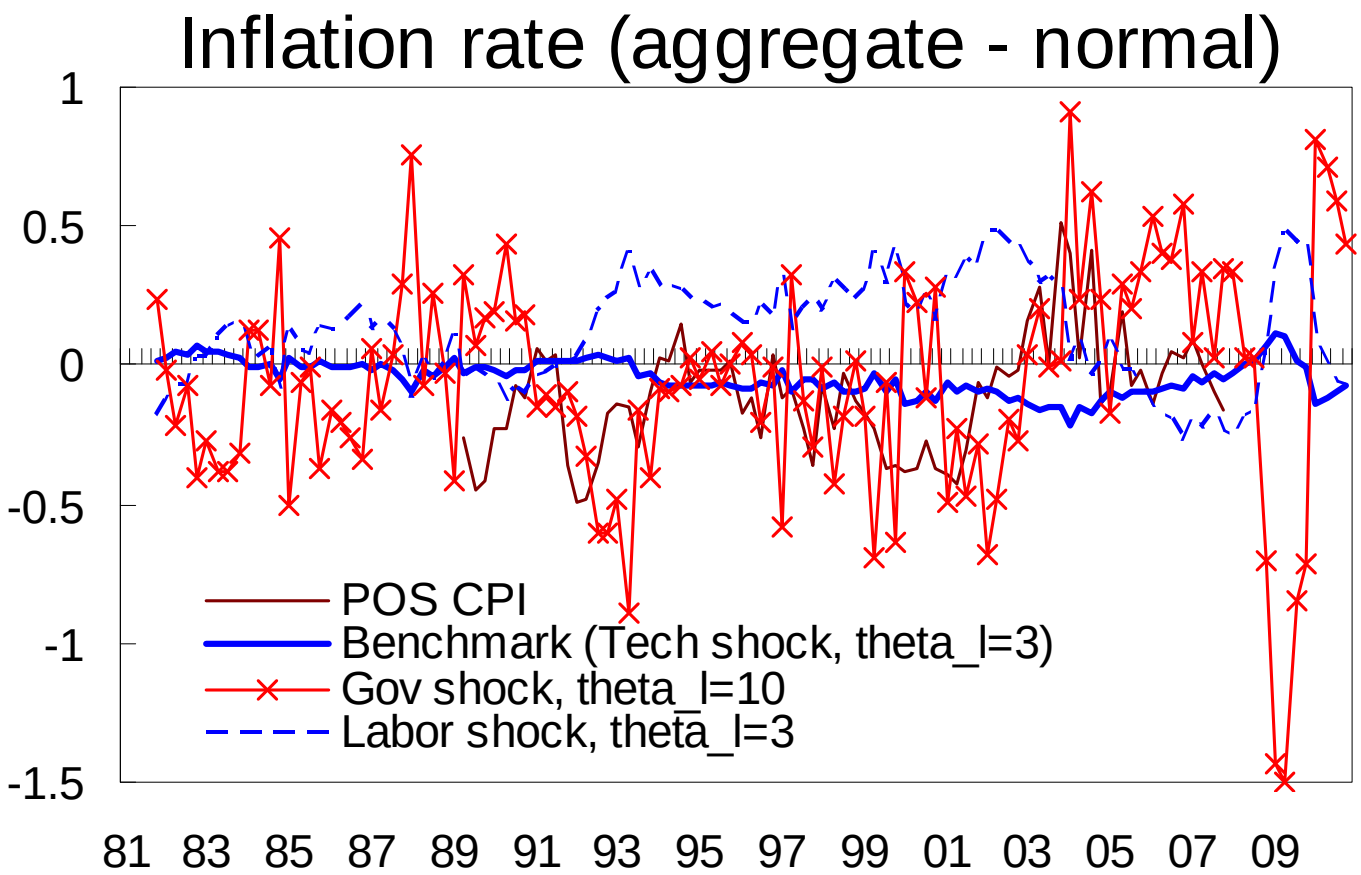
Alternative Explanations 1



Fraction of loyal customers l

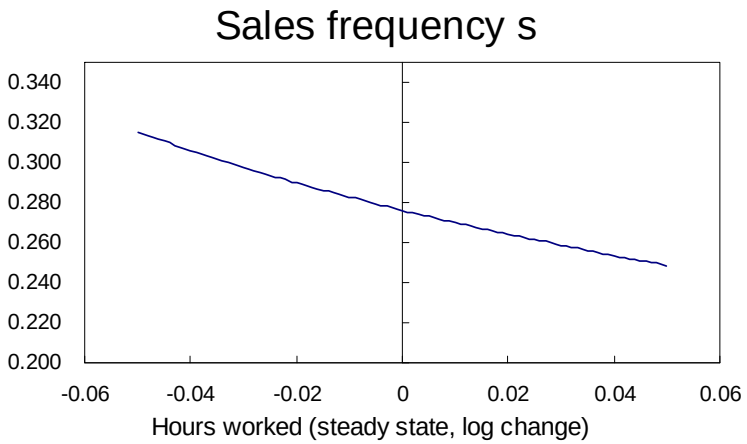


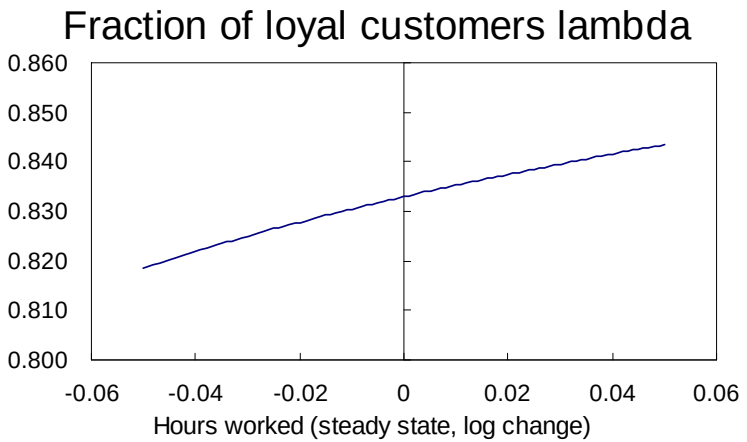

Inflation rate
4
3
2
1
0
-1
-2
81
83
85
87
89
91
93
95
97
99
01
03
05
07
09
Actual CPI
Benchmark (Tech shock, theta_l=3)
Gov shock, theta_l=10
Labor shock, theta_l=3


Inflation rate (aggregate - normal)
1
0.5
0
-0.5
-1
-1.5
81
83
85
87
89
91
93
95
97
99
01
03
05
07
09
POS CPI
Benchmark (Tech shock, theta_l=3)
Gov shock, theta_l=10
Labor shock, theta_l=3

Alternative Explanations 2

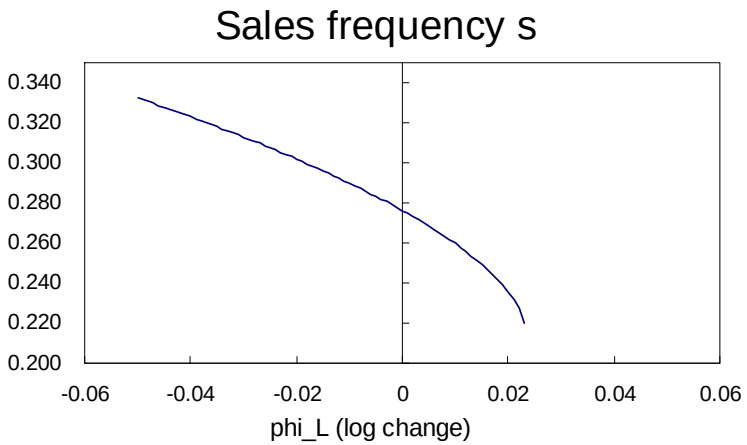
- Steady state change in hours worked, instead of the transitory shock.

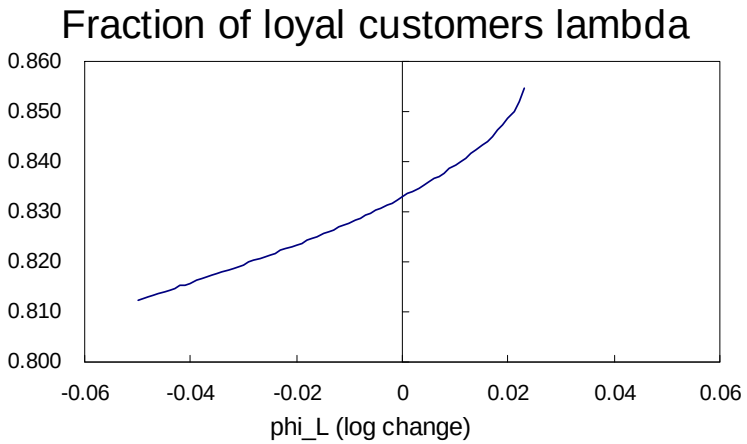




Alternative Explanations 3

- Innovations in bargain hunting technology ϕ_L
  - Brown and Goolsbee (2002) argue that the internet lowers search cost for customers.





Thank you