"Volatility and Pass-Through"

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Summary

- Time-variation in the reponse of inflation to nominal shocks
- Documenting of such time variation has been model-based ("indirect")
- Use BLS micro data to document such time variation
- Dispersion of price changes varies over time; FX pass-through varies over time
- Positive correlation between dispersion of price changes and FX pass-through
- Use model to interpret "model-free" evidence

Empirics

- Confidential BLS micro data on import prices, collected on monthly basis: 1994–2011. Voluntary confidential surveys.

- Target Universe: all items purchased from abroad by US residents. Item is defined as unique combination of a firm, a product and a shipping country.

- 10,000 imported goods. Prices collected FOB. $\approx$ 90% of US imports have reported price in dollars.

- Sample: exclude intrafirm transactions; exclude goods that show no price change; exclude goods for which prices are not in dollars; excludes petroleum.

Empirics

- Two measures of price dispersion

- Item-Level: dispersion of all non-zero price changes for item j across time. $DI_j = disp(\Delta p_{i,t} | i = j) = std(\Delta p_{i,t})$

- Month-Level: Fix month and calculate the dispersion of price changes across all items. $DM_k = disp(\Delta p_{i,t} | t = k) = IQR_t$.

Regression:

$$\Delta p_{i,t} = \beta \Delta_c e_{i,t} + Z'_{i,t}\gamma + \epsilon_{i,t} \tag{1}$$

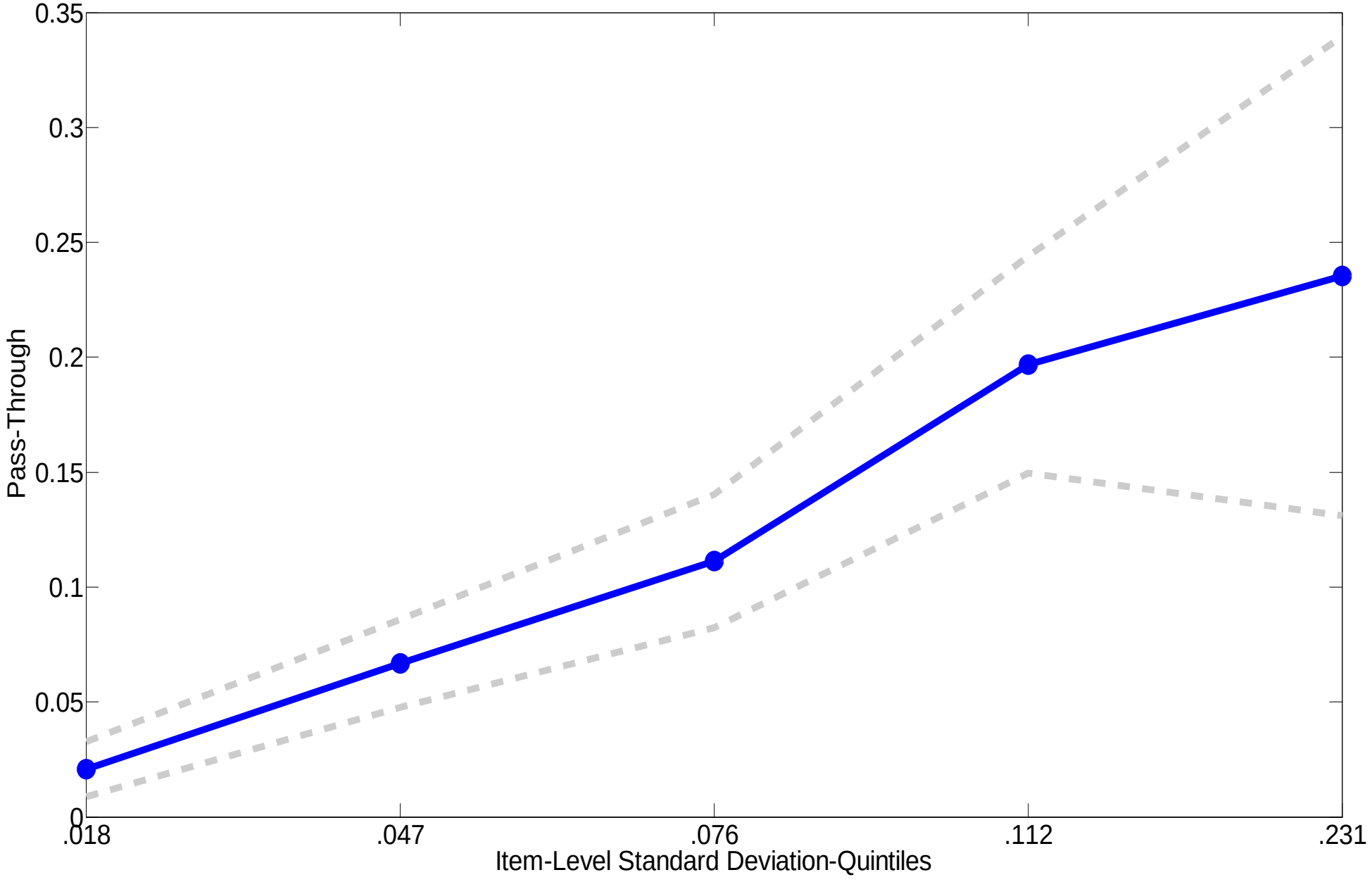
$\Delta p_{i,t}$ is log price; $\Delta_c e_{i,t}$ is cumulative change in FX; $Z'_{i,t}$ controls;

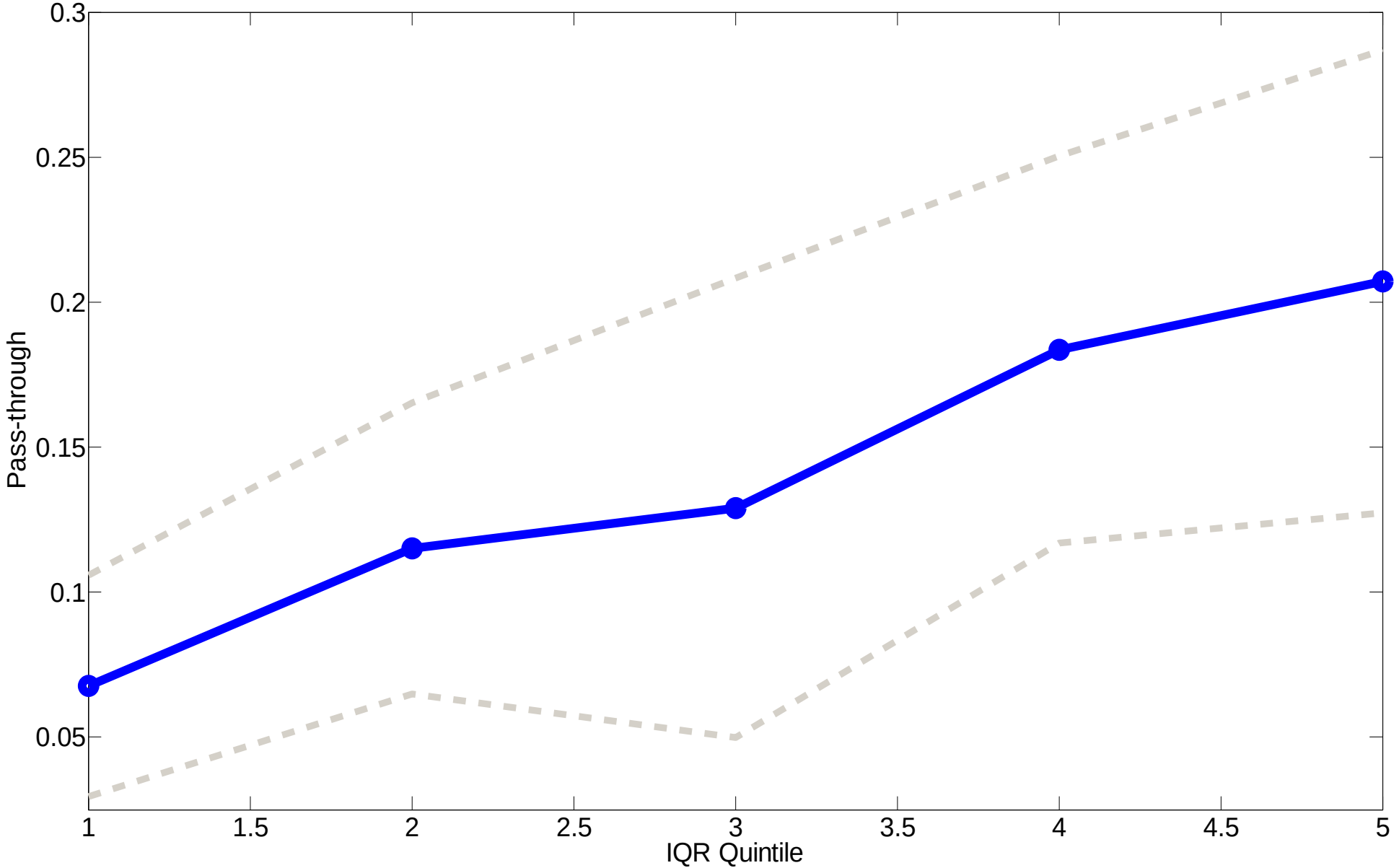
- Result: $\hat{\beta} = 0.144^{***}$. When a price changes, it only passes through about 0.14% of a 1% increase in the nominal exchange rate.

Empirics

- Item-level: Split sample into $std(\Delta p_{i,t})$ quintiles and run regression (1) separetely for each one.

- Month-level: Split sample into IQR_t quintiles and run regression (1) separetely for each one.


0.35
0.3
0.25
0.2
0.15
0.1
0.05
0
Pass-Through
.018
.047
.076
.112
.231
Item-Level Standard Deviation-Quintiles


0.3
0.25
0.2
0.15
0.1
0.05
Pass-through
1
1.5
2
2.5
3
3.5
4
4.5
5
IQR Quintile

Robustness

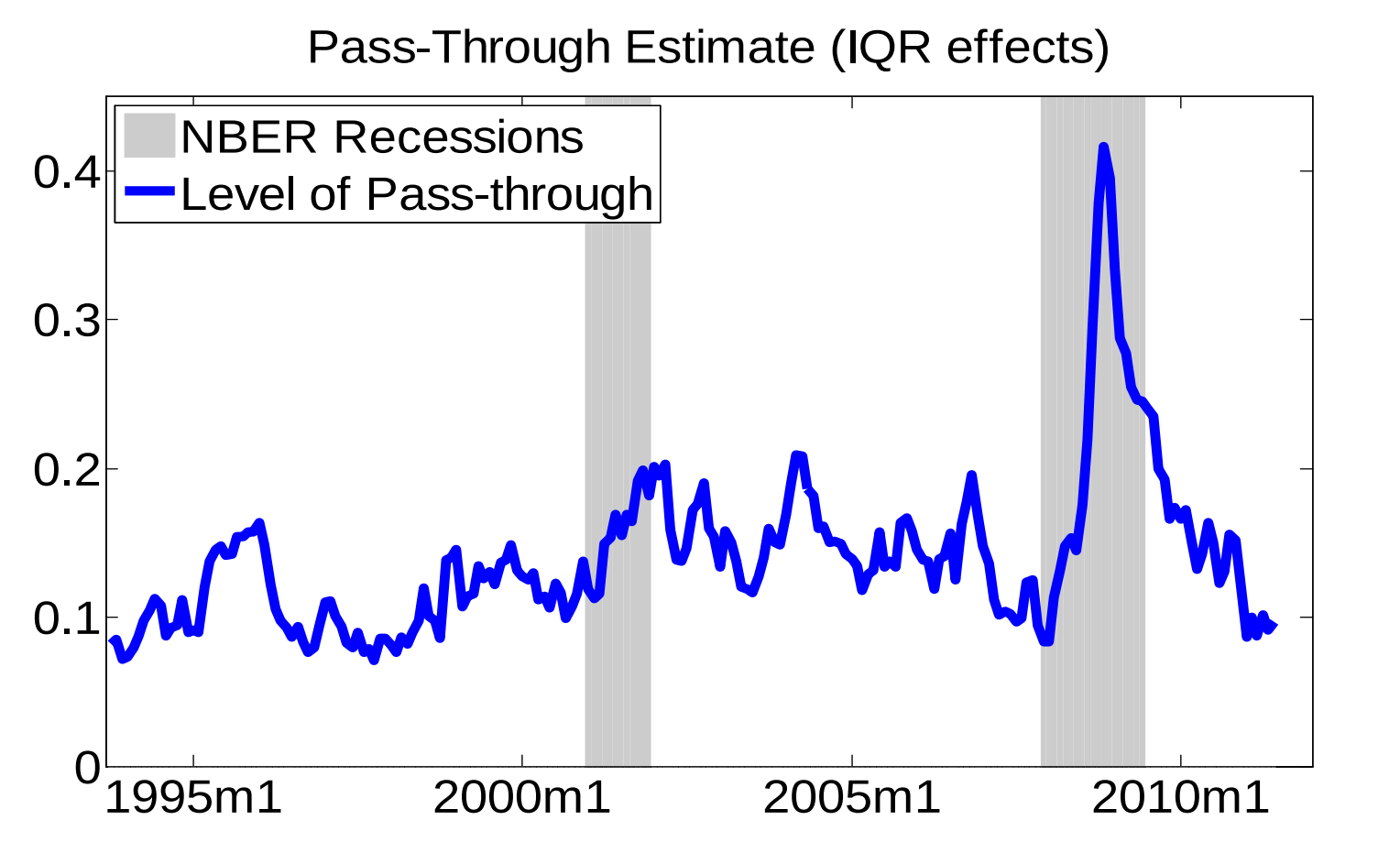
- Regressions with continuous measures of price change dispersion (interaction terms)
- Combining regression of item-level and month-level (interactions)
- Restrict sample to a balanced panel (it was not the case before because of sample rotation)
- Split sample into periods of FX appreciation and periods of depreciation
- Alternative pass-through specifications (rolling window, inclusion of lags)
- Restrict sample to items with more than 3, 5 price changes
- Etc.

Time Variation in Pass-Through

- Positive relationship between price dispersion and pass-through generates significant variation at business cycle frequencies.

- Implied time-series for FX pass-through: $M\hat{R}PT_t = \hat{\beta} \times IQR_t$.

- **Main Conclusion**: Pass-through varies dramatically over time and is strongly correlated w/ price change dispersion.


Pass-Through Estimate (IQR effects)
NBER Recessions
Level of Pass-through
0.4
0.3
0.2
0.1
0
1995m1
2000m1
2005m1
2010m1

Story

- Basic flex-price model. Foreign firm selling goods to US importers. Dollar marginal cost $mc_i(e,\ \eta_i)$ depends on exchange rate (e) and item-specific component orthogonal to exchange rate (η_i).

$$p_i = \mu_i + mc_i(e,\ \eta_i) \tag{2}$$

Taking total derivative:

$$\Delta p_i = -\Gamma_i \left(\Delta p_i - \Delta p\right) + \alpha_i \Delta e + \Delta \eta_i \tag{3}$$

where

- $\Gamma_i = \frac{\partial \mu_i}{\partial(\Delta p_i - \Delta p)}$: "responsiveness"; $\alpha_i = \frac{\partial mc_i}{\partial e}$: "import intensity"; $\Delta \eta_i$: idiosyncratic innovation to marginal cost

Story

- Direct effect of a change in exchange rate on prices ($\Delta p = 0$ and $\Delta \eta_i = 0$):

$$\frac{\Delta p_i}{\Delta e} = \frac{\alpha_i}{1 + \Gamma_i} \tag{4}$$

- If marginal cost is entirely denominated in dollars ($\alpha_i = 0$), fluctuations in exchange rate are irrelevant. Pass-through increases with import intensity.

- If $\Gamma_i > 0$, then as the price of the foreign firm increases relative to its competitors, the elasticity of its demand rises, lowering its optimal markup.

- When Γ_i is large, foreign firm will move its price less than one-for-one in response to cost shocks. Therefore, lower Γ_i means greater "responsiveness". This implies a positive relationship between responsiveness and pass-through.

Story

- Also, taking the variance of equation (3), we have:

$$Var\left(\Delta p_i\right) = \left(\frac{\alpha_i}{1+\Gamma_i}\right)^2 Var\left(\Delta e\right) + \left(\frac{1}{1+\Gamma_i}\right)^2 Var\left(\Delta \eta_i\right) \qquad (5)$$

widthheight$_{\text{itemize}}$

Price dispersion increases with volatility of idiosyncratic shock and exchange-rate.

Factors that increase exchange rate pass-through (greater responsiveness), also increase the variance of price changes

A Menu-Cost Model

Building on Gopinath and Itskhoki (2010)

- Industry is characterized by a continuum of varities j. Unit measure of US varieties and measure $\omega < 1$ of foreign varieties.
- Variable Markups – Kimball (1995) aggregator with demand elasticity σ and markup elasticity ε.
  - Γ_i is increasing in ε and decreasing in σ.
  - Assume variation in Γ_i is solely driven by ε.
- Firm's marginal cost depends on idiosyncratic productivity, A_{jt} (AR(1) in logs) and on the exchange rate $e_t = log(W_t^*/W_t)$ (Random Walk in logs).
- Firms face a menu cost κ when adjusting prices.
- Joint calibration of α, ε and σ_A to match: average level of pass-through, R^2 of regression (5) and average standard-deviation of item-level price changes.

Calibration

Table 8: Parameter Values

Parameter	Symbol	Menu Cost Model	Source
Discount Factor	β	$0.96^{1/12}$	Annualized interest rate of 4%
Fraction of imports	$\omega/(1+\omega)$	16.5%	BEA input-output table
Cost sensitivity to ER shock			
Foreign firms	α^*	0.18	Estimation (see text)
U.S. firms	α	0	
Menu cost	κ	4.3%	Estimation (see text)
markup elasticity	ε	2.5	Estimation (see text)
Demand elasticity	σ	5	Broda and Weinstein (2006)
Std. dev. Exchange rate shock, e_t	σ_e	2.5%	Match bilateral RER
Idiosyncratic productivity process, a_t			
Std. dev. of shock	σ_A	7.0%	Estimation (see text)
Persistence of shock	ρ_A	0.85	Gopinath and Itshkoki (2010)

A Menu-Cost Model
Value Functions

State vector: $S_{jt} = (P_{j,t-1}, A_{jt}; P_t, e_t)$. The firm's problem is characterized by the following value functions.

$$V(S_{jt}) = \max\{V^N(S_{jt}), V^A(S_{jt}) - \kappa\} \tag{6}$$

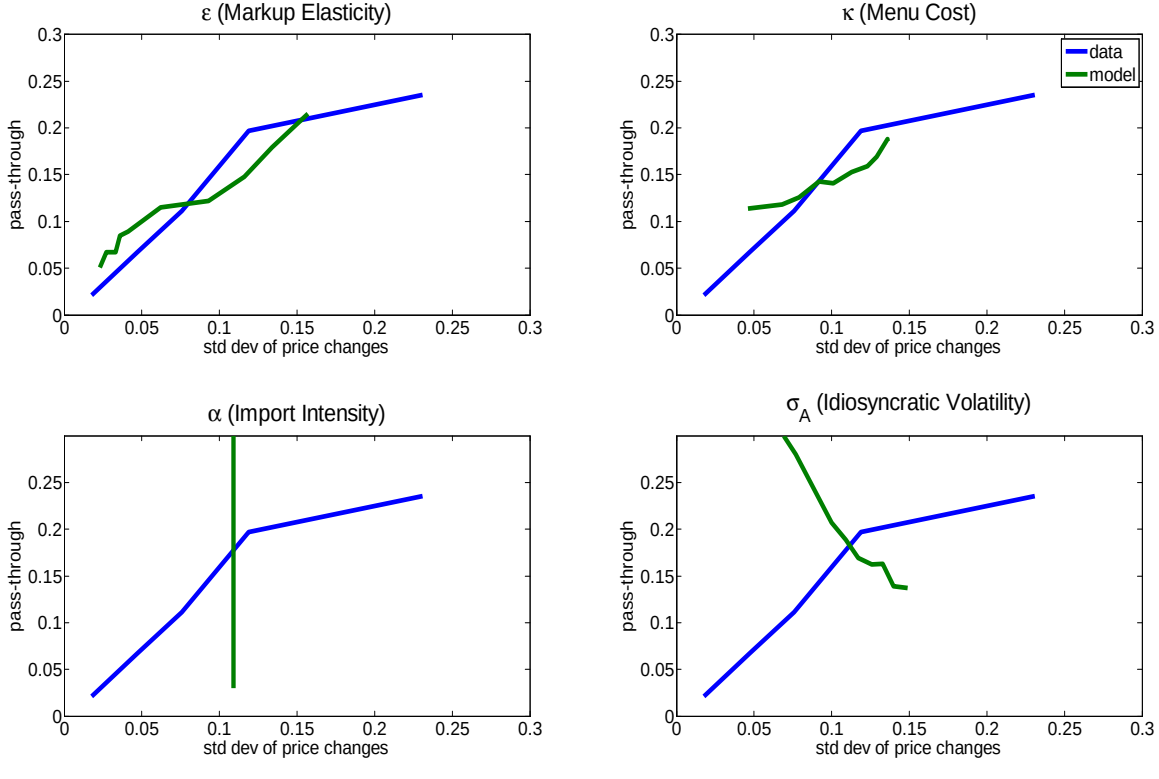
$$V^N(S_{jt}) = \Pi_{jt}(S_{jt}) + E[Q(S_{jt+1}) V(S_{jt+1})] \tag{7}$$

$$V^A(S_{jt}) = \max_{P_{jt}}\{\Pi_{jt}(S_{jt}) + E[Q(S_{jt+1}) V(S_{jt+1})]\} \tag{8}$$

Solution Method: Krussel and Smith (1998)
$E_t[\log P_{t+1}] = \gamma_0 + \gamma_1 \log P_t + \gamma_2 e_t$.

Comparative Statics
Menu-Cost Model

Given the parameters ε, κ, α, σ_A, consider fixing three of them and varying the fourth. For each set of parameters, simulate a panel of firms and compute MRPT and the standard deviation of price changes as in BLS data.



Mechanisms: κ and σ_A

Selection

By definition, estimated coefficient in regression (5) is:

$$\hat{\beta} = \frac{Cov(\Delta p_{i,t},\ \Delta_c e_{i,t})}{Cov(\Delta_c e_{i,t},\ \Delta_c e_{i,t})} = \beta + Cov\left(\Delta_c e_{i,t},\ \epsilon_{i,t}\right) \qquad (9)$$

- Menu-costs induce $Cov\left(\Delta_c e_{i,t},\ \epsilon_{i,t}\right) > 0$ because of **SELECTION**! Firms are more likely to adjust when the idiosyncratic shock and the x-rate movement reinforce each other.
- Higher κ lead firms to adjust less often and by larger amounts, thus increasing $\Delta p_{i,t}$. Higher κ also increases selection bias (inaction region widens), which increases MRPT (via β).
- Higher σ_A lowers MRPT because the selection bias is decreasing in σ_A: firms become more likely to adjust based on idiosyncratic reasons. At the same time, higher σ_A increases $\Delta p_{i,t}$, which yields the negative correlation.

Indirect Inference

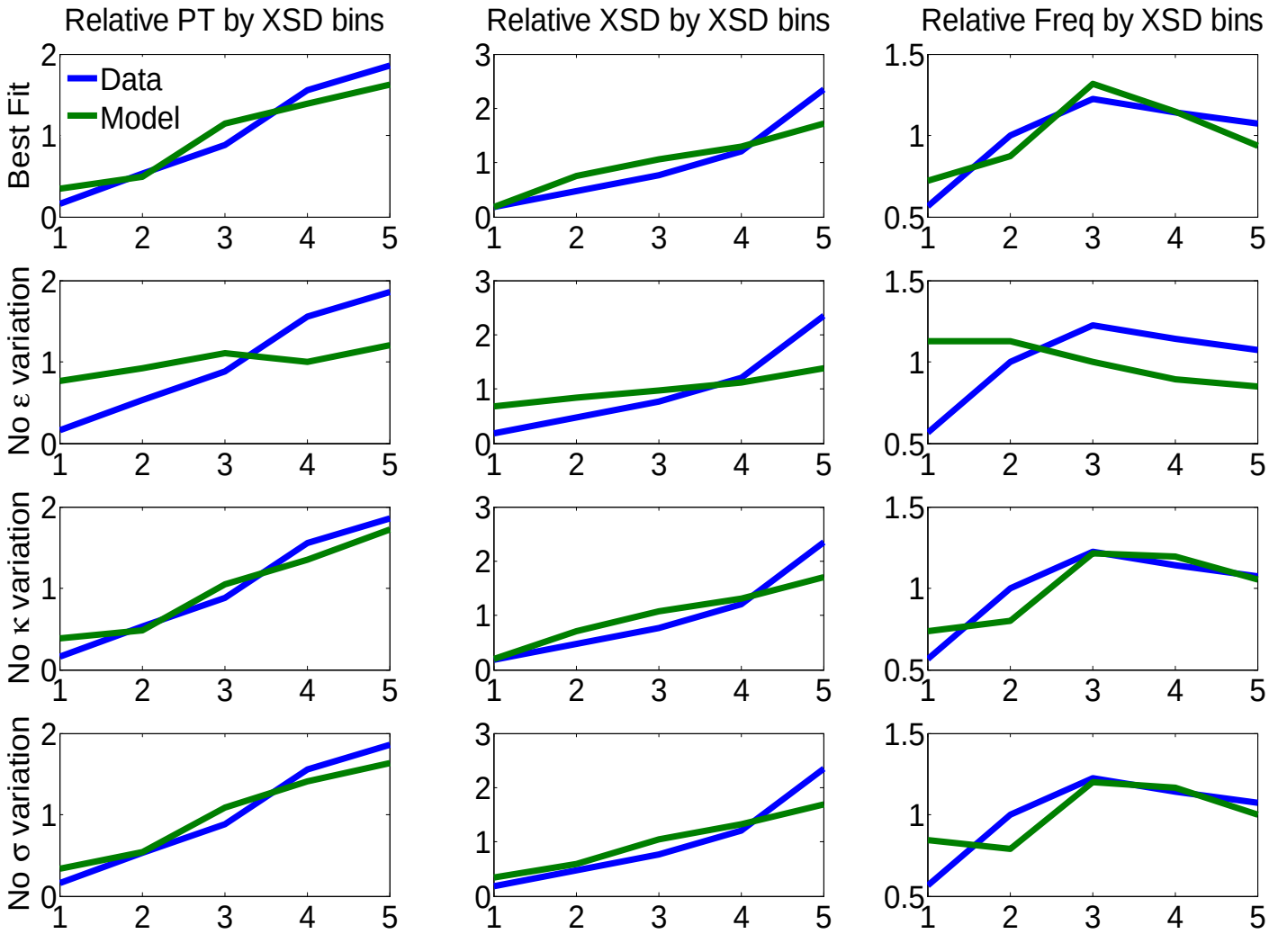
- It appears that variation in either ε or κ might explain the relationship between MRPT and price change dispersion.
- However, note that variation in κ induces a strong negative correlation between dispersion and adjustment frequency. In the data, on the other hand, such correlation is positive.

Indirect Inference Exercise: allow for permanent firm heterogeneity (not observable by the econometrician).

- Firms can differ by κ, ε and σ_A. Each parameter can take one of two values uniformly distributed around the previous mean.
- Eight different types of firms in the model.
- Solve sectoral equilibrium for each type of firm and simulate firm panel like the BLS data.
- From this simulated panel they calculate some moments, sorting firms into five bins according to price change dispersion.
- Also simulate models where there is heterogeneity in only 2 of those 3 parameters.

Indirect Inference

Results



Comments

- Very interesting paper
- Striking empirical results
- Discussion of "story"
- Needs some reorganization + polishing, but should fly!

Connecting to other literature

- Literature on non-linearities and time-variation in pass-through (e.g. Shintani et al. 2013, Sekine 2006)
- Different objects:
  - Standard pass-through measure with aggregate data
  - Hence PT depends on frequency of price changes and "responsiveness"
  - E.g., changes in inflation can affect frequency of price changes, and hence "unconditional pass-through"
- But should relate to that literature; explore whether some of the stories behind time-variation in that literature can explain your findings (e.g., non-linearities in the size of the FX change)
- Also, settle on the issue of cyclicality versus time-variation (recessions, business cycle fluctuations)

Nominal-rigidity-free measure

- Argument that measure of pass-through is "nominal-rigidity free"
- Not convinced
- If some nominal rigidities and some strategic complementarities, hard to separate the two even conditional on a price change
- A given extent of pass-through can arise because
  - Adjusting firm cares only some about other firms' prices, but those will change only very infrequently; hence adjusting firm responds to some given extent
  - Adjusting firm cares a lot about other firm's prices, but those will change somewhat more frequently than above; adjusting firm responds to the same extent
- True that without complementarities response should be complete; but in the presense of complementarities they interact with nominal rigidities
- Should discuss how looking only at price changes gets rid of this interaction (I don't think it does)

About the story

- Nice that same mechanism that succeeds in making sense of cross-sectional PT facts in menu-cost model works to account for time-variation
- But idea that structural determinants of degree of strategic complementarities (real rigidities) vary at such high frequencies might be less appealing
- Useful to think about alternative stories
  - Informational stories? Allocation of attention affecting degree of responsiveness?
  - Different dimensions of strategic interactions among price-setting decisions; different composition of shocks over time $\Longrightarrow$ as if degree of strategic complementarities varied over time