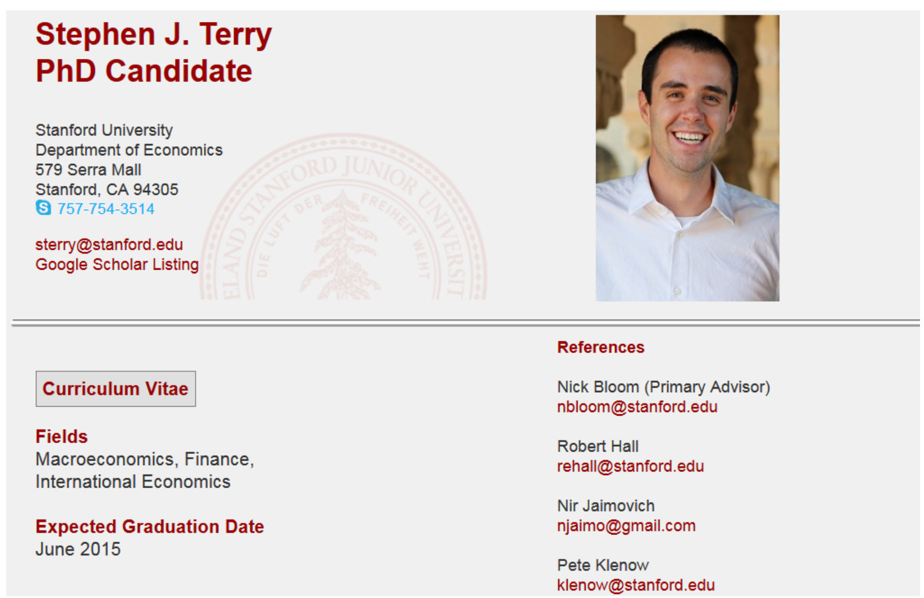
The Price of Variance Risk

Ian Dew-Becker, Stefano Giglio, Anh Le & Marcus Rodriguez

discussed by Nick Bloom, with help from Stephen Terry

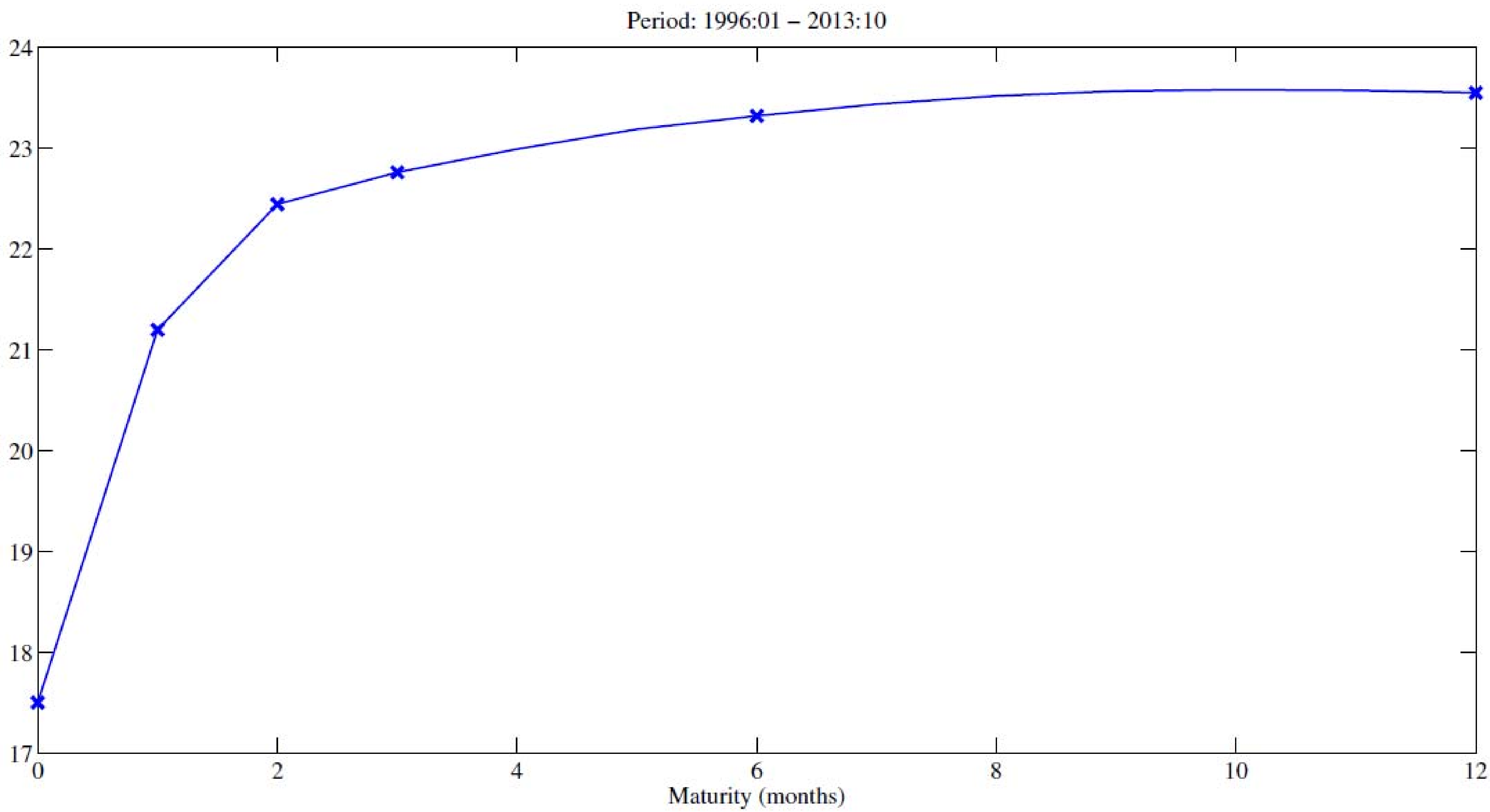


Very careful paper with a fascinating result

They got hold of two detailed datasets on variance swaps

Within this they discovered a new stylized fact which changed the way I think about uncertainty

What they find: zero-coupon variance claim prices are flat from about 3+ months

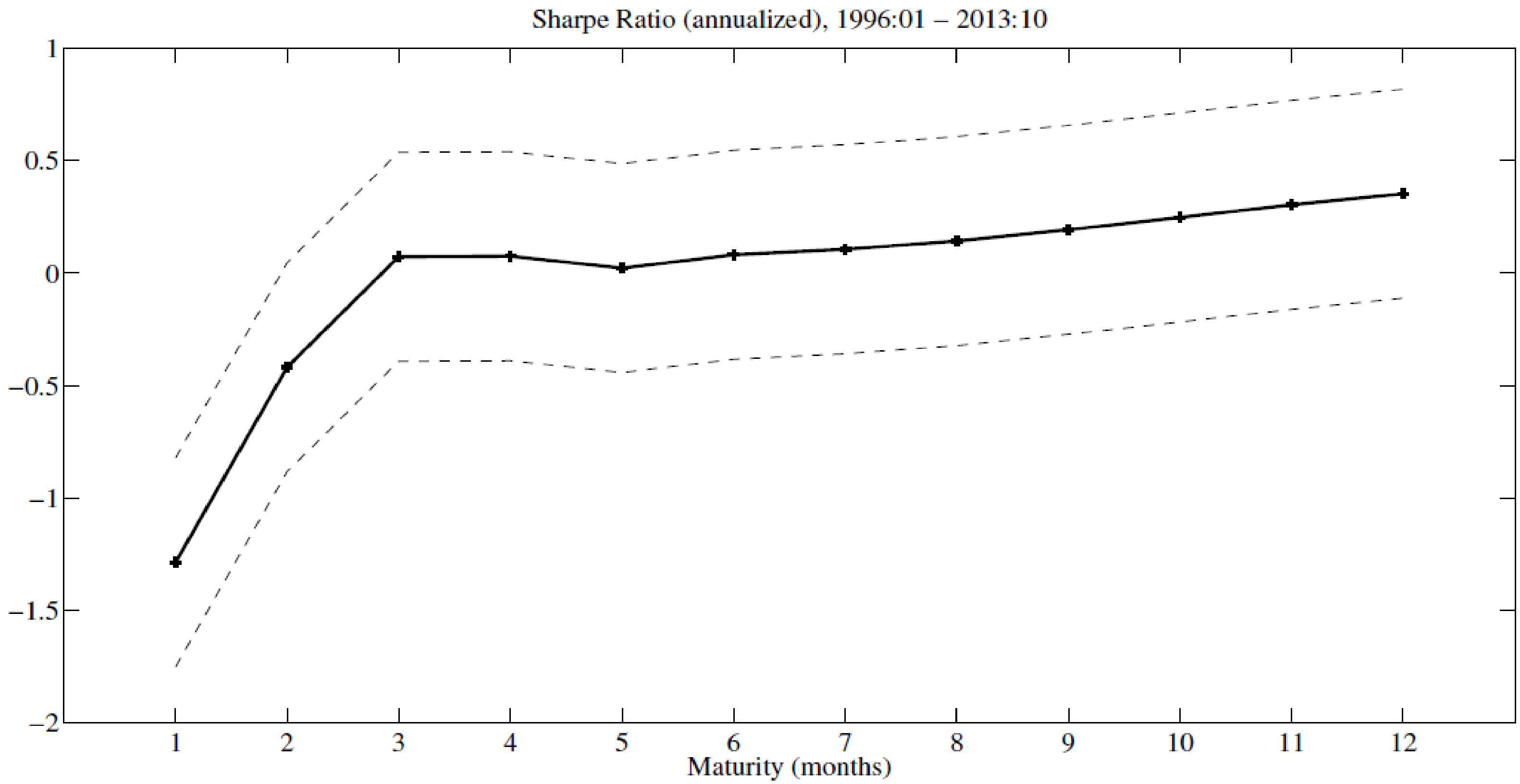


So no return to extra maturity in variance swaps from 3+ months

- Returns to each of these constant-maturity strategies are:

$$R_{t+1}^{n} = \frac{Z_{t+1}^{n-1} - Z_t^n}{Z_t^n}$$

- Sharpe ratios:



To summarize in their words…

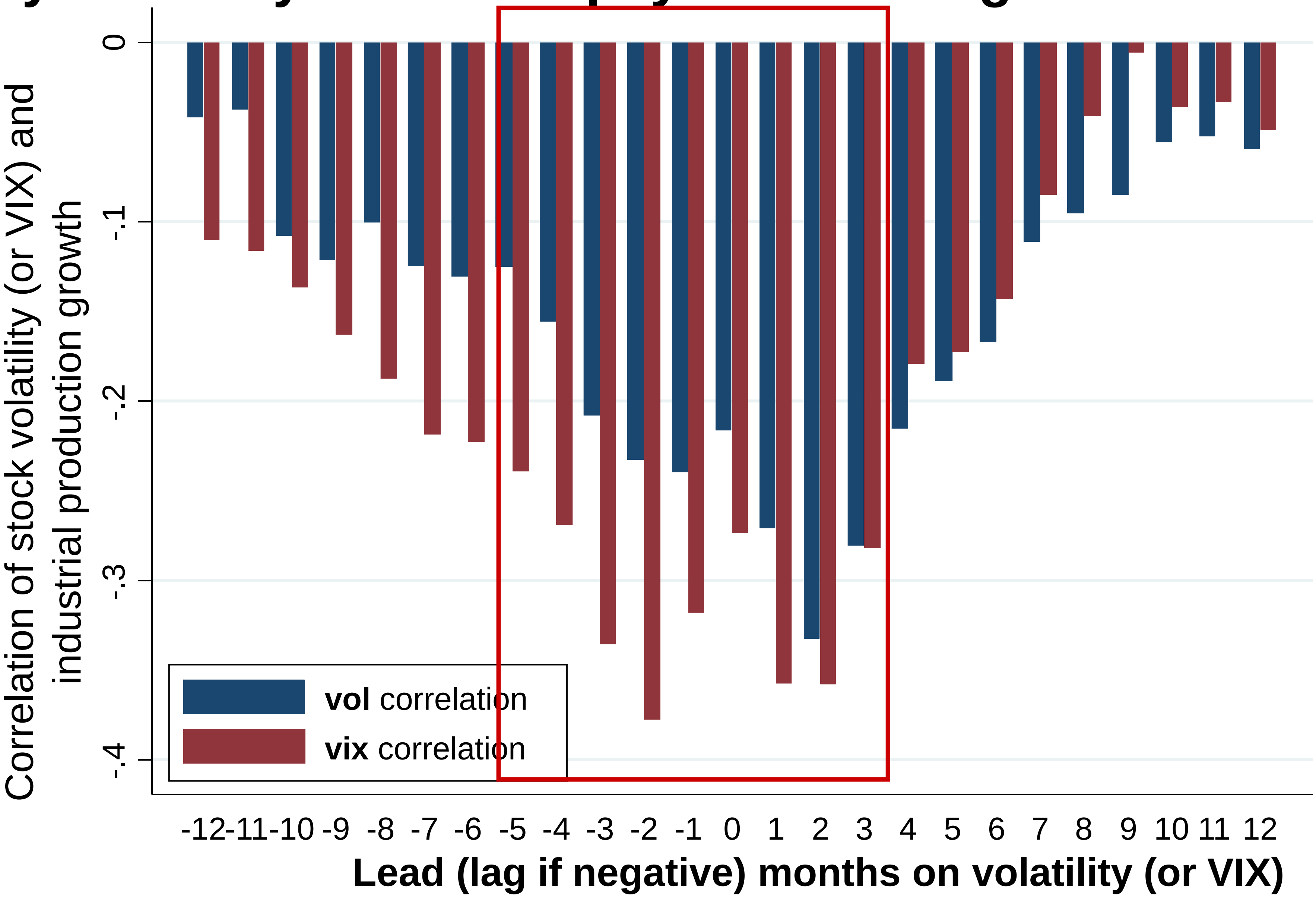
- Investors are willing to pay huge sums to insure against RV_{t+1}
- **Not** willing to pay anything to insure against $(E_{t+1} - E_t)RV_{t+j}$
- **News about future volatility doesn't matter to investors**

Puzzle

Two explanations

Excluded uncertainty?

Stock-volatility is negatively correlated with the cycle – so you should pay to insure against this?



Source: Industrial production monthly data from Federal Reserve Board data from 1970 onwards (VIX from 1990 onwards)

Puzzle

Two explanations

Excluded uncertainty?

One explanation is disaster risk with time varying recovery (bad disasters and really bad disasters…)

Builds on Gabaix (2012) to exploit the idea of asset resilience

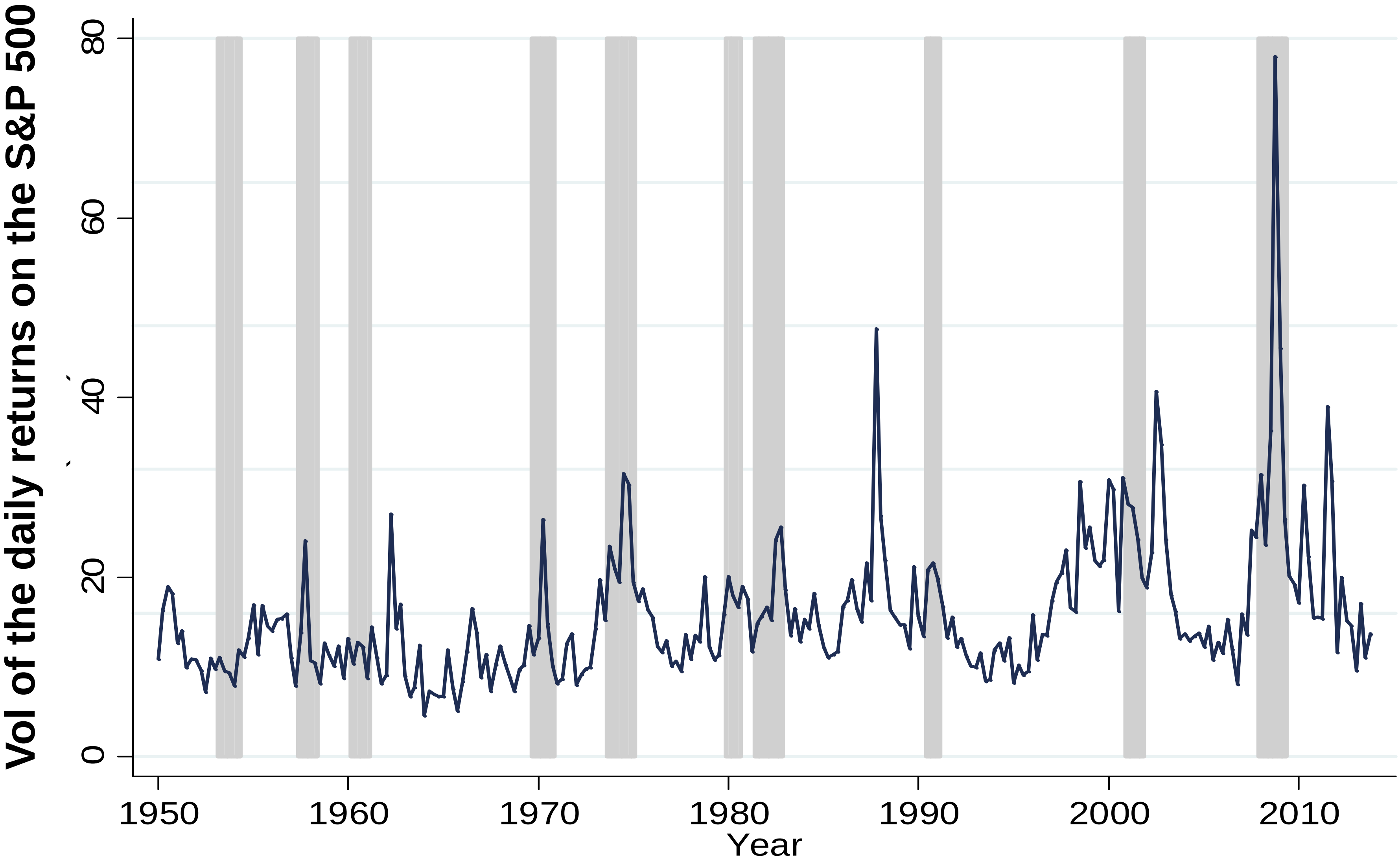
Recovery rates (L_t) varies over time – some disasters cause massive drops in dividends while others do not

$$L_t = (1 - \rho_L)\,\bar{L} + \rho_L L_{t-1} + \varepsilon_{L,t}$$

But this recovery rate is independent of current consumption, breaking the connection between the real and financial side

Possible, but I would like to see empirical evidence for this

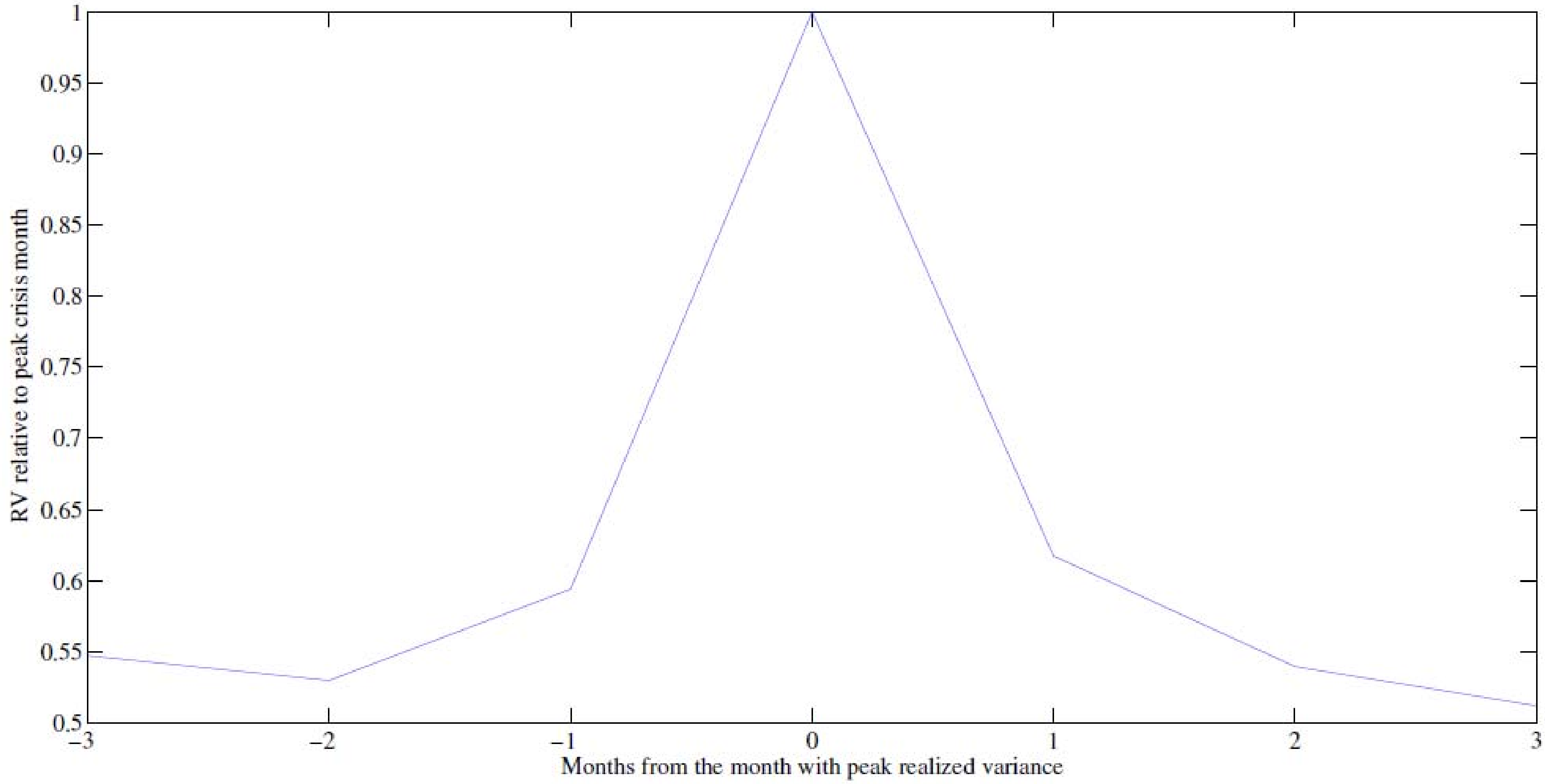
Another explanation is stock-market jumps are short lived, so are unpredictable 3+ months out



Source: Monthly volatility of the daily returns on the S&P500 at an annualized level. Grey bars are NBER recessions. Data spans 1950Q1-2013Q4.

They show this in Figure 13: vol spikes are rapid

Figure 13: Average behavior of RV during consumption disasters and financial crises



Note: We calculate realized variance in each month of a crisis and scale it by the maximum realized variance in each crisis. The figure plots the average of that scaled series for each country and crisis in terms of months relative to the one with the highest realized variance.

Roughly matches auto-regressive forecasts for the VIX and VOL – from 4+ months no power

```
. reg vol l.vol l2.vol l3.vol l4.vol ,rob

Linear regression                                      Number of obs =     764
                                                       F(  4,   759) =   60.35
                                                       Prob > F      =  0.0000
                                                       R-squared     =  0.5001
                                                       Root MSE      =  6.1714

------------------------------------------------------------------------------
             |               Robust
         vol |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
         vol |
         L1. |   .5682728    .087333     6.51   0.000     .3968298    .7397157
         L2. |   .0569803   .0550807     1.03   0.301    -.0511484     .165109
         L3. |   .1482992   .0518266     2.86   0.004     .0465587    .2500397
         L4. |   .0021637   .0519585     0.04   0.967    -.0998358    .1041631
             |
       _cons |   3.464136   .7841733     4.42   0.000      1.92473    5.003542
------------------------------------------------------------------------------
```

Use monthly data on daily S&P500 volatility from 1950:1 to 2013:12

Roughly matches auto-regressive forecasts for the VIX and VOL – from 4+ months no power

```
. reg vol l.vol l2.vol l3.vol l4.vol l5.vol l6.vol l7.vol l8.vol l9.vol l10.vol l11.vol l12.vol,rob

Linear regression                                      Number of obs =     756
                                                       F( 12,   743) =   24.17
                                                       Prob > F      =  0.0000
                                                       R-squared     =  0.5140
                                                       Root MSE      =  6.1326

------------------------------------------------------------------------------
             |               Robust
         vol |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
         vol |
         L1. |   .5568854   .0883991     6.30   0.000     .3833437    .7304272
         L2. |   .0511136    .054791     0.93   0.351    -.0564499    .1586772
         L3. |   .1287981   .0530928     2.43   0.016     .0245684    .2330279
         L4. |  -.0506038   .0549505    -0.92   0.357    -.1584805     .057273
         L5. |    .041176   .0505953     0.81   0.416    -.0581507    .1405028
         L6. |    .035369   .0552899     0.64   0.523    -.0731741    .1439121
         L7. |  -.0253249   .0586329    -0.43   0.666    -.1404308     .089781
         L8. |    .044142   .0499264     0.88   0.377    -.0538715    .1421556
         L9. |   .0048471   .0452229     0.11   0.915    -.0839328     .093627
        L10. |  -.0144364   .0514377    -0.28   0.779     -.115417    .0865443
        L11. |   .0046521   .0537511     0.09   0.931    -.1008701    .1101742
        L12. |   .0692814   .0511537     1.35   0.176    -.0311415    .1697043
             |
       _cons |   2.362213   .8053663     2.93   0.003     .7811483    3.943277
------------------------------------------------------------------------------
```

Use monthly data on daily S&P500 volatility from 1950:1 to 2013:12

Roughly matches auto-regressive forecasts for the VIX and VOL – from 4+ months no power

```
. reg vix l.vix l2.vix l3.vix l4.vix

      Source |       SS           df       MS      Number of obs   =       283
-------------+----------------------------------   F(4, 278)       =    281.59
       Model |  13963.8481         4  3490.96204   Prob > F        =    0.0000
    Residual |  3446.47893       278  12.3974062   R-squared       =    0.8020
-------------+----------------------------------   Adj R-squared   =    0.7992
       Total |  17410.3271       282  61.7387485   Root MSE        =     3.521

------------------------------------------------------------------------------
         vix |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
         vix |
         L1. |    1.09618   .0600253    18.26   0.000      .978018    1.214342
         L2. |  -.3716817    .088419    -4.20   0.000    -.5457375    -.197626
         L3. |   .1625566   .0883569     1.84   0.067     -.011377    .3364902
         L4. |   .0025341   .0600081     0.04   0.966     -.115594    .1206621
             |
       _cons |   2.201615   .6326393     3.48   0.001     .9562433    3.446987
------------------------------------------------------------------------------
```

Use monthly data on daily VIX 1990:1 to 2013:12

I think of this as the "weather model"

Stock-market jumps initiate recessions – hence the negative correlation with GDP growth (and leading indicator property)

But stock-market jumps hard to predict 3+ months out – hence the flatish variance swap slope 3+ months ahead

Similar to extreme weather (or earthquakes) – damaging (possibly for many years) but very predict 3+ months out

25 Years Later: The legacy of the Loma Prieta quake at Stanford

When the Loma Prieta earthquake shook campus 25 years ago it damaged campus structures and forced students and classes to relocate. Once they'd cleared the rubble, faculty and students took up the challenge of devising better methods for understanding the physics of earthquakes, and designing buildings that could withstand the powerful forces.

AT THE EPICENTER OF LOMA PRIETA

On a recent fall morning, Stanford geophysicist Greg Beroza hiked through the Forest of Nisene Marks State Park to arrive at a brown signpost on which the word "Epicenter" was printed in all caps. Today, the marker is the only indication that this tranquil redwood forest, located about 10 miles from Santa Cruz, Calif., was the source of the largest earthquake to strike the Bay Area in more than 80 years. But in 1989, the 6.9-magnitude Loma Prieta quake that originated approximately 10 miles beneath this signpost triggered landslides throughout the forest and violently shook and even toppled trees. "These tall redwoods like the one to my left were here in 1989, and they would have shaken like crazy," Beroza said. "It would have been quite a ride for anything that was up in the treetops."

Beroza, a professor in the School of Earth Sciences, is

SHOW MORE

Puzzle

Two explanations

Excluded uncertainty?

Two other types of uncertainty also appear to rise and good to think how these fit in

Micro uncertainty (industries, firms, plants and products)

Knightian uncertainty (more diffuse Bayesian priors rather than increased stochastic volatility)

Empirics suggest the economy is ‘fractal’ - micro uncertainty also rises at every level in recessions

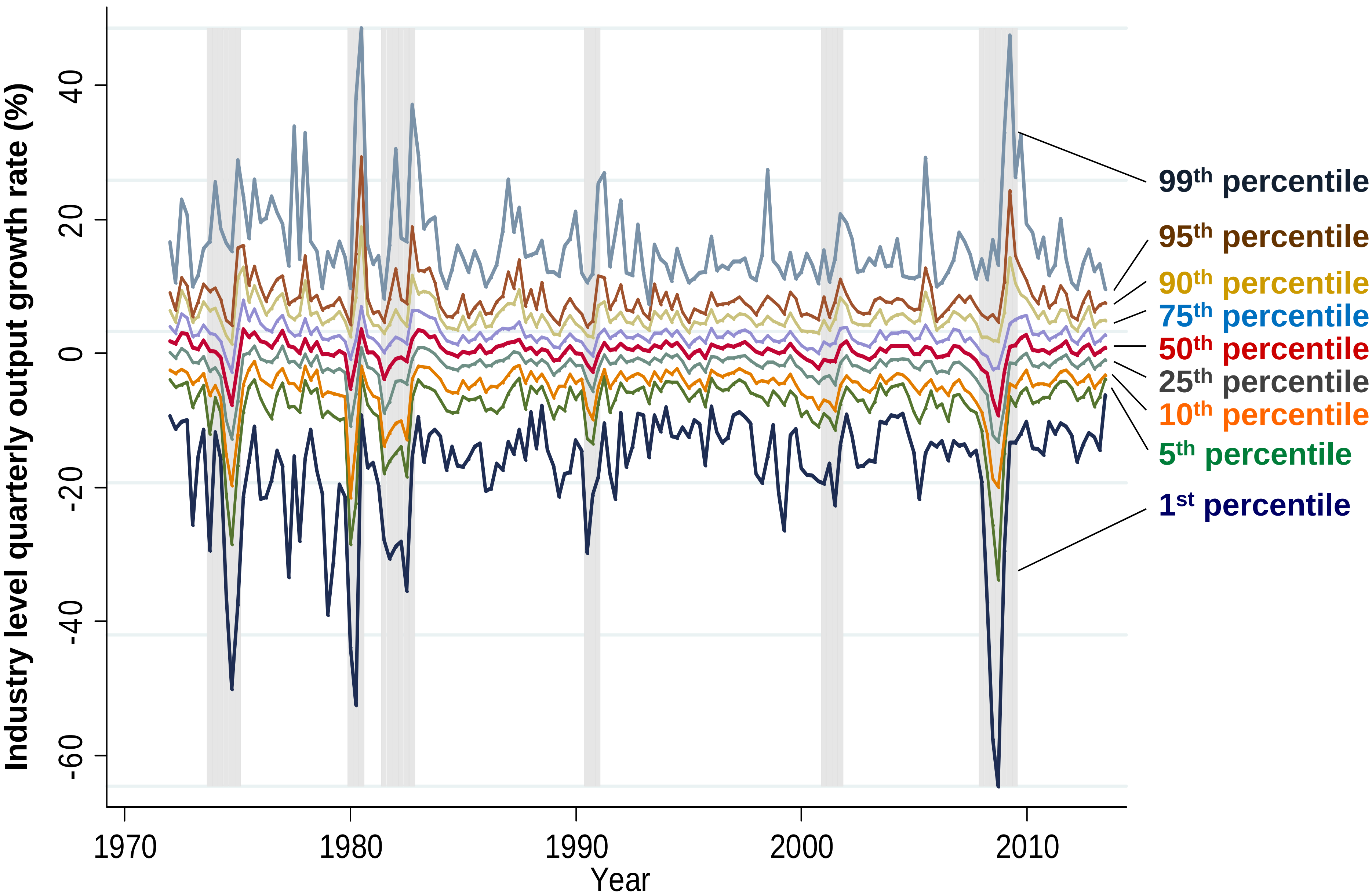
$$\underbrace{y_{j,t}}_{\text{Output}} = \underbrace{A_{,t}}_{\text{Aggregate Productivity}} * \underbrace{z_{j,t}}_{\text{Idiosyncratic Productivty}} * \underbrace{k_{j,t}^{\alpha} n_{j,t}^{\nu}}_{\text{Production Function}}$$

Macro uncertainty

ro uncertainty: shocks more volatile in recessions at all levels

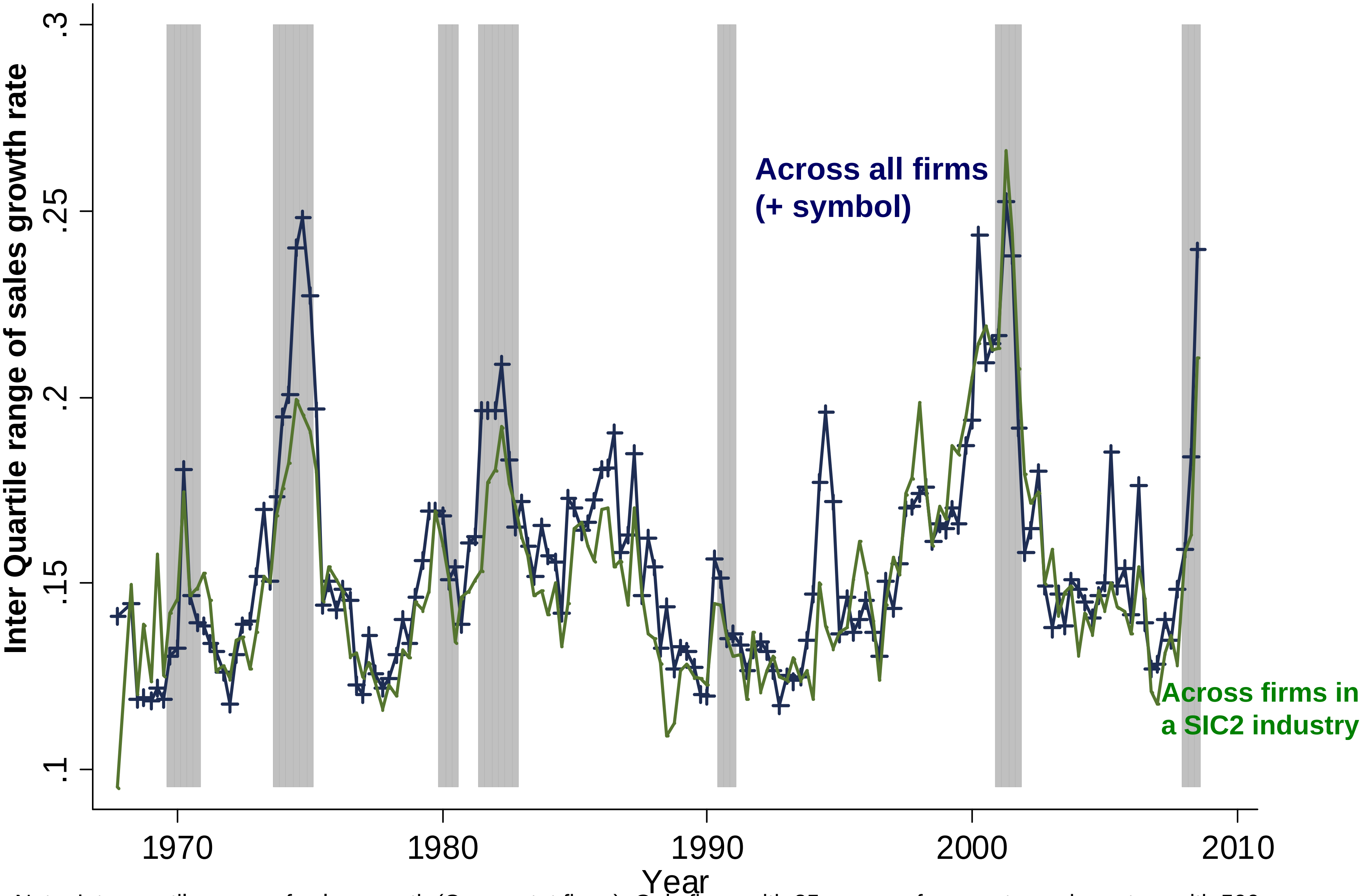
- industry
- firm
- plant
- product

Industry growth dispersion (by month)



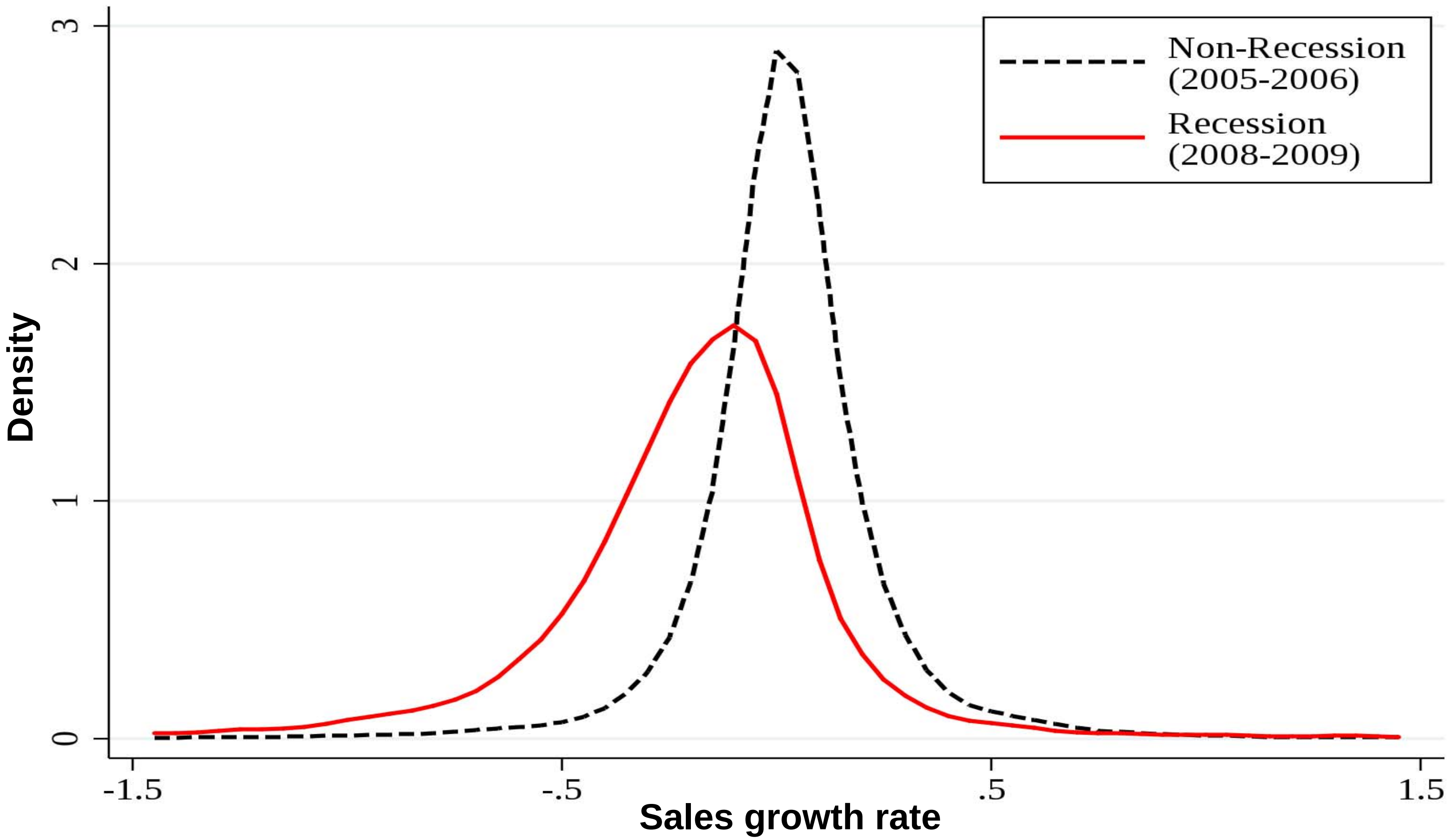
Note: 1st, 5th, 10th, 25th, 50th, 75th, 90th, 95th and 99th percentiles of 3-month growth rates of industrial production within each quarter. All 196 manufacturing NAICS sectors in the Federal Reserve Board database. Source: Bloom, Floetotto and Jaimovich (2009)

Firm growth dispersion (by quarter)



Note: Interquartile range of sales growth (Compustat firms). Only firms with 25+ years of accounts, and quarters with 500+ observations. SIC2 only cells with 25+ obs. SIC2 is used as the level of industry definition to maintain sample size. The grey shaded columns are recessions according to the NBER. Source: Bloom, Floetotto, Jaimovich, Saporta and Terry (2011)

Plant growth dispersion pre & during great recession

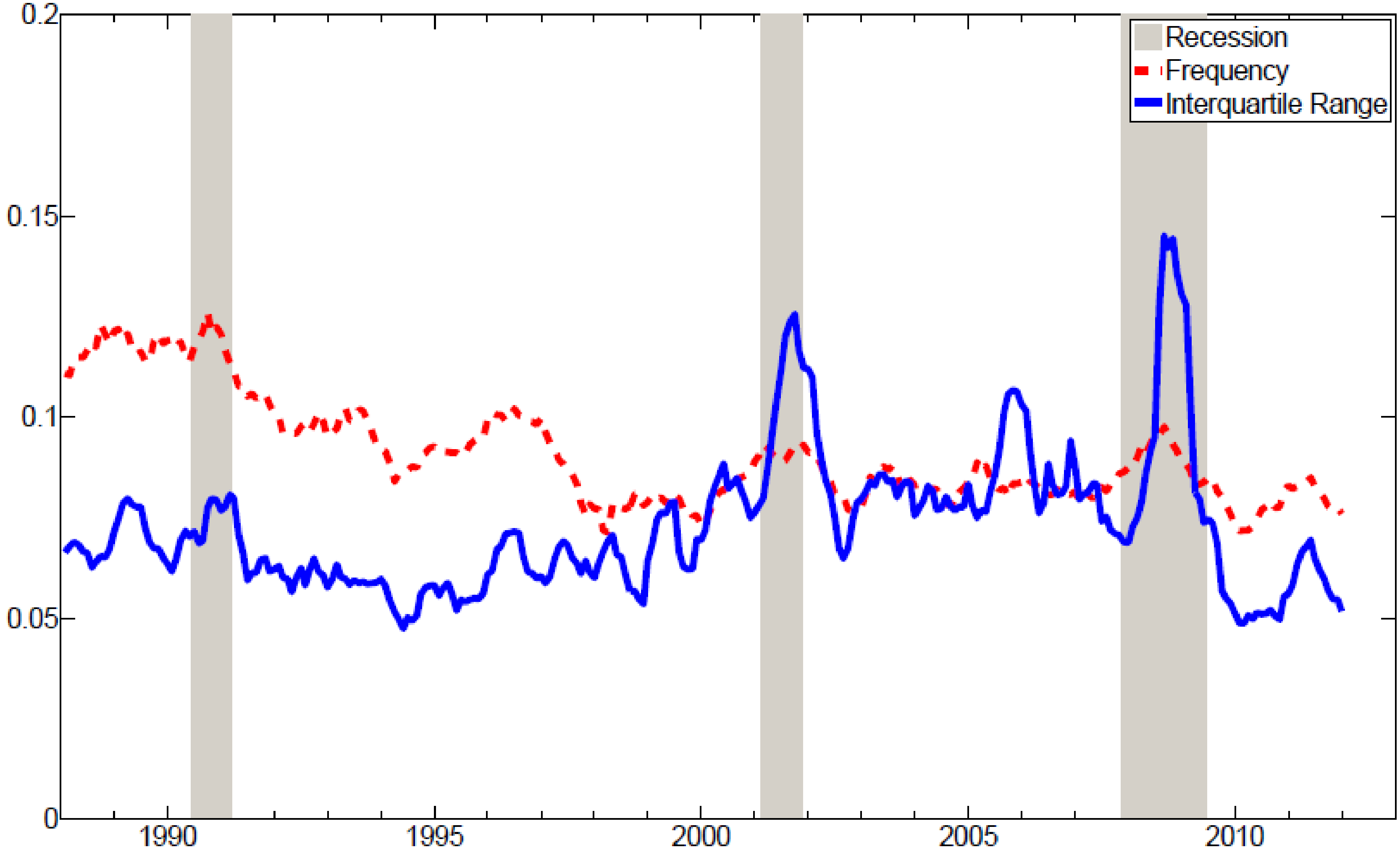


Source: “Really Uncertain Business Cycles” by Bloom, Floetotto, Jaimovich, Saporta and Terry (2012)

Notes: Constructed from the Census of Manufactures and the Annual Survey of Manufactures using a balanced panel of 15,752 establishments active in 2005-06 and 2008-09. Moments of the distribution for non-recession (recession) years are: mean 0.026 (-0.191), variance 0.052 (0.131), coefficient of skewness 0.164 (-0.330) and kurtosis 13.07 (7.66). The year 2007 is omitted because according to the NBER the recession began in December 2007, so 2007 is not a clean “before” or “during” recession year.

Product level price dispersion (by quarter)

Figure 1: Price Changes Across Time



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

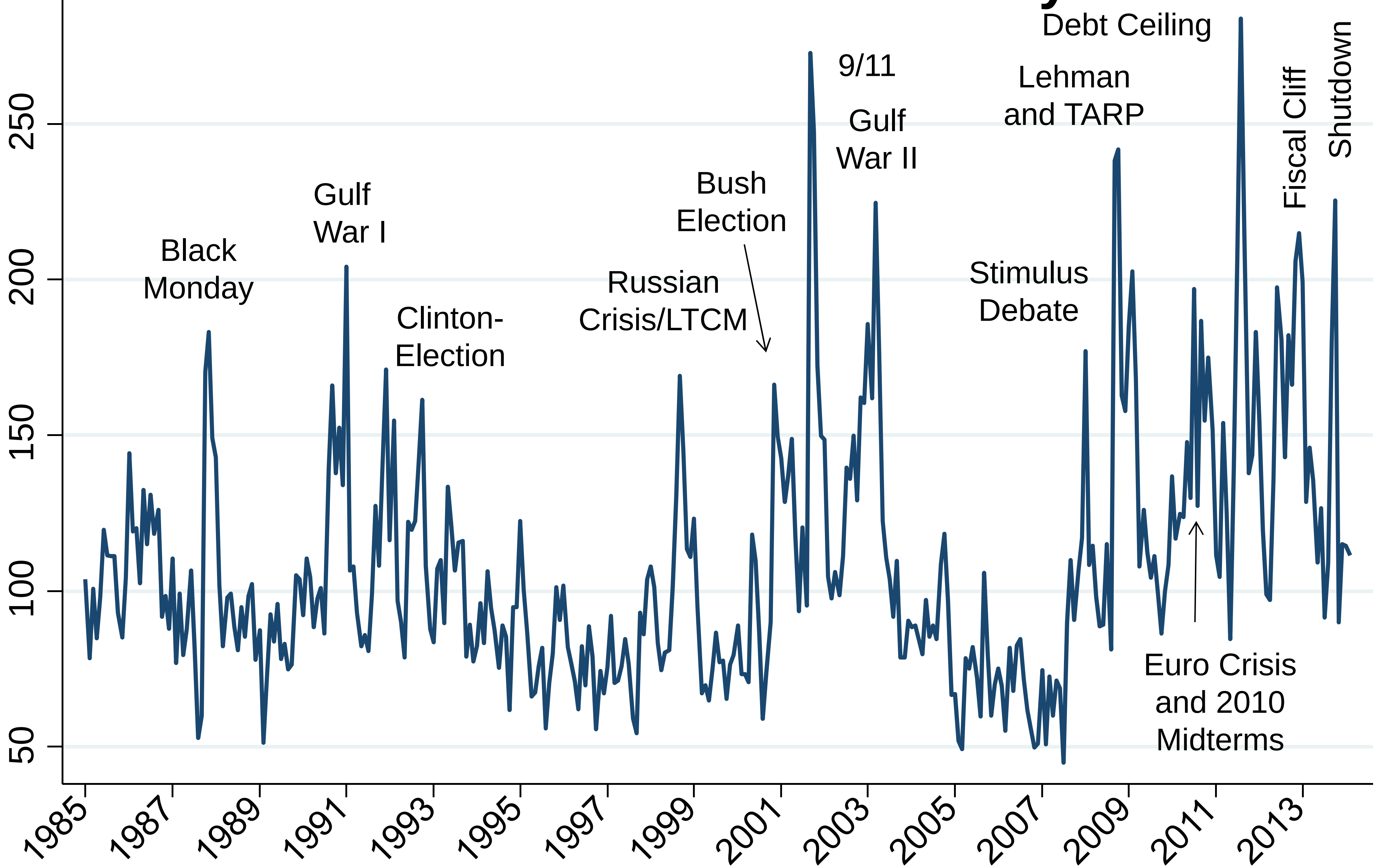
Source: Joe Vavra (2014, QJE) “Inflation dynamics and time varying volatility”

Two other types of uncertainty also appear to rise and good to think how these fit in

Micro uncertainty (industries, firms, plants and products)

Knightian uncertainty (more diffuse Bayesian priors rather than increased stochastic volatility)

Policy uncertainty somewhat ‘Knightian’, so may not show in raised stock-market volatility



Source: “Measuring Economic Policy Uncertainty” by Scott R. Baker, Nicholas Bloom and Steven J. Davis, all data at www.policyuncertainty.com. Data normalized to 100 prior to 2010.

So a really fantastic paper which uses a unique dataset to introduce a new stylized fact

The empirics were very careful and I believe the stylized fact

It poses a challenge for models with time varying uncertainty

They suggest one explanation – time varying recovery – which is possible, but I can see alternatives like “weather” model story

So the “what” seems well shown, but less clear on the “why”

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