Seller's Attention in a Multiproduct Store

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QUESTION

How much can rational inattention help us understand variation in nominal rigidity across products and sellers?

- Models with information constraints can rationalize important features of price behavior at the micro level

- Substantial variation in nominal rigidity across products **and** across sellers

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Our Contribution

- Build a tractable model of **multiproduct seller** to relate measures of nominal rigidity to product and seller observables

- Quantify in relationships in reduced form

- Calibrate model to quantify costs of rational inattention, state-dependence of nominal rigidity

Preview of Results

Write down tractable model of rational inattention of multiproduct seller

- Generates clear measures of nominal rigidity related to attention
  - levels per regime and duration of regime

- Simple, intuitive predictions relating product observables to nominal rigidity
  - UPCs with more **elastic demand**, that **generate more revenue**, and with more **volatile cost shocks** should be more flexible
  - Information-constrained sellers should be less responsive to observables

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Take the model to the data

- Substantial variation in nominal rigidity **across and within** UPCs

- Sellers pay attention in the way they should, but maybe not that much
  - 1 SD increase in elasticity increases regime duration by two weeks
  - Differences in observables explain **25-50%** of variation across good categories

- Sellers who are likely to be more information constrained pay less attention to the observables that should matter

LITERATURE

Rational Inattention and nominal rigidity

- Matejka (2010), Stevens (2013)
- Sims (1998, 2003), etc

Nominal rigidity

- Barro (1972), Klenow and Malin (2004), Boivin, Giannoni, and Mihov (2009), Eichenbaum, Jaimovich, and Rebelo (2011), Nakamura and Steinsson (2008)

Multiproduct sellers

- Bhattarrai and Schoenle (2014), Dutta, Bergen, Levy, and Venable (1999), Midrigan (2011)

MODEL

Competitive model of consumption and pricing

- No production, no strategic interactions, no dynamics (in baseline)

Household:

- Representative household
- Nested CES demand: across stores and products (UPCs)
- Perfect attention

Seller:

- Sets prices for multiple products in store
- Faces stochastic cost shock (wholesale price)
- Information constraint
- Chooses what to learn about the shock and price as a function of acquired information

MODEL: DEMAND

Demand for a UPC (*u*) at store (*s*) given by

$$C_{us} = p_{us}^{-\sigma_u} \Omega_u$$

Model: Supply

Let κ_{us} be the "attention" paid to pricing a good , the seller's profit from a product is

$$\pi_{us}(\kappa_{us}) = \Omega_u \psi_{us}(\kappa_{us})$$

MODEL: SUPPLY

Let κ_{us} be the "attention" paid to pricing a good , the seller's profit from a product is

$$\pi_{us}(\kappa_{us}) = \Omega_u \psi_{us}(\kappa_{us})$$

Define entropy as

$$H(x) = -\int h(x) \log\big(h(x)\big)\, dx\ .$$

Then

$$\psi_{us}(\kappa_{us}) = \max_{f(p_{us}, c_{us})} \int\int (p_{us} - c_{us}) p_{us}^{-\sigma_u} f(p_{us}, c_{us}) dp_{us} dc_{us}$$

s.t.

$$f(p_{us}, c_{us}) \geq 0,$$

$$\int f(p_{us}, c_{us}) dp_{us} = g(c_{us}),$$

$$H[g(c_{us})] - E_p[H[f(c_{us}|p_{us})]] \leq \kappa_{us}\ , \qquad (\Lambda\big(\kappa_{us}, \sigma_u, g(c_{us})\big).$$

MODEL

Before setting a price for each product, the seller decides how much attention to pay to each product

$$\max_{\kappa_{\mathrm{us}}} \sum_{u} \pi_{us}(\kappa_{us})$$

$$\sum_{\mathrm{u}} \kappa_{us} \leq K_s, \qquad (\mu_s).$$

MODEL

Taking the first order condition, log-linearizing, and substituting:

$$\kappa_{\mathrm{us}} = \beta_{us} + \beta_{us}^{\Omega} \log(\Omega_u) + \beta_{us}^{\sigma}\sigma_u + \beta_{us}^{var} var(c_u)$$

where

$$\beta_{us} \equiv \left(\frac{\partial \log \Lambda_{us}}{\partial \kappa_{us}}\right)^{-1} (\log \mu_s - \log \Lambda_{us})$$

$$\beta_{us}^{\Omega} \equiv -\left(\frac{\partial \log \Lambda_{us}}{\partial \kappa_{us}}\right)^{-1}, \qquad \text{(Demand)}$$

$$\beta_{us}^{\sigma} \equiv -\left(\frac{\partial \log \Lambda_{us}}{\partial \kappa_{us}}\right)^{-1} \frac{\partial \log \Lambda_{us}}{\partial \sigma_u}, \quad \text{(Elasticity)}$$

$$\beta_{us}^{var} \equiv -\left(\frac{\partial \log \Lambda_{us}}{\partial \kappa_{us}}\right)^{-1} \frac{\partial \log \Lambda_{us}}{\partial var(c)_{u},}, \quad \text{(Shock volatility)}$$

We can run the simple regression using observations on stores and UPCs

$$\kappa_{\mathrm{us}} = \alpha + \beta_1 \log(\Omega_u) + \beta_2\sigma_u + \beta_3 var(c_u) + e_{us}$$

Data and Measurement

IRI Marketing: **prices and quantities**

- Weekly store sales at UPC level for 30 categories, 2001-2008
- 47 markets, we limit ourselves to one (San Francisco)
- 54 grocery stores

PromoData Price-Trak: **wholesale costs to retailers**

- Survey of large wholesale firms (~one per market)
- UPC-level, daily

Data and Measurement

UPC Elasticities: $\boldsymbol{\sigma^u}$

- CES: regress expenditure shares on price changes (time differenced)
  - Fixed effects: store, date, upc X date
  - Hausman (1993) instruments: price changes in other market
- Non-linear (in progress)

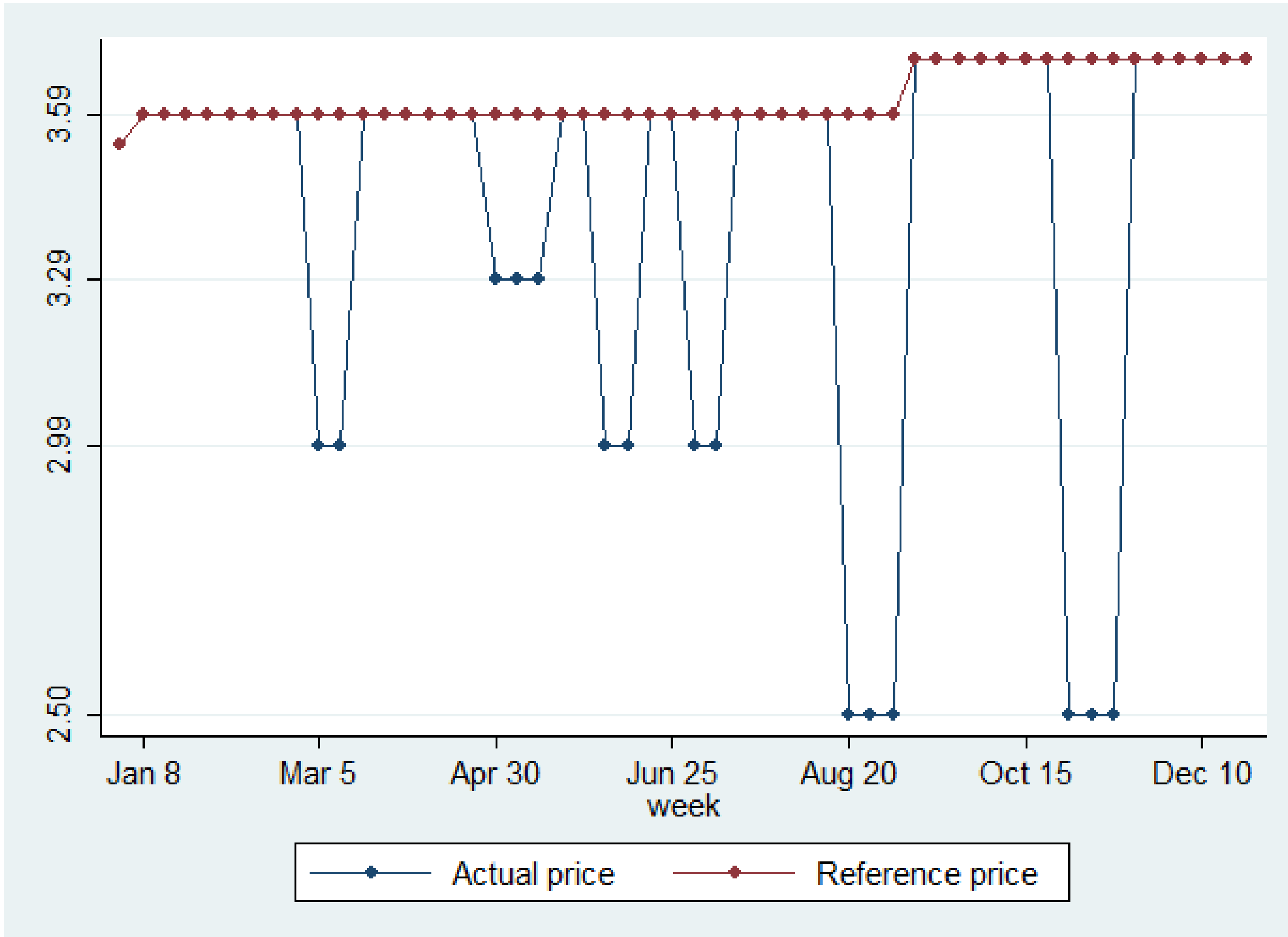
UPC Demand: $\boldsymbol{\Omega_u}$

- We show: $\Omega_u \propto$ revenue
- Model assumes UPC-level demand is the relevant observable
  - Revenue generated in SF market 2001-2008 in IRI data
  - Can also use share of revenue within store

UPC cost shock volatility: $\boldsymbol{c_u}$

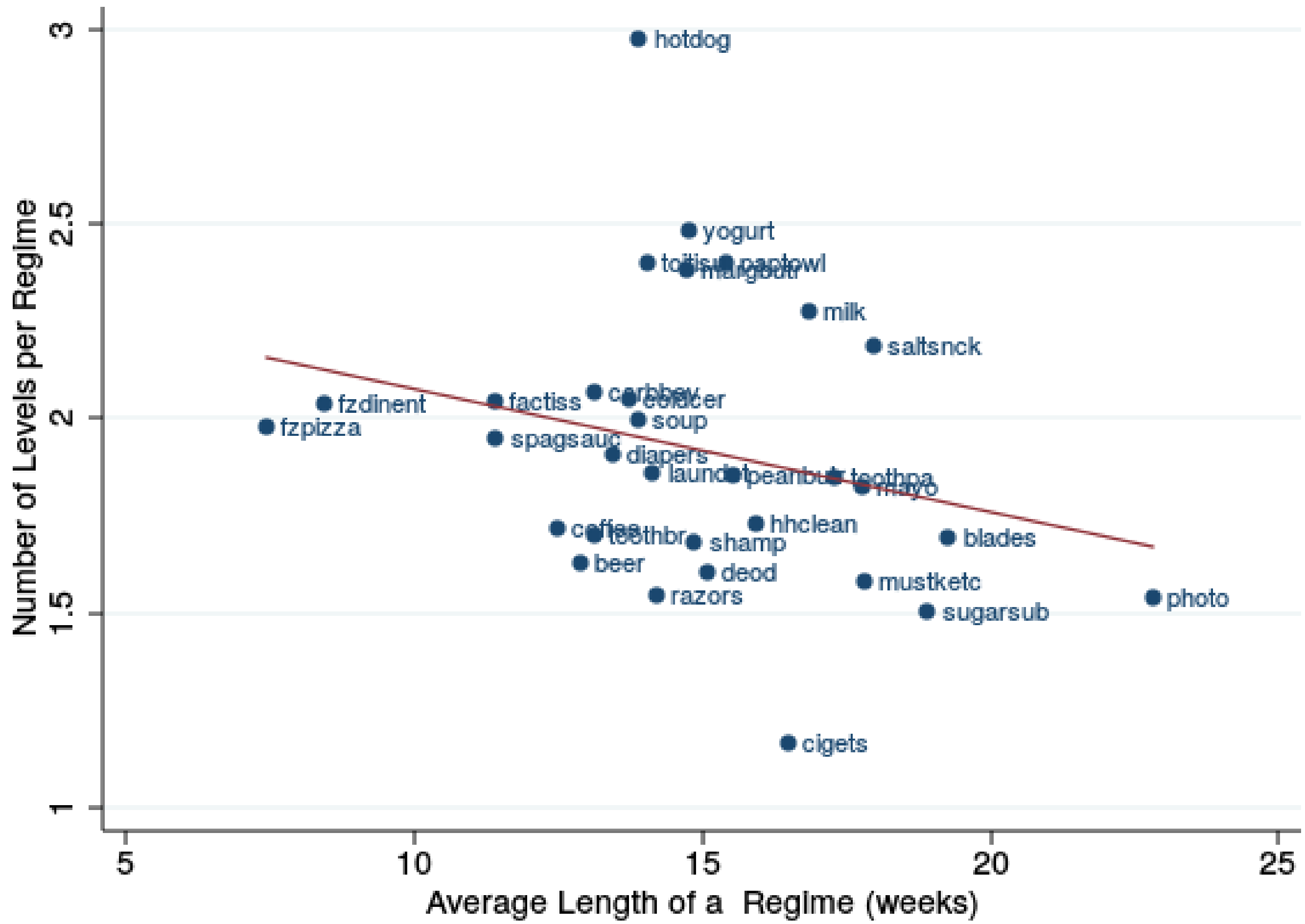
- Reported wholesale prices (including discounts, etc)
- Expected absolute price change (normalized by average price)

MEASURING REGIMES



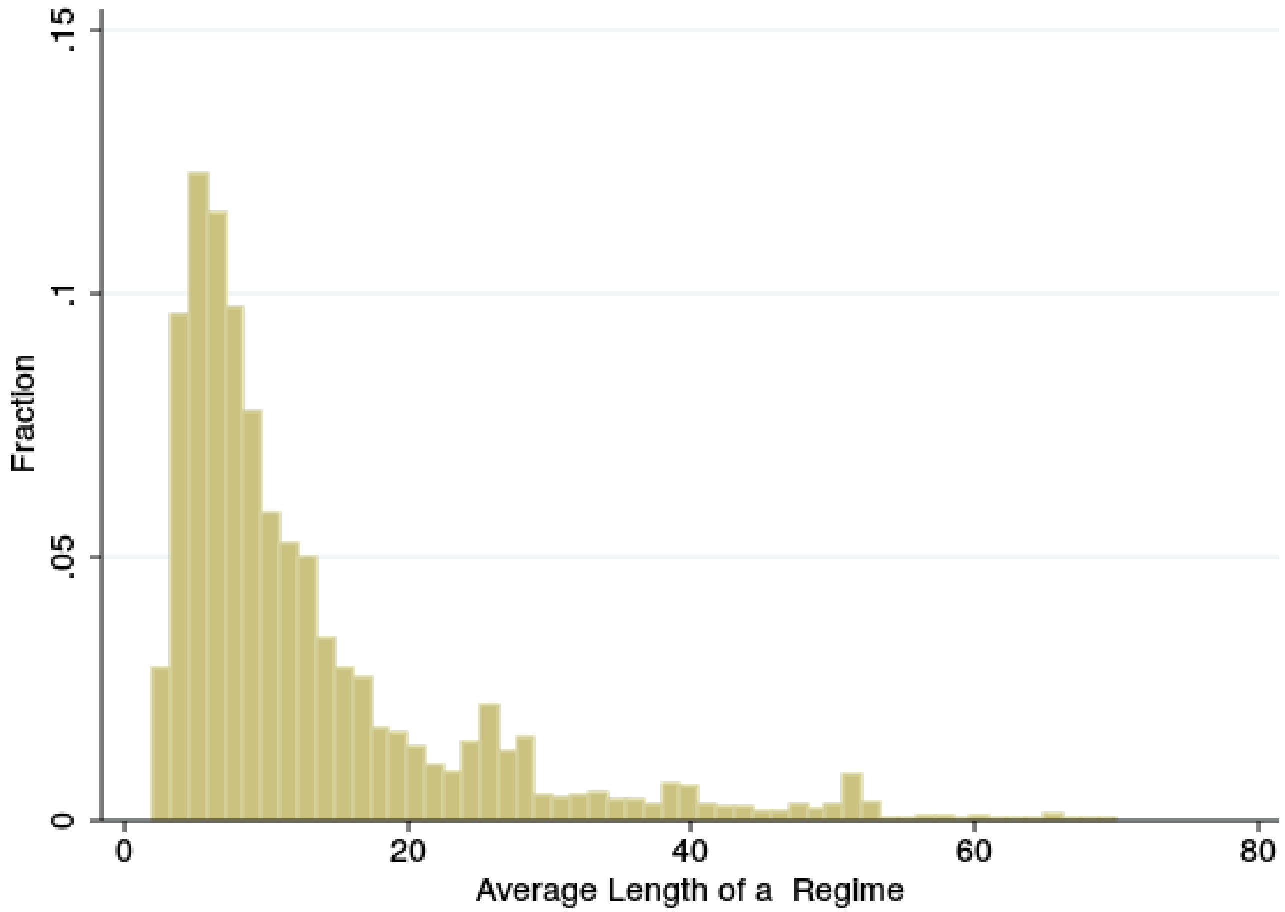
Related to v-shaped filter ala Nakamura and Steinsson (2008), but reults similar to running-mode as in Kehoe and Midrigran (2010)

VARIATION IN NOMINAL RIGIDITY: CATEGORIES



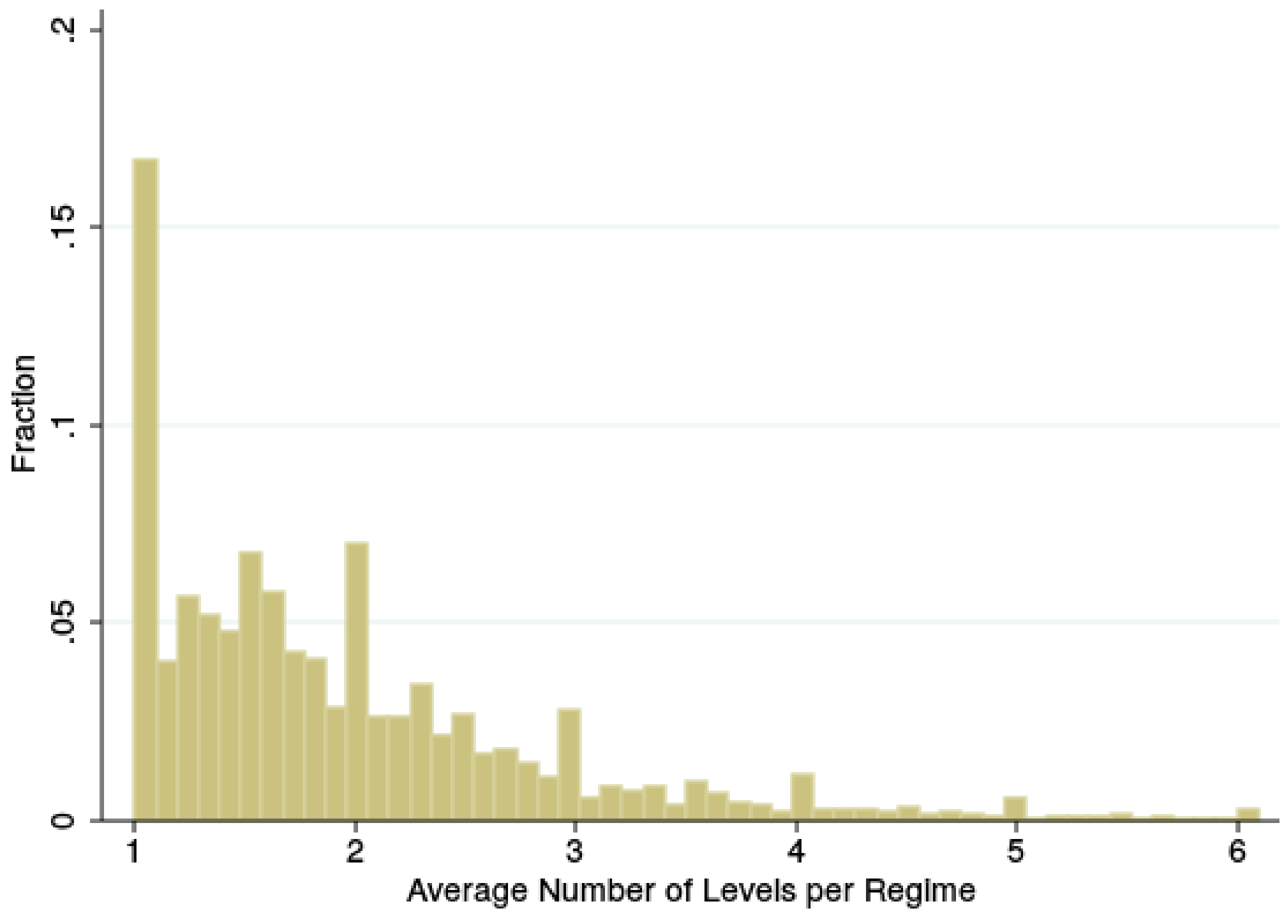
	Mean	SD
Levels	1.92	0.36
Length (weeks)	14.8	3.06

VARIATION IN REGIME DURATION ACROSS STORE-UPC



	Store-UPC
SD	12.14
Share Within UPCs	43%
N	208,878

VARIATION IN REGIME LEVELS ACROSS STORE-UPC



	Store-UPC
SD	0.893
Share Within UPCs	69%
N	210,996

VARIATION IN REGIME DURATION ACROSS UPCS

$$Average\ Duration_{ucs} = \alpha_c + \beta_1 Elasticity_u + \beta_2 Log(Rev_u) + \beta_3 \sigma(costs_u) + e_{ucs}$$

Elasticity (β_1)	
Log Revenue (β_2)	
Costs (β_3)	
FE	
N	
R2	

Variation in Regime Duration across UPCs

$$Average\ Duration_{ucs} = \alpha_c + \beta_1 Elasticity_u + \beta_2 Log(Rev_u) + \beta_3 \sigma(costs_u) + e_{ucs}$$

Elasticity (β_1)	-1.406***
	(0.149)
Log Revenue (β_2)	-0.246
	(0.200)
Costs (β_3)	-1.810***
	(0.067)
FE	--
N	25248
R2	0.053

VARIATION IN REGIME DURATION ACROSS UPCS

$$Average\ Duration_{ucs} = \alpha_c + \beta_1 Elasticity_u + \beta_2 Log(Rev_u) + \beta_3 \sigma(costs_u) + e_{ucs}$$

Elasticity (β_1)	-1.406***	-2.126***
	(0.149)	(0.116)
Log Revenue (β_2)	-0.246	-1.044***
	(0.200)	(0.132)
Costs (β_3)	-1.810***	-0.932***
	(0.067)	(0.070)
FE	--	Category
N	25248	25248
R2	0.053	0.194

Variation in Regime Duration across UPCs

$$Average\ Duration_{ucs} = \alpha_c + \beta_1 Elasticity_u + \beta_2 Log(Rev_u) + \beta_3 \sigma(costs_u) + e_{ucs}$$

Elasticity (β_1)	-1.406***	-2.126***	-2.017***
	(0.149)	(0.116)	(0.115)
Log Revenue (β_2)	-0.246	-1.044***	-0.967***
	(0.200)	(0.132)	(0.116)
Costs (β_3)	-1.810***	-0.932***	-0.925***
	(0.067)	(0.070)	(0.076)
FE	--	Category	Category-Store
N	25248	25248	25248
R2	0.053	0.194	0.330

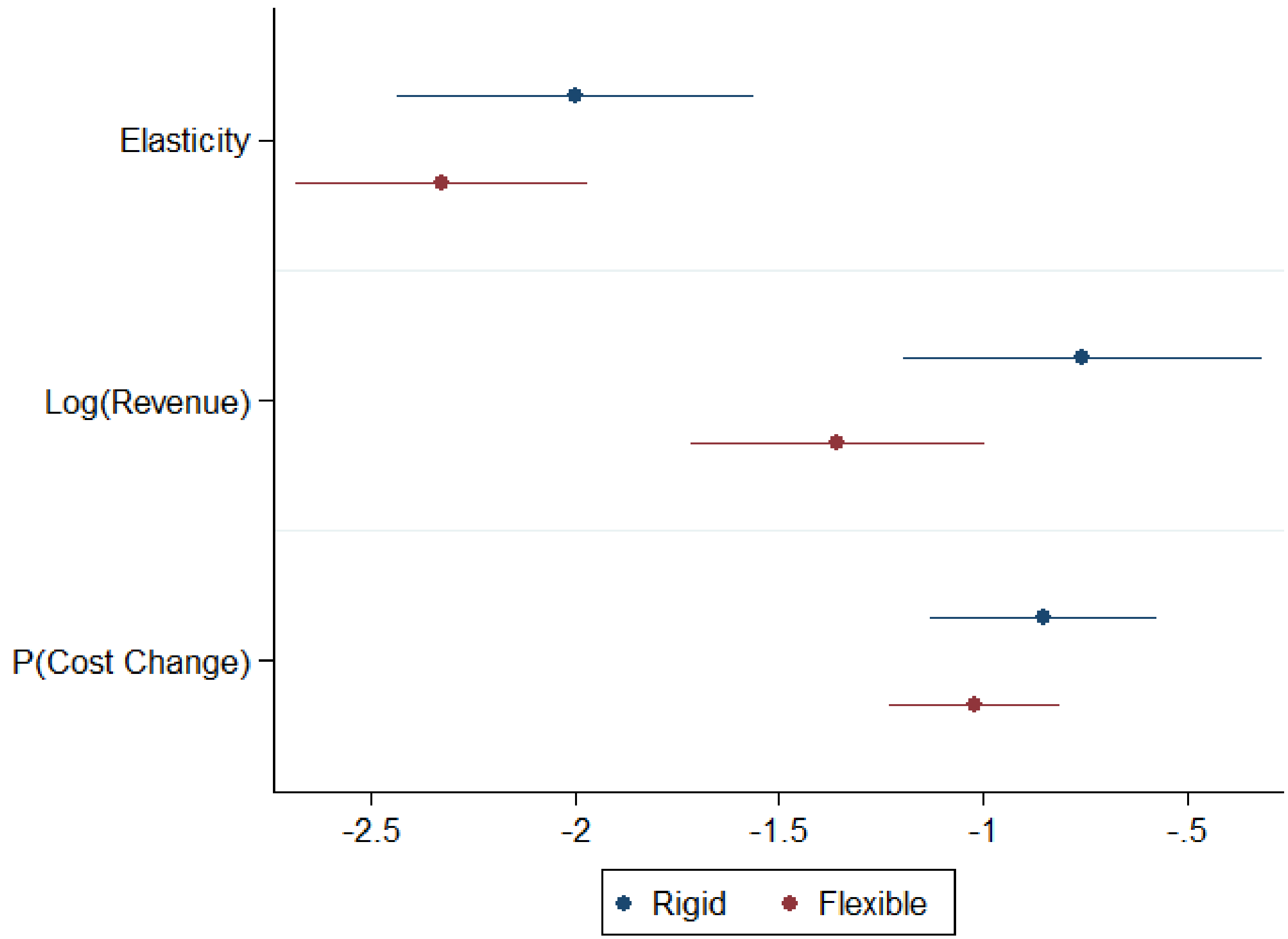
Variation in Regime Levels across UPCs

$$Average\ \#\ Levels\ = \alpha_c + \beta_1 Elasticity_u + \beta_2 Log(Rev_u) + \beta_3 \sigma(costs_u) + e_{ucs}$$

Elasticity (β_1)	-0.0839***	-0.0423*	-0.0229
	(0.020)	(0.016)	(0.016)
Log Revenue (β_2)	0.389***	0.362***	0.388***
	(0.037)	(0.038)	(0.041)
Costs (β_3)	0.0402*	0.0807***	0.0857***
	(0.018)	(0.017)	(0.019)
FE	--	Category	Category-Store
N	25248	25248	25248
R2	0.043	0.086	0.470

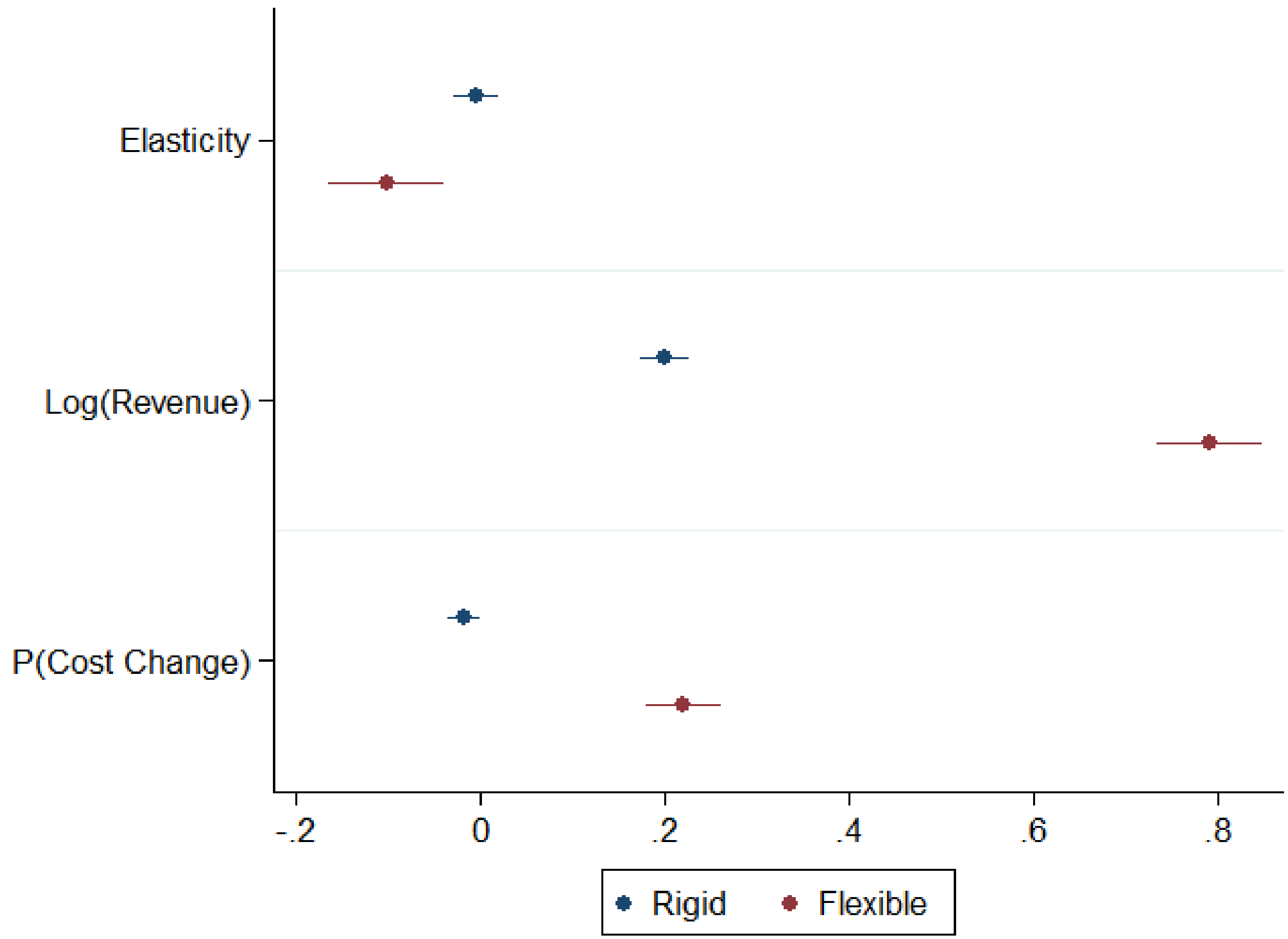
VARIATION IN REGIME DURATION WITHIN UPCS

$$Average\ Duration_{ucs} = \alpha_c + \beta_1 Elasticity_u + \beta_2 Log(Rev_u) + \beta_3 \sigma(costs_u) + e_{ucs}$$



Variation in Regime Levels within UPCs

$$Average\,\#\,Levels_{ucs} = \alpha_c + \beta_1 Elasticity_u + \beta_2 Log(Rev_u) + \beta_3 \sigma(costs_u) + e_{ucs}$$



Conclusions and Going Forward

Conclusions:

- Product observables are related to nominal rigidity in intuitive ways
  - 25-50% of variation across product categories related to these observables
  - But economic effects appear small

- Firms that are more rigid on average are also less responsive to observables
  - Unlikely to be generated by menu costs

- Rational inattention model calibrated to these results suggest costs of inattention are small
  - Removing information capacity constraint increases profit by at most 10%
  - Likely consistent with monetary non-neutrality (speculative)

Going forward:

-Extend sample to additional markets

-Alternative demand systems

-Explore state-dependence (local employment, etc)

-Full general equilibrium model to determine macroeconomic implications