Economics 742 Price Ridigity Bonus Lecture 4: Time Variation in Monetary Policy

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Status of Micro-To-Macro Pricing Literature

- Literature comparing models to Calvo seems settled.
- Where to go from here?

1. Real rigidity is a big question, but difficult to answer.
2. Pricing of durable goods not well understood.
3. Normative analysis of policy with state-dependent pricing.
    - Positive similarity of Calvo to state-dependent does not imply normative equivalence.
    - See Blanco (2017) for instance.
4. Use pricing micro data to answer other questions of interest to macroeconomists:
    - New micro facts.
    - Combined with model to show matters for macro.

- Today, examine a paper in fourth category.

Vavra (2014): Inflation and Time-Varying Volatility

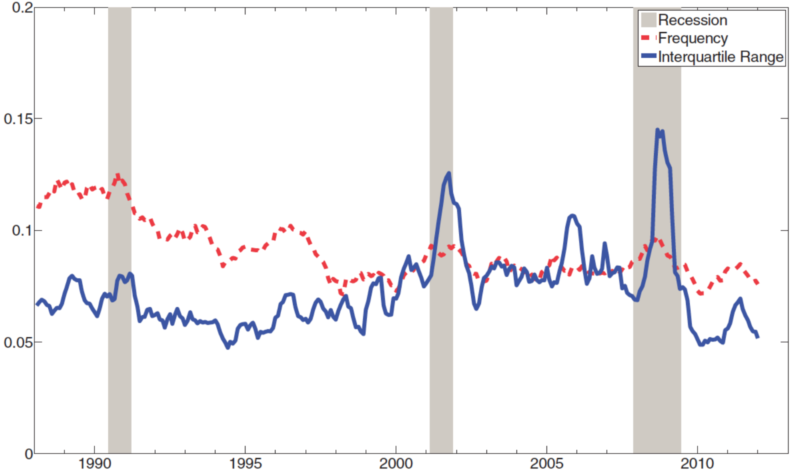
- Is the effectiveness of monetary policy time varying?
- If so is it more effective in a boom or a bust? Or is there some other variable that controls its effectiveness?

1. Micro facts on higher order moments of price distribution.
   1.1 Cross-sectional dispersion of price changes counter cyclical.
   1.2 Dispersion co-moves with frequency of adjustment.
2. Model to rationalize facts with surprising implications:
   2.1 Facts consistent with price setting models with idiosyncratic "volatility shocks" but inconsistent with first moment shocks.
   2.2 Output responds less to nominal stimulus during high volatility.
   2.3 Implies monetary policy less effective in downturn.

Vavra (2014): Facts on Higher Moments

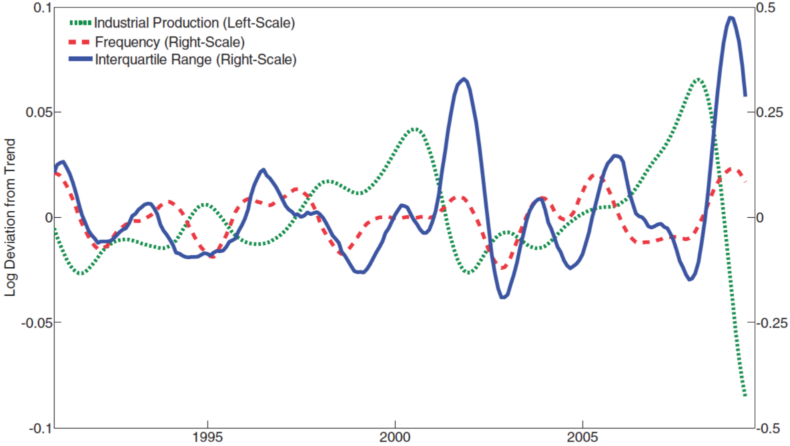
- Let $dp_{i,t} = \log \frac{p_{i,t}}{p_{i,t-1}}$ for item i at time t.
- Compute dispersion and higher order moments (st dev, kurtosis, interquartile range) of $dp_{i,t}$ weighted using CPI weights.
- Details
  - Exclude zeros, get at this by targeting frequency.
  - Robustness to treatment of sales, substitutions, z score for price changes, balanced panel.
  - Holds within nearly all sectors.

Vavra (2014): Raw Frequency and IQR



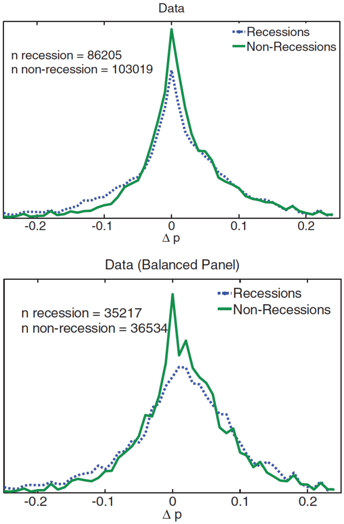
Data is seasonally adjusted using 12 monthly dummies and smoothed with a 6 month moving average.
Frequency is the Median Frequency of Adjustment.

Vavra (2014): Band Pass Filtered Frequency and IQR



Log frequency and interquartile range are seasoanlly adjusted using monthly dummies. All series are bandpass filtered with a Baxter-King (18,96,33) filter

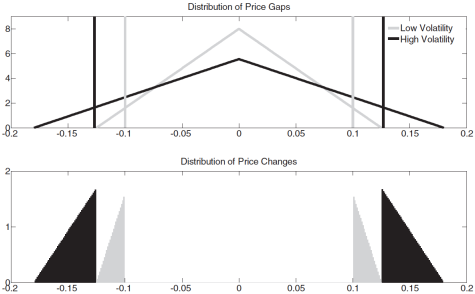
Vavra (2014): Distribution in Recession vs. Expansion



Vavra (2014): Analytical Results

- For intuition, starts with analytically-tractable (S, s) model as in Barro (1972)
  - Cost bx^2 of departures of price gap $x_{it} \equiv p^*_{it} - p_{it}$ from zero.
  - x follows Brownian motion $dx = \sigma dw$. Cost k to set $x = 0$.
- Adjust if $|x| \geq S = \left(\frac{6k\sigma^2}{b}\right)^{1/4}$.
  - Frequency is $\sigma\sqrt{\frac{b}{6k}}$ and stdev of price changes is S.
  - Changes in b and k yield counterfactual negative correlation between frequency and dispersion.
  - Increasing σ leads to increase in frequency and dispersion as in data.

Vavra (2014): Intuition For Analytical Results

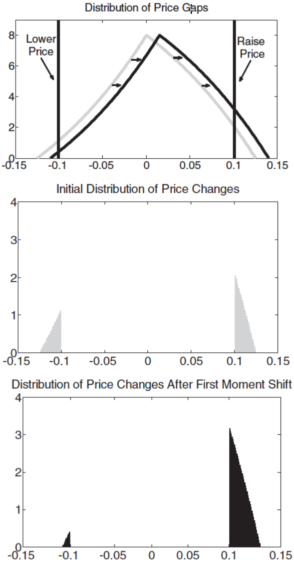


- Increase in σ:
  1. Firms hit adjustment region of given width more frequently. Frequency $\uparrow$. Price change dispersion $\uparrow$ due to wider x dist.
  2. Widens inaction region (real options effect) $\Rightarrow$ frequency $\downarrow$.
- In steady state, direct effect is stronger and frequency rises.

Vavra (2014): Analytical Results For Shocks to x

- Of free variables only σ goes in right direction.
- What about first moment shocks to x?
  - With no inflation, σ and frequency unchanged.
  - With inflation, frequency $\uparrow$ and standard deviation $\downarrow$.
- Intuition:
  - With inflation, first moment shock pushes more firms out of inaction region.
  - This increases inflation, but more firms pushed out of inaction region in same direction.
  - This reduces dispersion of price changes.
- First moment shocks are counterfactual. Leads him to incorporate second moment shocks in quantitative model.

Vavra (2014): Intuition For Shocks to x



Vavra (2014): Quantitative Model

- Standard Midrgan-style model solved by Krusell-Smith.

1. Leptokurtic shocks: shock is zero with Poisson probability.

$$\log A_t = \varepsilon_t(z) \sim \begin{cases} \rho_A \log A_{t-1} + d_t \sigma_A \varepsilon_t^A, & \text{with } Pr\left[1 - p^a\right] \\ \log A_{t-1} & \text{with } Pr\left[p^a\right] \end{cases}$$

2. Random menu cost (as in DKW): Adjustment cost is zero with Poisson probability (rather than multi-product firms).

- Stochastic volatility of idiosyncratic shocks:

$$\log d_t = \rho_D \log d_{t-1} + \sigma_D \varepsilon_t^d$$

- Weakness: relationship between d and A exogenous and reduced form.
  - Starts with $\rho_A = \rho_D$ and $\varepsilon_t^A = -\varepsilon_t^d$.
  - Looks at extensions and robustness in appendix.

Vavra (2014): Quantitative Model Fit of Micro Facts

	Data	First+Second	Only First
Moments targeted			
Frequency	0.11	0.11	0.11
Fraction up	0.65	0.66	0.67
Size up	0.07	0.055	0.055
Size down	0.09	0.064	0.061
Fraction small	0.33	0.34	0.34
Kurtosis	6.4	7.2	7.3

- Model with second moment shocks fits micro facts used in calibration equally well.
  - Does not screw up these features of data.

Vavra (2014): Quantitative Model Fit of New Facts

	Data	First + Second	Only First
Time-series moments not targeted			
Correlation dispersion and frequency	0.61	0.62	–0.58
Correlation dispersion and Y	–0.41	–0.60	0.14
Correlation freq. and Y	–0.27	–0.24	–0.07
Correlation dispersion/freq. and Y	–0.30	–0.39	0.11
Time-series std. dev. of dispersion	0.099	0.072	0.018
Time-series std. dev. of frequency	0.054	0.046	0.031

- First moment: counterfactual neg relationship between dispersion and frequency.
  - Intuition that direct effect dominates real option effect from simple analytic model carries through.
- Second moment matches this and other non-targeted facts.
  - Dispersion more corr with cycle than frequency: Firms with large price gaps and firms with "free" Poisson adjustment will always adjust and have little effect on frequency, but dispersion for these firms goes up.

Vavra (2014): Implications

Volatility	Price IRF on impact (T)	Output IRF on impact (%)	Total output IRF (%)
10th percentile	28.9	71.1	418.0
50th percentile	35.0	65.0	360.8
90th percentile	39.3	60.7	325.0

Notes. Output impulse as a percent of nominal shock. The nominal shock is a one-month doubling of nominal output growth from 0.002 to 0.004.

- More volatility $\Rightarrow$ monetary policy leads to more inflation, smaller output effect.
  - Monetary policy also more persistent.

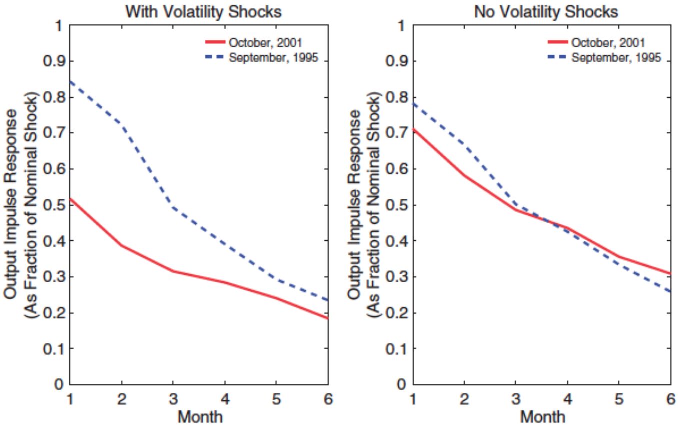
Vavra (2014): Intuition Through Caballero-Engel

$$\left.\frac{dp}{dm}\right|_{dm=0} = \int \Lambda(x) f(x)\, dx + \int x\Lambda'(x) f(x)\, dx$$

Volatility	Intensive margin (%)	Extensive margin (%)
10th percentile	10.2	18.7
90th percentile	12.2	27.1

- Intensive margin isomorphic with frequency of adjustment.
- Extensive margin related to number of firms close to adjustment, large values of $|x|$.
    - Volatility pushes more firms towards margin of adjustment.
    - Wider inaction region $\Rightarrow$ larger $|x|$

Vavra (2014): Simulation of Time-Varying Efficacy



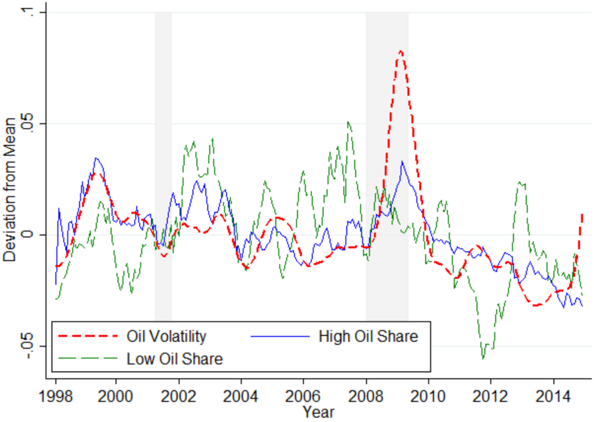
Vavra (2014): Evaluation

- Great combination of theory and empirics.
  - Paper would not be nearly as successful if just facts.
  - Big contributions in this literature have an important "so what" component to them. This requires a model.
- But is this the right story?
  - Time-varying volatility could be caused by something other than stochastic volatility in shock process.
  - Vavra says little about this "omitted variable story."

Klepacz (2017)

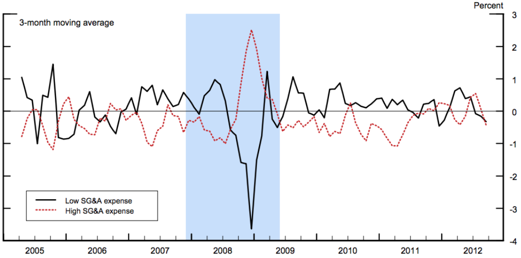
- Vavra is about times with high idiosyncratic uncertainty.
- What about high aggregate uncertainty?
  - Relevant to things like commodity price vol, policy uncertainty.
- Concern: Higher frequency or lower dispersion of price changes when aggregate uncertainty rises.
  - Frequency: More flexible aggregate prices.
  - Dispersion is more subtle.
    - If dispersion is lower, more firms changing prices in same direction, and aggregate prices are more flexible.
- Klepacz (2017) answers using PPI microdata and oil shocks.
  - Oil volatility shocks plausibly exogenous.
  - See whether they have a bigger effect in oil intensive industries.

Klepacz (2017)



- Finds that when oil price vol rises, dispersion rises more in industries that have a larger cost share for oil.
  - No effect on frequency

Gilchrist et al. (2014): Financing and Price Dispersion



- Gilchrist, Schoenle, Sim, and Zakrajsek (2015) show firms with weak balance sheets increased prices in financial crisis.
  - Customer markets story for this.
  - Opposite Implication: Volatility of price changes due to binding credit constraints. If monetary policy weakens constraints, then more powerful in recession.
  - Do not investigate whether state-dependent model with this feature matches micro facts.