(Dis-)Aggregate Consumption & Monetary Policy

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Motivation

Q: How does Consumption Behavior Influence Monetary Policy?

Standard New Keynesian Model:

- Sticky Prices
    - $\Rightarrow$ Monetary policy has real effects
- Bundle of Goods
    - $+$ CES preferences $\Rightarrow$ aggregate consumption
- No Unemployment

But:

- Goods differ in *price flexibility* and *consumption elasticity*
- Unemployment does exist

Empirical Findings

Intensive Margin Consumption:

- ΔC_t due to permanent income change other then employment status (wages, hours, ...)
- Households consume disproportionately more sticky price goods (luxuries)

Extensive Margin Consumption:

- ΔC_t due to change in employment
- Households consume disproportionately more flexible price goods (necessities)

Expansionary Monetary Policy:

- no significant effect on weekly earnings
- increases employment

Theoretical Findings

Textbook New Keynesian model with:

- Search and Matching Friction $\Rightarrow$ Unemployment
- Non-homothetic preferences (Necessity vs. Luxury consumption)
- Home-Production of Necessity
- Representative Family $\Rightarrow$ Complete Consumption Insurance

Comparison to Standard NK Model:

- Worse Trade-Off - Real Output vs. Inflation
- State-Dependence
- Optimal Policy reacts to Unemployment

Literature

- **Consumption Response to Income Changes**
  Expected vs Unexpected: Johnson et al (2006), Parker et al (2013)
  Transitory vs Permanent: Blundell et al (2008), Arellano et al (2017)
  Intensive vs Extensive: Alonso (2016), Hubner (2018)

- **Home Production & Shopping Time Behavior**
  Benhabib et al (1991), Aguiar, Hurst (2005, 2007, 2013), Nevo, Wong (2015)
  Subset of Goods

- **New Keynesian Models**
  Multi-sector: Barsky et al (2006), DiPace, Hertweck (2016)
  Search-and-Matching: Trigari (2009), Blanchard, Gali (2010), Ravenna, Walsh (2012)
  Non-homotheticity: Huang et al (2013), Cavallari (2018)
  Home-Production: Gnocchi et al (2016)

Outline

1 Introduction

2 Empirical Findings
   - ► Intensive Margin Consumption
   - ► Extensive Margin Consumption
   - ► Monetary Policy

3 Theoretical Findings
   - ► Comparison to New Keynesian Model
   - ► State-Dependence
   - ► Welfare Analysis

Data - Consumption Expenditures

CEX - Consumption Expenditure Survey

- US *household level* consumption expenditures
- Quarterly 1980-2016
- Households (HH) interviewed for 4 consecutive quarters
- 22 Consumption Categories (Details)
  - ▸ E.g. Apparel, Gasoline, Recreation

Data - Price Flexibility

1. Price Change Frequency
   - Micro Price Data underlying the Consumer Price Index (CPI)
   - Average, regular price change frequencies 1988-2005
     - ⋆ Klenow, Kryvtsov (2008) - 1988-1997
     - ⋆ Nakamura, Steinsson (2008) - 1998-2005

2. Price Cyclicality $\qquad \log \frac{P_{ct}}{P_t} = \alpha + \beta_c \log Y_t$
   - $\log \frac{P_{ct}}{P_t} =$ (hp-filtered) log relative price index (NIPA)
   - $\log Y_t =$ (hp-filtered) log real GDP

Correlation

Intensive Margin Consumption

- Income Elasticities (Engel Curves)
- Sample: No HH member changes employment status
  $\sim$ 45000 Households
- Specification:

$$\tilde{y}_{cht} = \alpha_{ct} + \alpha_{ch} + \beta_c^i \cdot \log C_{ht} + \gamma_c \cdot X_{ht} + \nu_{cht}$$

  - $\tilde{y}_{cht} = \frac{y_{cht}}{\bar{y}_{ct}}$ - zero expenditures
  - $\log C_{ht}$ - proxy for permanent income
  - β_c^i - expenditure elasticity of good c

- Measurement Error in y_{cht}
  - Add expenditures from 2nd-4th interview
  - Instrument by expenditures from 1st interview

Intensive Margin Consumption

- HHs spend intensive margin income increases on sticky price goods
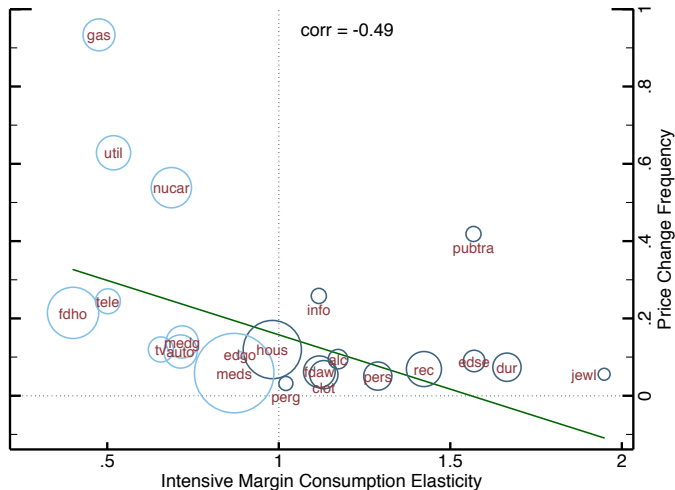
Intensive Margin Consumption

- HHs spend intensive margin income increases on sticky price goods
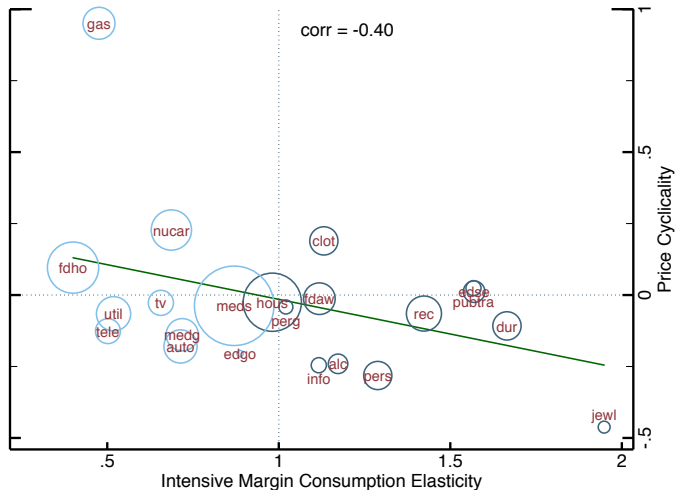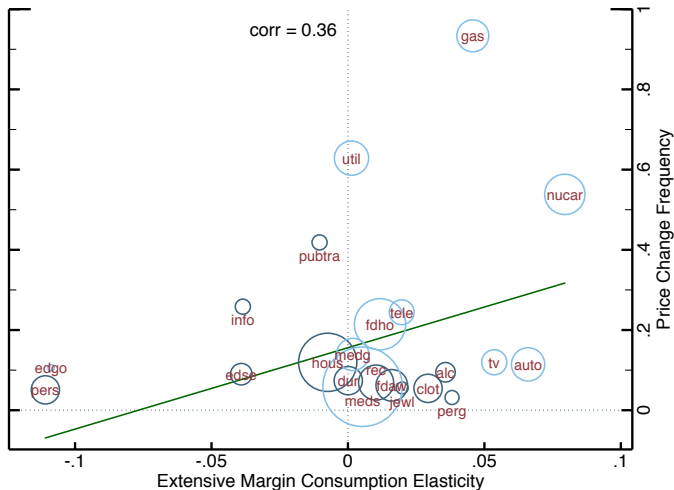
Extensive Margin Consumption

- Sample: Households with change in employment status
  $\sim$ 15000 Households
- Specification:

$$\tilde{y}_{cht} = \alpha_{ct} + \alpha_{ch} + \beta_c^e \cdot \#Earners_{ht} + \gamma_c \cdot X_{ht} + \nu_{cht}$$

  - ▸ $\tilde{y}_{cht} = \frac{y_{cht}}{\bar{y}_{ct}}$ - zero expenditures
  - ▸ $\#Earners_{ht}$ - Number of Earners in HH h at t
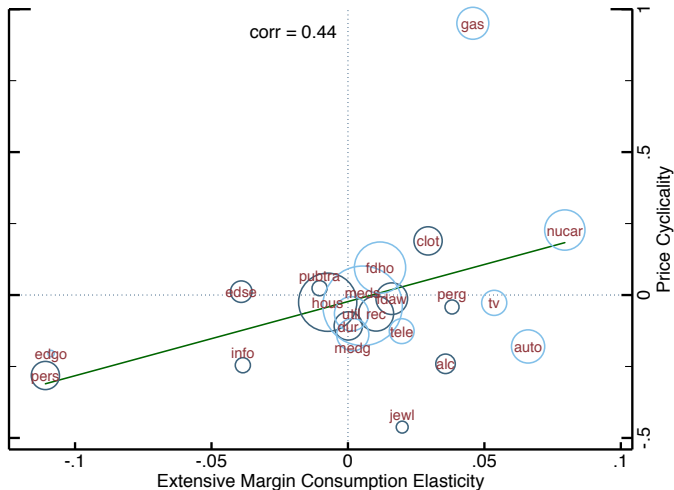 - ▸ β_c^e - Semi-elasticity of expenditure on good c

Extensive Margin Consumption

- HHs spend extensive margin income increases on flexible price goods

Extensive Margin Consumption

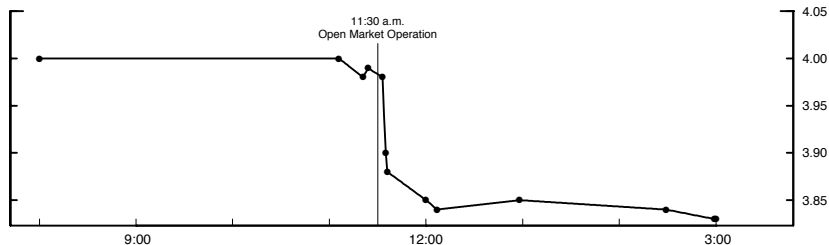- HHs spend extensive margin income increases on flexible price goods

Data - Monetary Policy Shocks

Monetary Shocks

- High-frequency changes of Federal Funds Futures 1990-2007 (Details)

April 9, 1992 (April 1992 contract)

11:30 a.m.
Open Market Operation

Gurkaynak et al (2005)

- Sum to quarterly measure ε_t^M

Data - Labor Market

CPS - Current Population Survey

- Monthly 4-8-4 Sampling Scheme
- Age-Education-Gender Cohorts
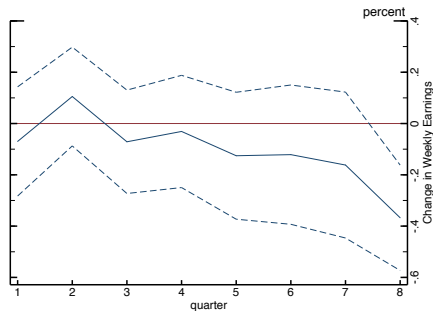- Quarterly 1990-2007
- Specification:

$$\Delta y_{it} = \alpha_i + \sum_{k=1}^{K} \beta_k \cdot \varepsilon_{t-k}^- + \sum_{k=1}^{K} \gamma_k \cdot \varepsilon_{t-k}^+ + \nu_{it}$$

- $\Delta y_{it} \in \{\text{real log weekly earnings}, \text{employment rate}\}$
- α_i - Cohort FE
- $\varepsilon_t^- = \min\{\varepsilon_t^M, 0\}$ - expansionary shock
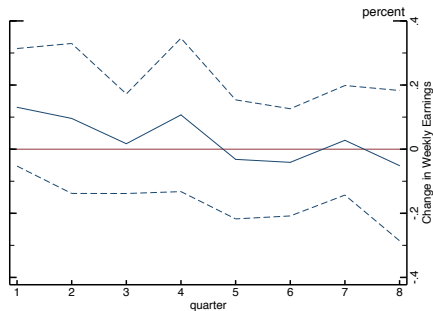- $\varepsilon_t^+ = \max\{0, \varepsilon_t^M\}$ - contractionary shock

Impulse Responses to MP - Real Weekly Earnings

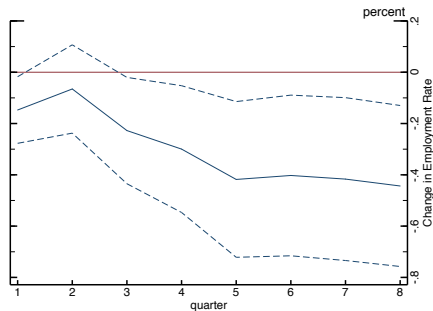- Monetary policy does not affect the intensive margin
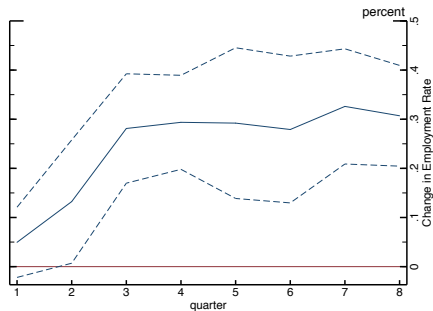
a) contractionary

b) expansionary

Impulse Responses to MP - Employment

- Expansionary monetary policy increases employment

a) contractionary

b) expansionary

Quick Recap

1. Intensive margin income increases are spend on sticky price goods

2. Extensive margin income increases are spend on flexible price goods

3. Monetary policy works through the extensive margin

(Textbook) New Keynesian Model

Households

- Representative Agent
  - ▶ Unemployed & Employed members
  - ▶ Complete Consumption Insurance
- CES preferences
  - ▶ Bundle of Goods $\Rightarrow$ Aggregate Consumption

Firms

- Retailer
  - ▶ Bundles intermediate goods
- Intermediate
  - ▶ Monopolistic Competition + Calvo Sticky Prices θ
  - ▶ Production
- Intermediate
  - ▶ Production + Hiring
  - ▶ Perfect Competition

Extended New Keynesian Model

Households

- Representative *Family*
  - ▸ Unemployed & Employed members
  - ▸ Complete Consumption Insurance
- Non-homothetic preferences
  - ▸ Necessity vs. Luxury Consumption
- Home Production of Necessity

Firms

- Retailer $s \in \{N, L\}$
  - ▸ Bundles wholesale goods
- Wholesale $s \in \{N, L\}$
  - ▸ Monopolistic Competition + Calvo Sticky Prices θ_s
  - ▸ Production
- Intermediate
  - ▸ Production + Hiring
  - ▸ Perfect Competition

Extended New Keynesian Model

Households

- Representative *Family*
- Non-homothetic preferences over bundle of goods
- Home Production of Necessity

Firms

- Retailer $s \in \{N, L\}$
- Wholesale $s \in \{N, L\}$
- Intermediate

Labor Market

- Members $\Leftrightarrow$ Intermediates
- Nash Bargained Wages

Household Preferences

$$\mathbb{E}_0 \sum_{t=0}^{\infty} \beta^t \left(\frac{V(C_{Nt}, C_{Lt})^{1-\sigma}}{1-\sigma} - \chi \frac{N_t^{1+\varphi}}{1+\varphi} \right)$$

where

$$V(C_{Nt}, C_{Lt}) = \left(C_{Nt}^{1-\lambda} + \eta \frac{1-\lambda}{1-\phi} C_{Lt}^{1-\phi} \right)^{1/(1-\lambda)}$$

and

$$C_{Nt} = (X_{Nt}^\rho + \psi(1-N_t)^\rho)^{1/\rho}$$

Household Constraints

Budget Constraint

$$P_{Nt}X_{Nt} + P_{Lt}C_{Lt} + Q_t B_t = W_t N_t + B_{t-1} + \Phi_t + T_t$$

Evolution of Employment:

$$N_t = (1-\delta)N_{t-1} + H_t$$

where

$$H_t = x_t U_t^0$$
$$U_t^0 = 1 - N_{t-1} + \delta N_{t-1} = 1 - (1-\delta)N_{t-1}$$

Firms

Retail Firm $s \in \{N, L\}$

$$Y_{st}(j) = \left(\frac{P_{st}(j)}{P_{st}}\right)^{\epsilon} Y_{st}$$

Wholesale Firms $s \in \{N, L\}$

$$\max_{P_{st}(j)} E_t \sum_{k=0}^{\infty} \theta_s^k Q_{t,t+k} Y_{st,t+k}(j) \left[P_{st}(j) - P_{t+k}^I\right]$$

Optimal Price

$$P_{st}^* = \frac{\epsilon}{\epsilon - 1} E_t \left\{ \frac{\sum_{k=0}^{\infty} \theta_s^k Q_{t,t+k} Y_{st+k} P_{st+k}^{\epsilon} P_{t+k}^I}{\sum_{k=0}^{\infty} \theta_s^k Q_{t,t+k} Y_{st+k} P_{st+k}^{\epsilon}} \right\}$$

Sectoral Price

$$P_{st} = \left[\theta_s P_{st-1}^{1-\epsilon} + (1 - \theta_s) P_{st}^{*1-\epsilon}\right]^{\frac{1}{1-\epsilon}}.$$

Intermediate Firm

$$\max_{\{N_t\}} E_t \left\{ \sum_{k=0}^{\infty} Q_{t,t+k} \left(P_{t+k}^I Y_{t+k}^I - W_{t+k} N_{t+k} - P_{Nt+k} G_{t+k} H_{t+k} \right) \right\}$$

s.t.

$$Y_t^I = A_t N_t^{1-\alpha}$$
$$N_t = (1-\delta)N_{t-1} + H_t$$

where

$$G_t = G(x_t) = \Gamma x_t^{\gamma}$$
$$\ln A_t = \rho_a \ln A_{t-1} + \varepsilon_t^a \qquad \varepsilon \sim N(0, \sigma_a^2)$$

FOC:

$$MRPN_t = P_t^I (1-\alpha) A_t N_t^{-\alpha}$$
$$= W_t + P_{Nt} G_t - (1-\delta) E_t \left\{ Q_{t,t+1} P_{Nt+1} G_{t+1} \right\}$$

Equalization

Wage Bargaining

Nash Bargaining

$$\max_{W_t} (S_t^H)^{1-\xi}(S_t^F)^{\xi}$$

s.t.

$$S_t^H = W_t - MRS_t + (1-\delta)E_t\left\{Q_{t,t+1}S_{t+1}^H\right\}$$
$$S_t^F = MRPN_t - W_t + (1-\delta)E_t\left\{Q_{t,t+1}S_{t+1}^F\right\}$$

where

$$MRS_t = \frac{P_{Lt}}{\eta C_{Lt}^{-\phi}}\left[\chi N_t^{\varphi}V(C_{Nt},C_{Lt})^{\sigma-\lambda} + C_{Nt}^{-\lambda}\psi\left(\frac{1-N_t}{C_{Nt}}\right)^{\rho-1}\right]$$

FOC:

$$W_t = \xi MRS_t + (1-\xi)MRPN_t.$$

$$P_{Nt}G_t - (1-\delta)E_t\left\{Q_{t,t+1}P_{Nt+1}G_{t+1}\right\} = \xi(MRPN_t - MRS_t)$$

Policy

Fiscal Policy

$$T_t + Q_t B_t = B_{t-1}$$

Monetary Policy

$$\frac{R_t}{R} = \left(\frac{R_{t-1}}{R}\right)^{\rho_r} \left[\left(\frac{\Pi_t}{\Pi}\right)^{\phi_p} \left(\frac{Y_t}{Y}\right)^{\phi_y}\right]^{1-\rho_r} \cdot \varepsilon_t^r$$

where

$$\Pi_t = P_t/P_{t-1}$$
$$\ln \varepsilon_t^r \sim N(0, \sigma_\varepsilon^2)$$

and

$$P_t = \frac{\text{Nominal GDP}}{\text{Real GDP}} = \frac{P_{Nt} Y_{Nt} + P_{Lt} Y_{Lt}}{P_N Y_{Nt} + P_L Y_{Lt}}$$

Market Clearing

Final Goods

$$Y_{Nt} = X_{Nt} + H_t G_t$$
$$Y_{Lt} = C_{Lt}$$

Intermediate Goods

$$\int_0^1 M_{Nt}(i)di + \int_0^1 M_{Lt}(i)di = Y_t^I$$
$$S_{Nt} Y_{Nt} + S_{Lt} Y_{Lt} = A_t N_t^{1-\alpha}$$

where

$$S_{st} \equiv \int_0^1 \left(\frac{P_{st}(i)}{P_{st}} \right)^{-\epsilon} di \quad s \in \{N, L\}$$

Calibration

Parameter	Value	Description
β	0.99	Discount Factor
σ	1	Intertemporal EoS
φ	5	(Inverse) Frisch Elasticity
χ	0.39	Disutility of Employment
λ	1.01	Relative Price Elasticity $= 1.7$
ϕ	0.36	Relative Expenditure Elasticity $= 0.66$
η	1.04	Expenditure Share Necessity $= 0.65$
ψ	0.15	Consumption weight on Home Production
ρ	2/3	EoS btw. Necessities and Home Production
ϵ	6	Demand Elasticity
θ_N	0.69	Price Change Frequency Necessities
θ_L	0.83	Price Change Frequency Luxuries
α	0.33	Labor Income Share
δ	0.1228	Separation Rate
γ	1	Matching Function Equivalence
ξ	0.5	Bargaining Power
Γ	0.1183	Hiring Cost
ρ_r	0.9	Monetary Policy Inertia
ϕ_p	1.5	Inflation Response
ϕ_y	0.5/4	Output Response
σ_ε^2	0.0025	Monetary Policy Volatility
ρ_a	0.9	Productivity Persistence
σ_a^2	0.008	Productivity Volatility

IRF MP for $\theta_N = \theta_L$

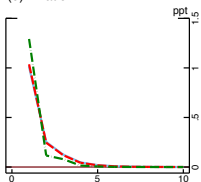- Home-Production introduces an *additional demand channel*
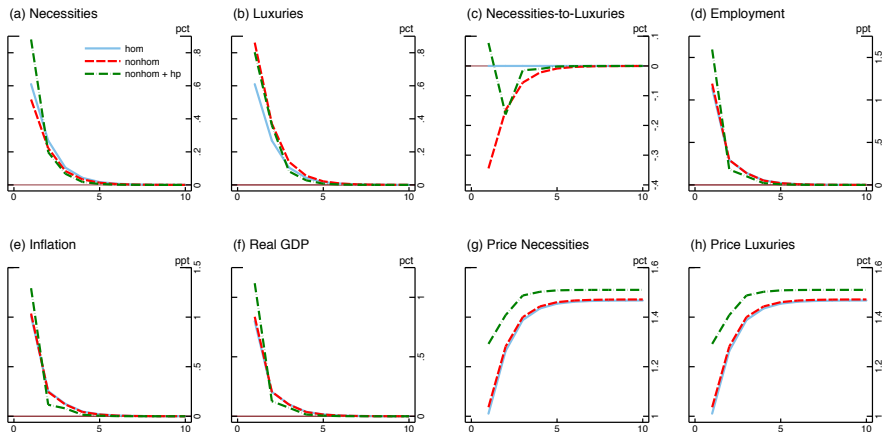
IRF MP for $\theta_N \neq \theta_L$

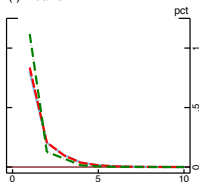- Additional demand occurs *for flexible price goods*

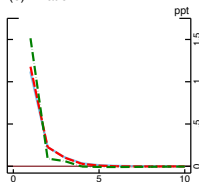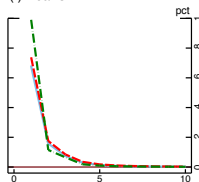a) $\theta_N = \theta_L$ b) $\theta_N \neq \theta_L$

State-Dependence of MP

- Higher unemployment mainly leads to increased inflation

(a) Necessities (b) Luxuries (c) Necessities-to-Luxuries (d) Employment
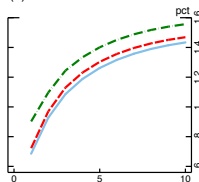
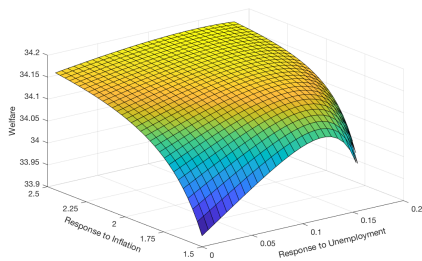(e) Inflation (f) Real GDP (g) Price Necessities (h) Price Luxuries

Welfare
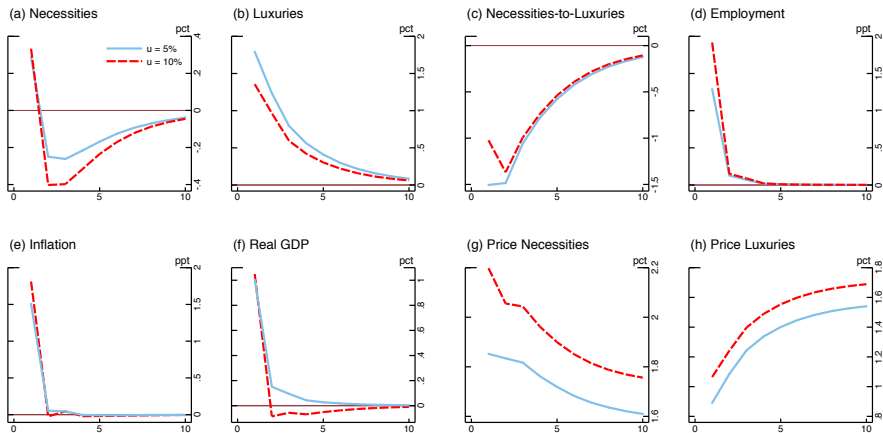
$$\frac{R_t}{R} = \left(\frac{R_{t-1}}{R}\right)^{\rho_r} \left[\left(\frac{\Pi_t}{\Pi}\right)^{\phi_p} \left(\frac{Y_t}{Y}\right)^{\phi_y} \left(\frac{U_t}{U}\right)^{\phi_u}\right]^{1-\rho_r} \varepsilon_t^r$$

a) Optimal Simple Rule
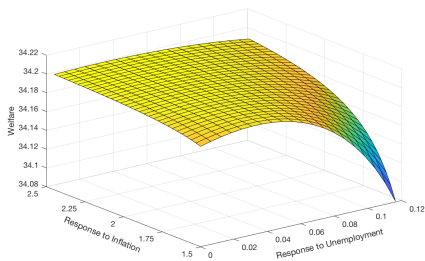
b) $\phi_y = 0.125$

$\phi_u^* = 0.037$

$\phi_u^* = 0.153$

Conclusion

1. Consumption Behavior differs at the intensive and extensive margin

2. Monetary Policy works through the extensive margin

3. Monetary Policy should take unemployment into account ...
   ... even if inflation is the main concern

Consumption Categories

- Apparel
- Jewelry
- Housing
- Utilities
- Durables
- New & Used Cars
- Gasoline
- Car Maintenance
- Public Transport
- Educational Goods
- Educational Services

- Telephone Services
- Information
- Medical Goods
- Medical Services
- TV & Audio
- Recreation
- Personal Goods
- Personal Services
- Food at Home
- Food Away
- Alcohol
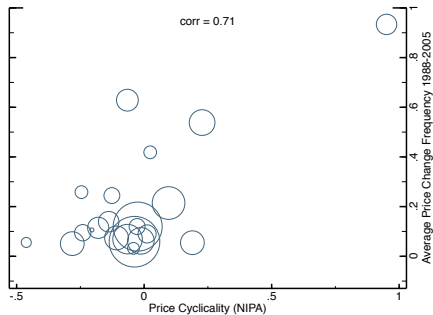
Back

Monetary Policy Shocks

MP shock

$$\epsilon_t^M = \frac{D}{D - T}(ffr_{t+\Delta^+} - ffr_{t-\Delta^-})$$
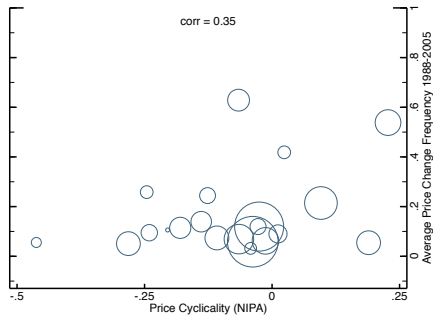
where

- t - FOMC announcement date
- ffr - Federal Funds Futures Rate ...
- ... $\Delta^+ = 45$min after/$\Delta^- = 15$min before FOMC Announcement
- $\frac{D}{D-T}$ - Adjustment Term
- D - Number of Days in FOMC announcement month
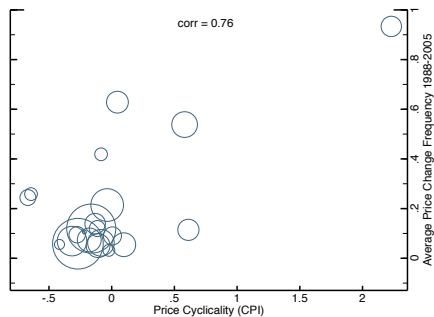
Correlation of Price Flexibility Measures
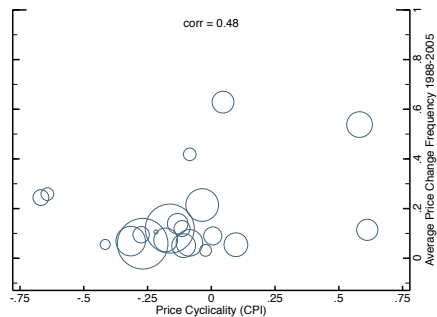

a) NIPA

b) NIPA - no gasoline

back
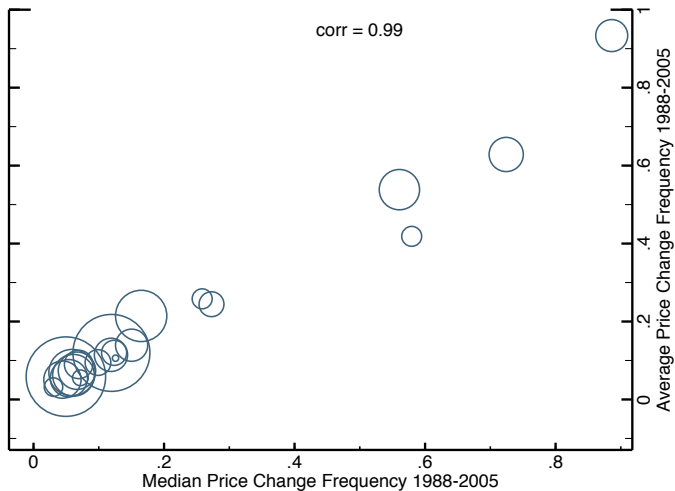
Correlation of Price Flexibility Measures

c) CPI

d) CPI - no gasoline

back

Correlation of Price Flexibility Measures

Robustness - Price Change Frequency

$$\beta_c^i = \alpha + \gamma \cdot \text{Price Flexibility}_c + \varepsilon$$

a) Average Price Change Frequency 1988-2005

	baseline	male heads	age 20-65	CEX share	EC deflator	log
	(1)	(2)	(3)	(4)	(5)	(6)
beta	-.837***	-.815***	-.848***	-.810***	-.745***	-1.09**
	[.200]	[.203]	[.196]	[.179]	[.198]	[.426]
correlation	-.485	-.474	-0.494	-.523	-.453	-.408

b) Median Price Change Frequency 1988-2005

	baseline	male heads	age 20-65	CEX shares	EC deflator	log
	(1)	(2)	(3)	(4)	(5)	(6)
beta	-.731***	-.706***	-.743***	-.711***	-.645***	-.968***
	[.183]	[.195]	[.177]	[.154]	[.185]	[.331]
correlation	-.445	-.430	-.454	-.478	-.412	-.379

back

Robustness - Price Cyclicality

$$\beta_c^i = \alpha + \gamma \cdot \text{Price Flexibility}_c + \varepsilon$$

c) Price Cyclicality (NIPA) 1980-2016

	baseline	male heads	age 20-65	CEX shares	EC deflator	log
	(1)	(2)	(3)	(4)	(5)	(6)
beta	-.666***	-.665***	-.673***	-.555***	-.625***	-.664*
	[.210]	[.209]	[.214]	[.174]	[.208]	[.373]
correlation	-.402	-.402	-.408	-.377	-.396	-.256

d) Price Cyclicality (CPI) 1980-2016

	baseline	male heads	age 20-65	CEX shares	EC deflator	log
	(1)	(2)	(3)	(4)	(5)	(6)
beta	-.249***	-.246***	-.249***	-.212***	-.225***	-.243
	[0.070—	[.070]	[.067]	[.059]	[.068]	[.147]
correlation	-.345	-.341	.346	-.345	-.327	-.217

back

Robustness - Price Change Frequency

$$\beta_c^e = \alpha + \gamma \cdot \text{Price Flexibility}_c + \varepsilon$$

a) Average Price Change Frequency 1988-2005

	baseline (1)	male heads (2)	age 20-65 (3)	CEX share (4)	EC deflator (5)	log (6)
beta	.064* [.033]	.058* [.030]	.047* [.023]	.046* [.024]	.064* [.033]	.021 [.037]
correlation	.359	.354	.325	.359	.359	.121

b) Median Price Change Frequency 1988-2005

	baseline (1)	male heads (2)	age 20-65 (4)	CEX shares (4)	EC deflator (5)	log (6)
beta	.058* [.033]	.054* [.029]	.044* [.024]	.041 [.026]	.058* [.033]	.021 [.037]
correlation	.346	.347	.317	.335	.346	.123

Robustness - Price Cyclicality

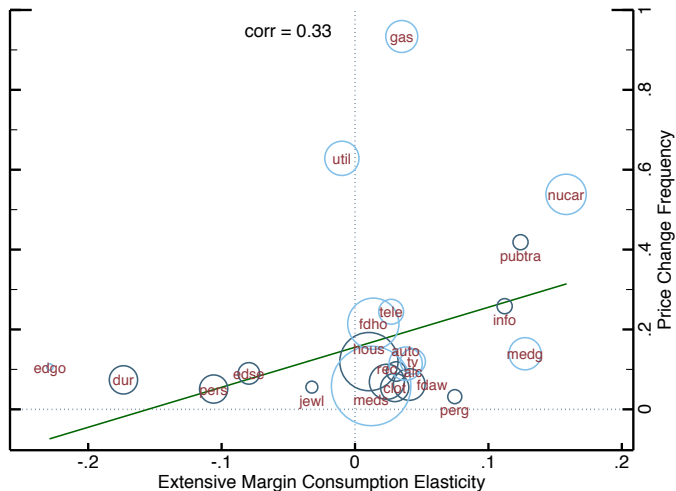$$\beta_c^e = \alpha + \gamma \cdot \text{Price Flexibility}_c + \varepsilon$$

c) Price Cyclicality (NIPA) 1980-2016

	baseline (1)	male heads (2)	age 20-65 (3)	CEX shares (4)	EC deflator (5)	log (6)
beta	.075*	0.060	.056**	.046**	.075*	.028
	[.042]	[.035]	[.027]	[.019]	[.042]	[.020]
correlation	.441	.380	.401	.377	.441	.172

d) Price Cyclicality (CPI) 1980-2016

	baseline (1)	male heads (2)	age 20-65 (3)	CEX shares (4)	EC deflator (5)	log (6)
beta	.031***	.027*	.026**	.026**	.031**	.023*
	[.014]	[.014]	[.011]	[.010]	[.014]	[.013]
correlation	.415	0.390	.429	.513	.415	.316

back

Robustness - Employment Status of HH Head

Robustness - Employment Status of HH Head

Figure axes: x-axis "Extensive Margin Consumption Elasticity" (-.2 to .2), y-axis "Price Cyclicality" (-.5 to 1). Text label "corr = 0.29". Bubbles labeled: gas, nucar, clot, fdho, edse, hous, tdw, util, medd, tv, dur, perg, pubtra, tele, medg, edge, auto, alc, pers, info, jewl.
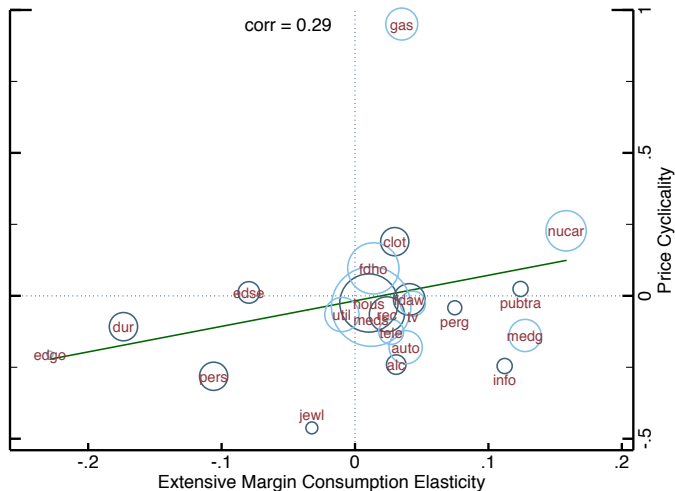
Robustness - Employment Status of HH Head

$$\beta_c^e = \alpha + \gamma \cdot \text{Price Flexibility}_c + \varepsilon$$

a) Average Price Change Frequency 1988-2005

	baseline (1)	male heads (2)	age 20-65 (3)	CEX share (4)	EC deflator (5)	log (6)
beta	.107	.129*	.100	.066	.107	.014
	[.076]	[.071]	[.075]	[.052]	[.076]	[.058]
correlation	.328	.318	.348	.267	.328	.057

b) Median Price Change Frequency 1988-2005

	baseline (1)	male heads (2)	age 20-65 (3)	CEX shares (4)	EC deflator (5)	log (6)
beta	.108	.132*	.101	.066	.108	.013
	[.074]	[.069]	[.072]	[.054]	[.074]	[.057]
correlation	.345	.342	.367	.275	.345	.054

back

Robustness - Employment Status of HH Head

$$\beta_c^e = \alpha + \gamma \cdot \text{Price Flexibility}_c + \varepsilon$$

c) Price Cyclicality (NIPA) 1980-2016

	baseline (1)	male heads (2)	age 20-65 (3)	CEX shares (4)	EC deflator (5)	log (6)
beta	.089	.166	.053	.058	.089	.046
	[.069]	[.116]	[.049]	[.041]	[.069]	[.028]
correlation	.281	.426	.189	.245	.281	.193

d) Price Cyclicality (CPI) 1980-2016

	baseline (1)	male heads (2)	age 20-65 (3)	CEX shares (4)	EC deflator (5)	log (6)
beta	.029	.036*	.023	.022	.029	.030**
	[.024]	[.021]	[.026]	[.015]	[.024]	[.014]
correlation	.209	.211	.192	.221	.209	.299

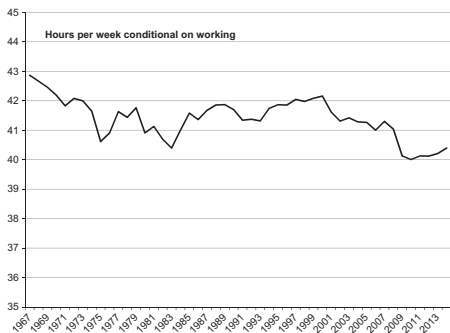back
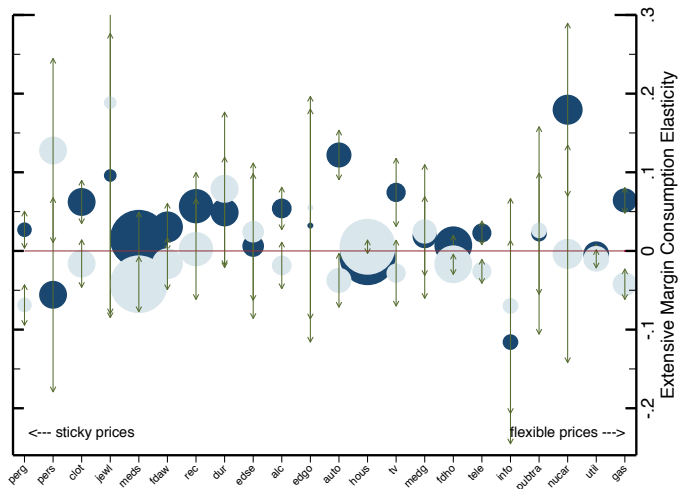
Robustness - Symmetry

Robustness - Significance
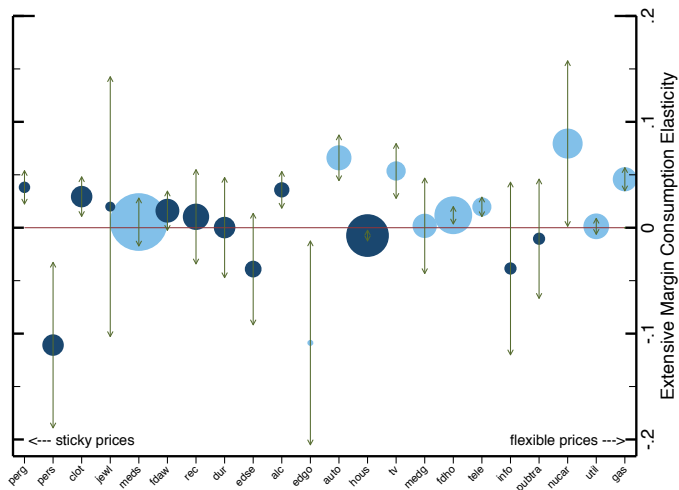
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Robustness - Symmetry
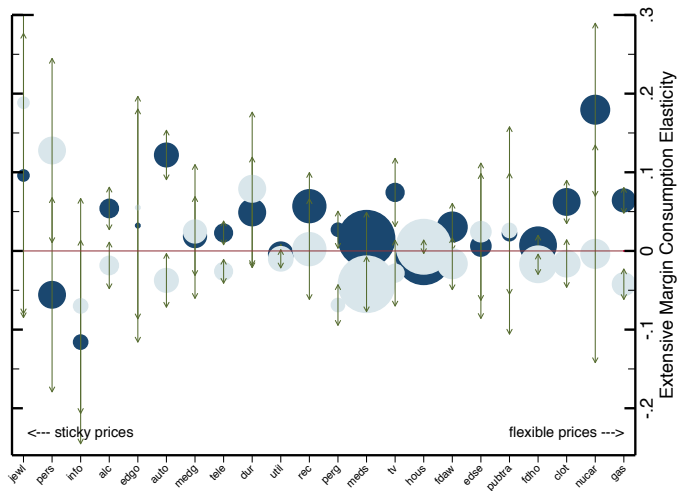
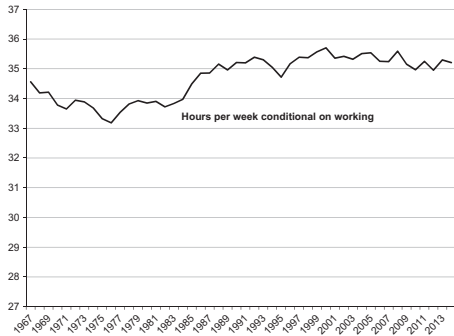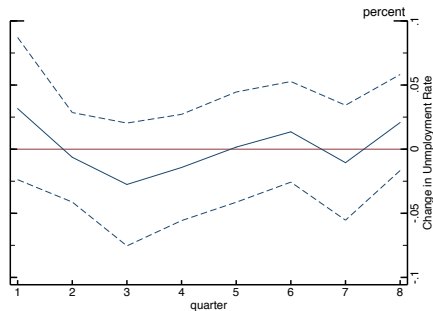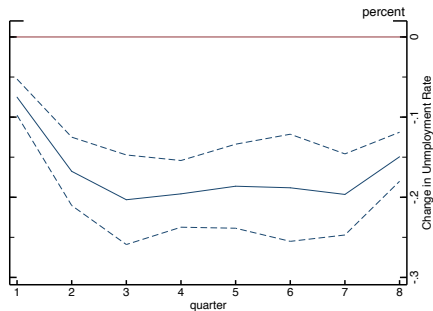# Hours worked per week

a) men

b) women

Impulse Responses to MP - Unemployment

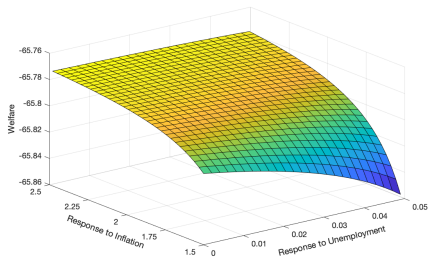- Expansionary monetary policy decreases unemployment

a) contractionary

b) expansionary

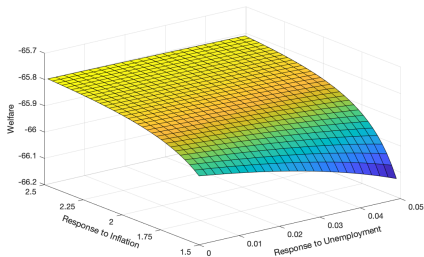# Welfare in NK model

a) Optimal Simple Rule

$$\phi_u^* = 0$$

b) $\phi_y = 0.125$

$$\phi_u^* = 0$$

Back

Equalization of Wages

Intermediate Firm FOC:

$$MRPN_t(i) = P_t^I(1-\alpha)A_t N_t(i)^{-\alpha}$$
$$= W_t(i) + P_{Nt}G_t - (1-\delta)E_t\{Q_{t,t+1}P_{Nt+1}G_{t+1}\}$$

Nash Bargaining FOC:

$$W_t(i) = \xi MRS_t + (1-\xi)MRPN_t(i).$$

where

$$MRS_t = \frac{P_{Lt}}{\eta C_{Lt}^{-\phi}}\left[\chi N_t^\varphi V(C_{Bt},C_{Lt})^{\sigma-\lambda} + C_{Bt}^{-\lambda}\psi\left(\frac{1-N_t}{C_{Bt}}\right)^{\rho-1}\right]$$