The Macroeconomics of (time-varying) Uncertainty

Nick Bloom (Stanford & NBER)

CREI, December 2014

In these lectures I want to argue *uncertainty* is another potential driver of growth and cycles

Already many potential sources of growth and business cycles:

- Technology shocks
- Investment technology shocks
- Oil price shocks
- Labor supply shocks
- Monetary policy shocks
- Fiscal policy shocks
- Financial shocks
- News shocks

All of these are first moment (levels) shocks. I want to focus on second moment (uncertainty) shocks

One reason for the interest is policymakers talked a lot about uncertainty in the recent recessions

FOMC (October 2001) “increased uncertainty is depressing investment by fostering an increasingly widespread wait-and-see attitude about undertaking new investment expenditures

FOMC (April 2008)
“participants reported that uncertainty about the economic outlook was leading firms to defer spending projects until prospects for economic activity became clearer.”

FOMC (June 2009)
“participants noted elevated uncertainty was said to be inhibiting spending in many cases.”

FOMC (September 2010)
“A number of business contacts indicated that they were holding back on hiring and spending plans because of uncertainty about future fiscal and regulatory policies”

Famous economists also worry about uncertainty

Olivier Blanchard (January 2009)
"Uncertainty is largely behind the dramatic collapse in demand. Given the uncertainty, why build a new plant, or introduce a new product now? Better to pause until the smoke clears."

Christina Romer (April 2009)
"Volatility has been over five times as high over the past six months as it was in the first half of 2007. The resulting uncertainty has almost surely contributed to a decline in spending."

Larry Summers (March 2009)
"…unresolved uncertainty can be a major inhibitor of investment. If energy prices will trend higher, you invest one way; if energy prices will be lower, you invest a different way. But if you don't know what prices will do, often you do not invest at all."

And ex-policymakers are still talking about it…..

Activism

Alan Greenspan

Abstract

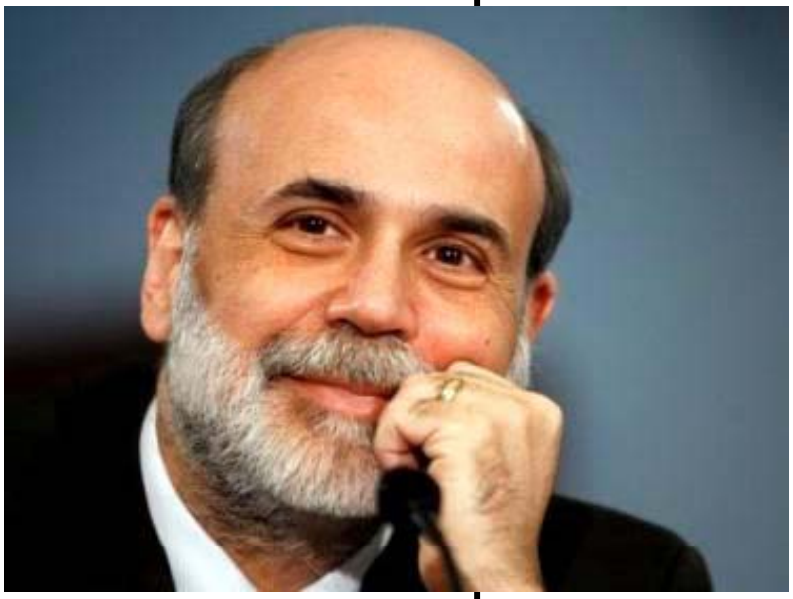
The US recovery from the 2008 financial and economic crisis has been disappointingly tepid. What is most notable in sifting through the variables that might conceivably account for the lacklustre rebound in GDP growth and the persistence of high unemployment is the unusually low level of corporate illiquid long-term fixed asset investment. As a share of corporate liquid cash flow, it is at its lowest level since 1940. This contrasts starkly with the robust recovery in the markets for liquid corporate securities. What, then, accounts for this exceptionally elevated level of illiquidity aversion? I break down the broad potential sources, and analyse them with standard regression techniques. I infer that a minimum of half and possibly as much as three-fourths of the effect can be explained by the shock of vastly greater uncertainties embedded in the competitive, regulatory and financial environments faced by businesses since the collapse of Lehman Brothers, deriving from the surge in government activism. This explanation is buttressed by comparison with similar conundrums experienced during the 1930s. I conclude that the current government activism is hampering what should be a broad-based robust economic recovery, driven in significant part by the positive wealth effect of a buoyant U.S. and global stock market.

…..and pre-policymakers were long ago talking about it….

IRREVERSIBILITY, UNCERTAINTY, AND CYCLICAL INVESTMENT*

BEN S. BERNANKE

This paper builds on the theory of irreversible choice under uncertainty to give an explanation of cyclical investment fluctuations. The key observation is that, when individual projects are irreversible, agents must make investment timing decisions that trade off the extra returns from early commitment against the benefits of increased information gained by waiting. In an environment in which the underlying stochastic structure is itself subject to random change, events whose long-run implications are uncertain can create an investment cycle by temporarily increasing the returns to waiting for information.



But I suggest that the essential character of the trade cycle . . . is mainly due to the way in which the marginal efficiency of capital fluctuates . . . . (T)he marginal efficiency of capital depends, not only on the existing abundance or scarcity of capital-goods and the current cost of production of capital-goods, but also on current expectations as to the future yield of capital-goods . . . . But, as we have seen, the basis for such expectations is very precarious. Being based on shifting and unreliable evidence, they are subject to sudden and violent changes.

Keynes, *The General Theory*, Ch. 22.

QJE, February 1983

So this is an old idea which seems to have been particularly important in the Great Recession

DISENTANGLING THE CHANNELS OF THE 2007-2009 RECESSION

James H. Stock
Mark W. Watson

Working Paper 18094
http://www.nber.org/papers/w18094

Consider the recession period, 2007Q4-2009Q2. The largest negative shock contributions to the drops in GDP and employment are seen in the financial shock measures (liquidity/risk and uncertainty shocks). The composite uncertainty/liquidity shock based on the first principal component of the five estimated shocks in this category attributes approximately two-thirds of the recession's decline in GDP and employment to financial factors (6.2 of 9.2 percentage points and 4.5 of 7.3 percentage points, respectively).

Uncertainty has also been in the media a lot

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How to make Europe's incipient recovery durable: End policy uncertainty

Marco Buti, Pier Carlo Padoan, 12 September 2013

The Eurozone is recovering but the revival is fragile – ringed by downside risks. This column argues that three steps – reducing policy uncertainty, repairing the financial system, and creating new investment opportunities – are essential. They could switch the negative confidence-growth feedback loop into a positive one, thus paving the way to robust medium-term growth. There is no room for complacency or procrastination.

108

When leaders met for the G20 Summit in Saint Petersburg last weekend, they welcomed the incipient recovery in the Eurozone. However, they also recognised that "despite our actions the [global] recovery is too weak" and fraught with risks. This is particularly relevant for the Eurozone, firstly because GDP growth in the area itself is still very weak and uneven, and secondly because, in the current external macroeconomic environment, the Eurozone economy

Related

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Laurence Boone, Céline Renucci, Ruben Segura-Cayuela

Returning to growth in the UK: Policy lessons from history
Nicholas Crafts

Marco Buti
Director General, DG Economic and Financial Affairs, European Commission

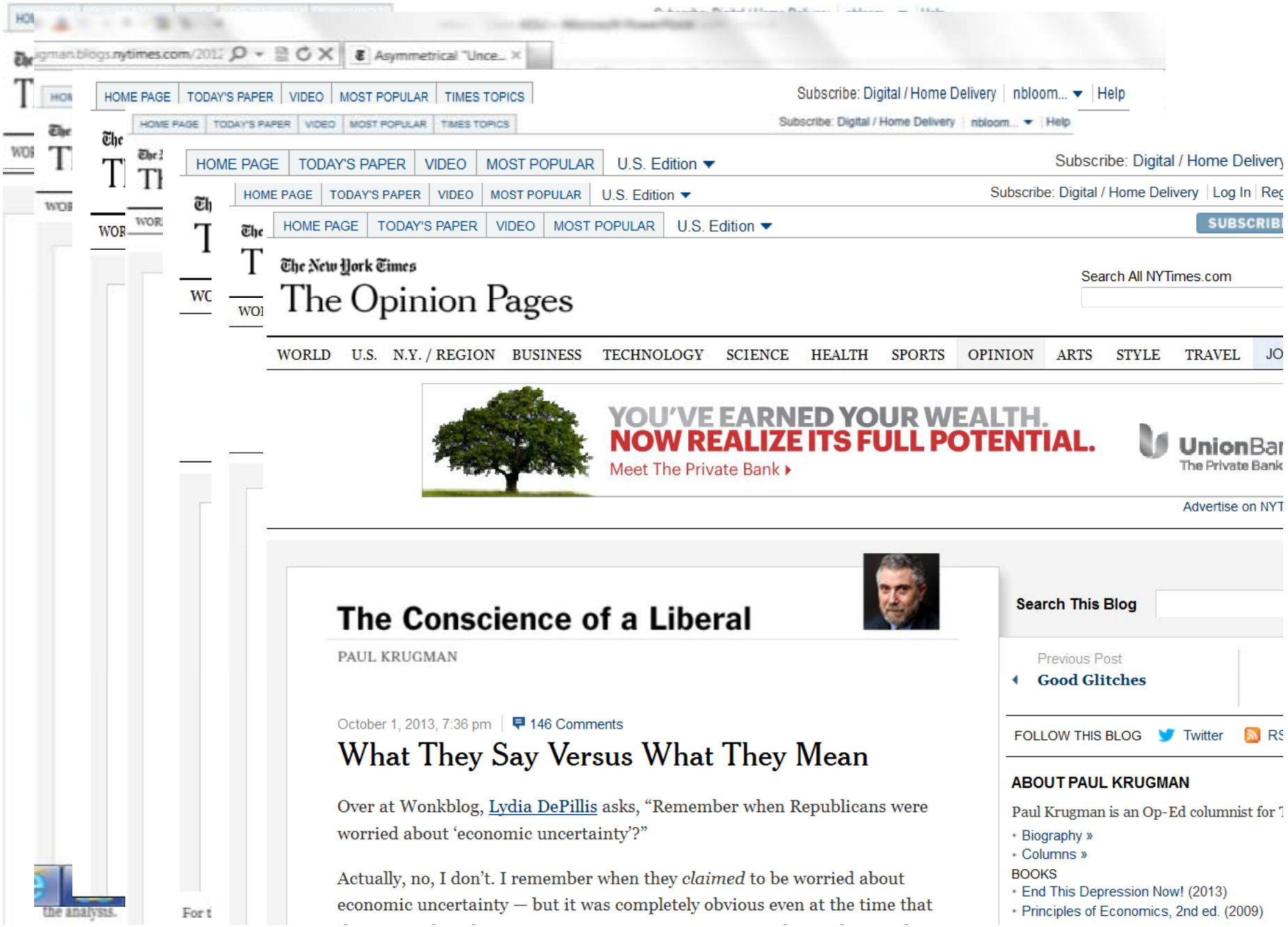
Pier Carlo Padoan
OECD Deputy Secretary-General and Chief Economist

Welcome. If you
asked to do so b

So it is hard to escape the interest in uncertainty as a factor behind the Great Recession

But, for some people the best evidence that uncertainty matters is that….

….Paul Krugman thinks it does not



So given all this policy and media interest not surprisingly there has been a surge of research

At a recent Chicago event Lars Hansen and I discussed why:

1. Great Recession: generated a large spike in uncertainty, ending the Great Moderation (1984-2007)

2. Faster computers: can run models with higher moments

3. More data: high-frequency trading, surveys, text-search etc

Hansen

So I see the renewed interest as likely to be permanent

Bloom

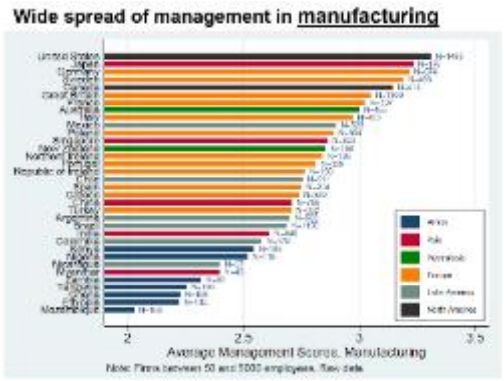
In these lectures I will discuss three areas

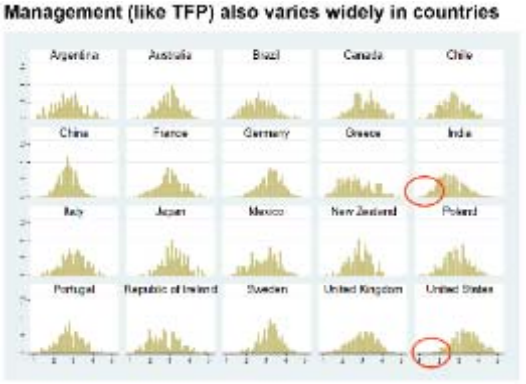
1. Measurement (Today): No one killer measure of uncertainty, but emerging stylized fact that uncertainty rises in recessions

2. Theory (Tomorrow): Generally in good shape, with a rich set of models identifying many channels of uncertainty impact

3. Empirics (Friday, 1st half): Less conclusive - my view is this goes in both directions: uncertainty ↔ growth

On Friday in the 2nd half I'll talk about Management practices





Lecture 1: Measuring Uncertainty

“Uncertainty” literature often rolls uncertainty & risk together, but theoretically they are distinct

Frank Knight (1921) defined:

Risk: A known probability distribution over events.

Example: A coin-toss

Uncertainty (Knightian): Unknown probability distribution

Example: Number of coins produced since 2000BC

In practice these are linked, so for simplicity I’ll refer to both as “uncertainty” (as has in fact most of the literature)

There are four stylized facts on uncertainty

1) **Macro uncertainty appears countercyclical**

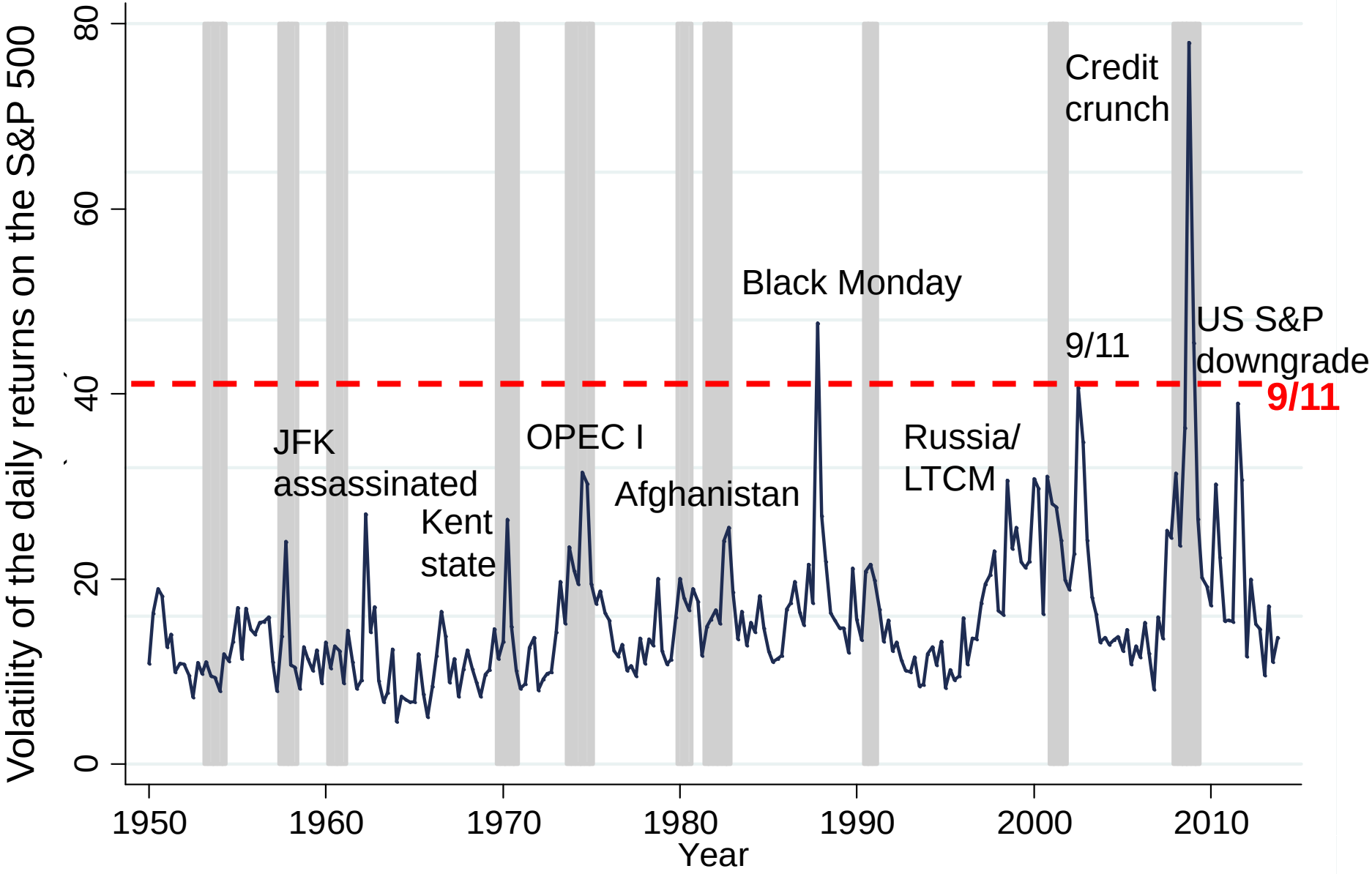
2) Micro firm uncertainty appears countercyclical

3) Higher micro moments appear *not* to be cyclical?

4) Uncertainty is higher in developing countries

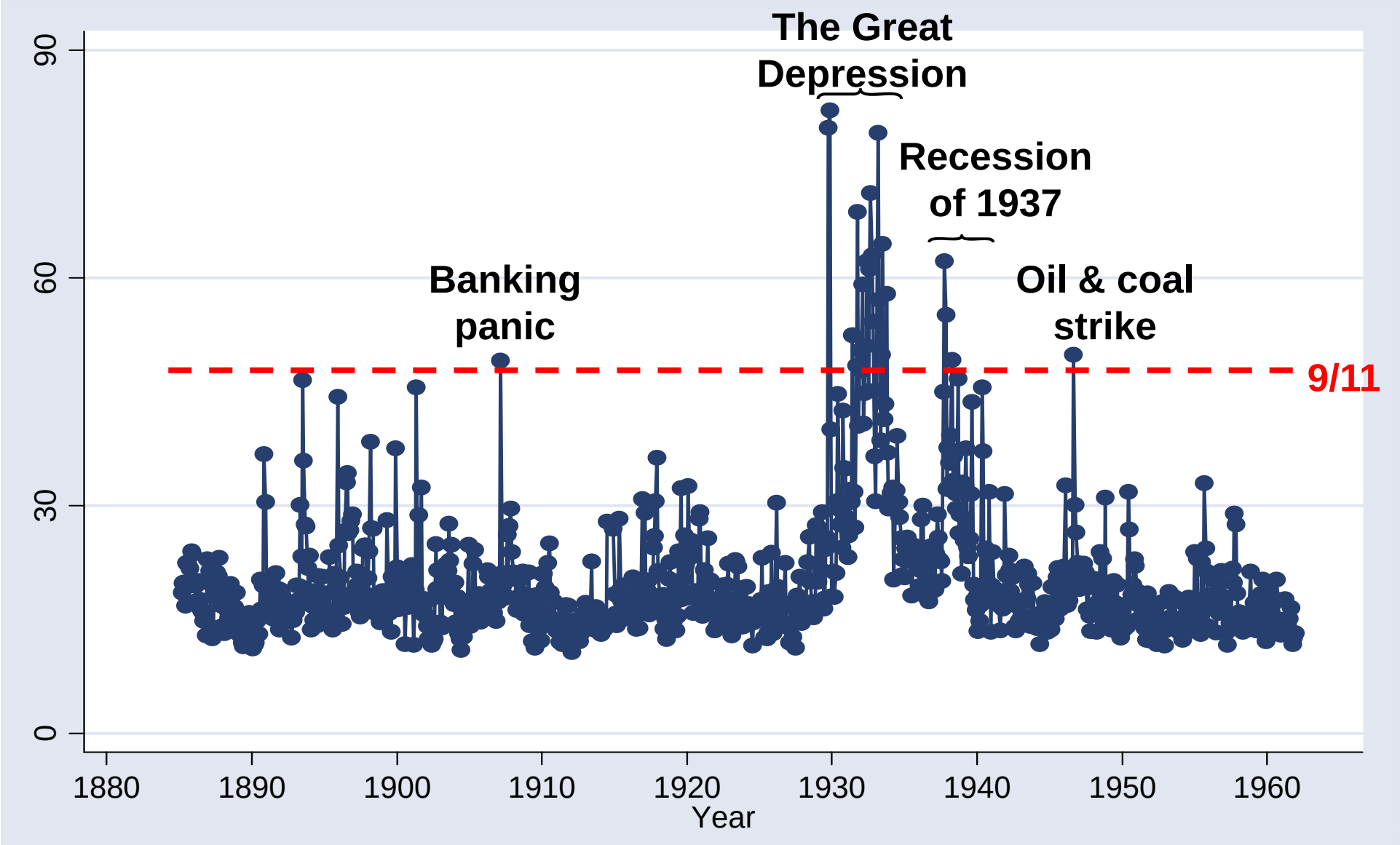
Uncertainty is hard to measure (it is not directly observed) – so I will show several proxies

Stock returns realized volatility (back to 1950)



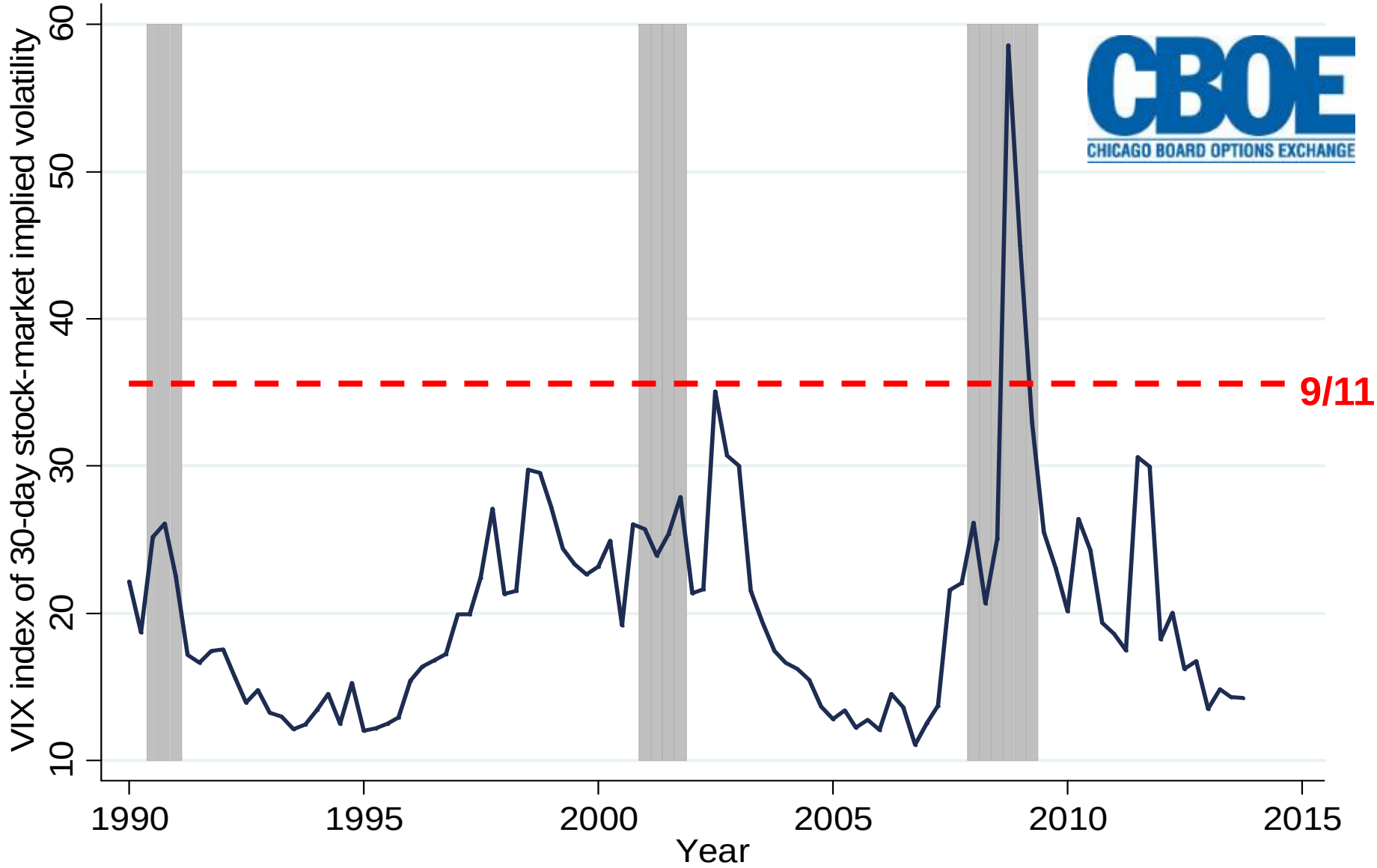
Source: Monthly volatility of the daily returns on the S&P500 at an annualized level. Grey bars are NBER recessions. Data spans 1950Q1-2013Q4.

Stock returns realized volatility (back to 1880)



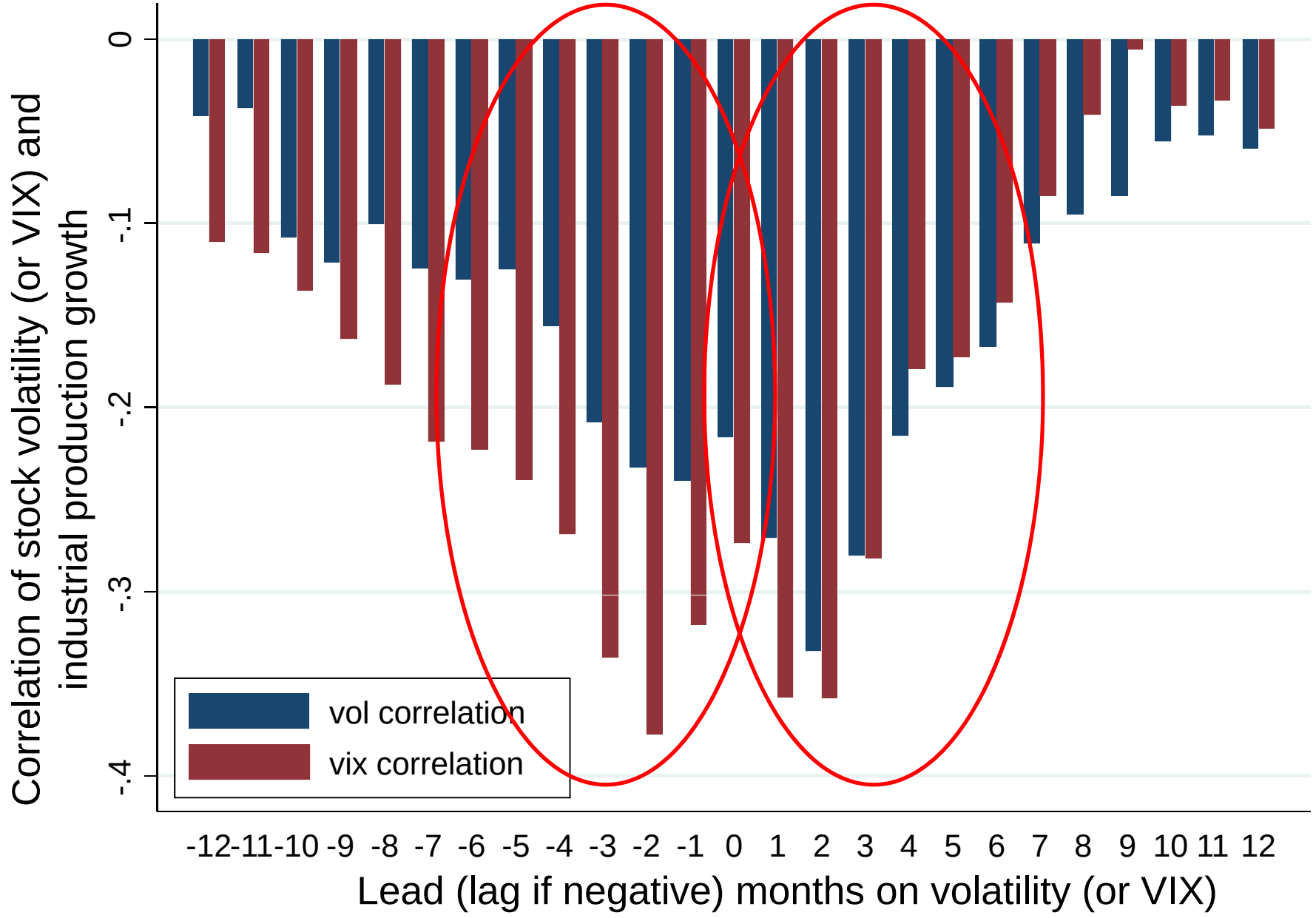
Source: Volatility of the daily returns index from "Indexes of United States Stock Prices from 1802 to 1987" by Schwert (1990). Contains daily stock returns to the Dow Jones composite portfolio from 1885 to 1927, and to the Standard and Poor's composite portfolio from 1928 to 1962. Figures plots monthly returns volatilities calculated as the monthly standard-deviation of the daily index, with a mean and variance normalisation for comparability following exactly the same procedure as for the actual volatility data from 1962 to 1985 in figure 1.

VIX, the 1-month ahead implied S&P500 volatility



Source: VIX is the implied volatility on the S&P500, averaged to the quarterly level, provided by the Chicago Board of Options and Exchange. The VIX is the markets implied level of stock-market volatility over the next 30-days, where values are in standard-deviations on the S&P 500 at an annualized level. Grey bars are NBER recessions. Data spans 1990Q1-2013Q4.

Stock-volatility and VIX lead and lag the cycle



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

Interestingly, volatility now at very low levels

Global Macro Research

Top of Mind

Goldman Sachs

June 25, 2014 Issue 24

Volatility: Lower for longer?

From the editor: The decline in economic and asset market volatility this year from already low levels in 2013 has been striking. Questions about how long this low volatility can last – and the impact it will have – are Top of Mind. We interview three experts to assess if low vol is breeding the same complacency and excessive risk-taking that led to crises past. Our own Charlie Himmelberg is relatively sanguine that the credit cycle will play out, but likely not for a long time; Markus Brunnermeier and Nicholas Bloom are somewhat more concerned, but not for the same reasons. We assert that low asset vol is consistent with the current phase of the business cycle and discuss investment implications should low vol persist (cheap options, but scarcer trading opportunities, and a need for active managers to focus more on stock-picking). We also ask what could push vol higher (interest rate and geopolitical risk – the latter (kind of) playing out in oil).

Inside

Another measure is policy uncertainty – which I have a paper I am currently working on

Measuring Economic Policy Uncertainty

Scott R. Baker[a], Nicholas Bloom[b], and Steven J. Davis[c]

December 2014

Abstract: We develop a new index of economic policy uncertainty (EPU) based on a range of indicators, including the frequency of newspaper references to policy uncertainty. Our index spikes near tight presidential elections, after the Gulf wars, the 9/11 attack, the Lehman bankruptcy, and during the 2011 debt ceiling debate. Several pieces of evidence – including a human audit of 5,000 newspaper articles – indicate that our EPU index offers a good proxy for movements in policy-related economic uncertainty over time. Using micro data, we investigate the effects of EPU on investment and hiring, finding negative effects for firms heavily exposed to government contracts. At the macro level, positive innovations in our EPU index foreshadow declines in investment, output and employment in VAR models. Extending our measurement efforts back to 1900, we find that EPU rose dramatically in the Great Depression, but only from 1932 onwards when Hoover and then Roosevelt initiated a period of intense policy activism. We also find a secular rise in policy uncertainty since the 1960s, coincident with government fiscal and regulatory expansion.

We build a news-based policy uncertainty indicator

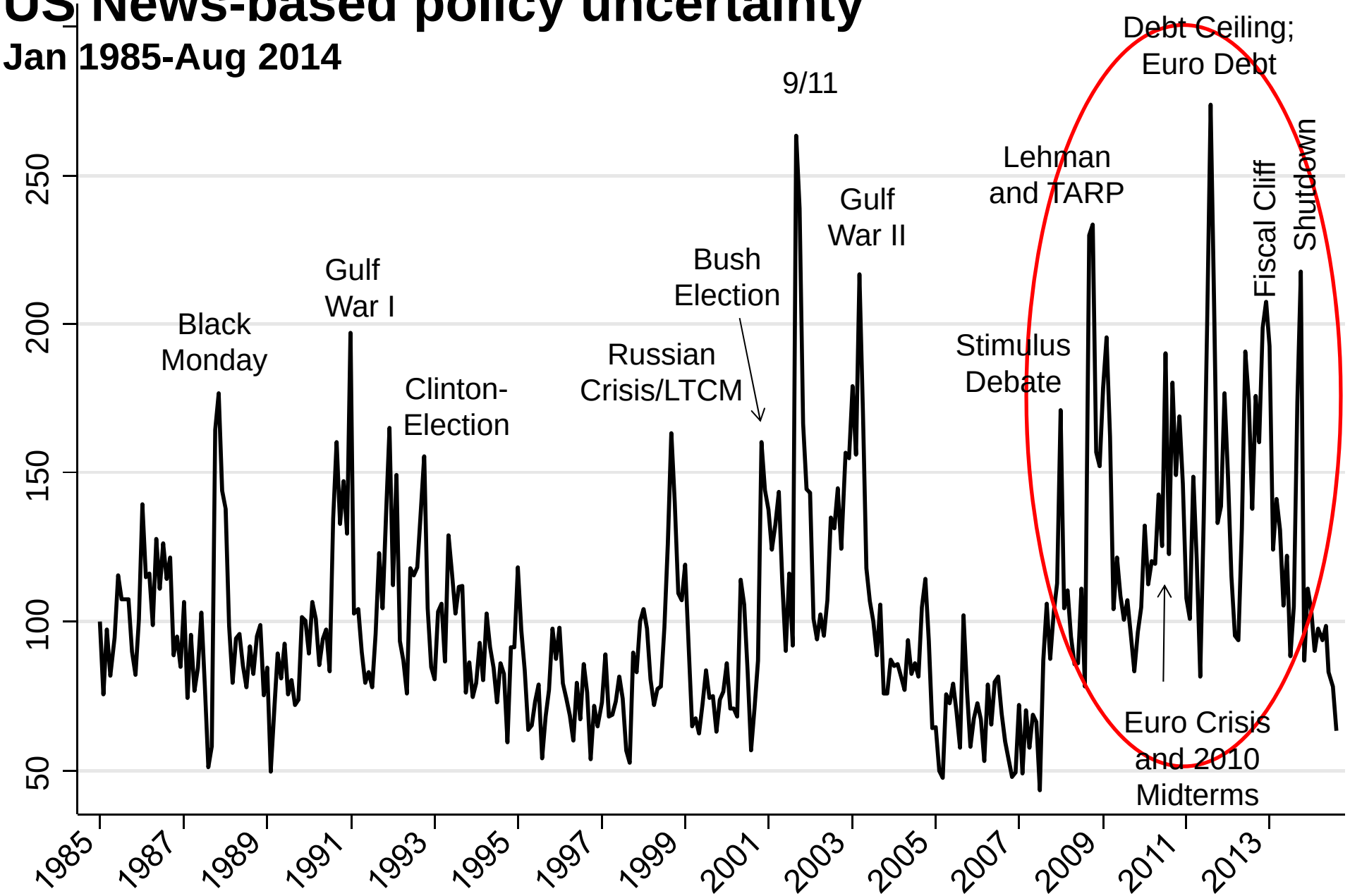
US Newspapers:

- Boston Globe
- Chicago Tribune
- Dallas Morning News
- Los Angeles Times
- Miami Herald
- New York Times
- SF Chronicle
- USA Today
- Wall Street Journal
- Washington Post

Basic idea is to search for frequency of words like econom* and uncert* in newspapers

US News-based policy uncertainty

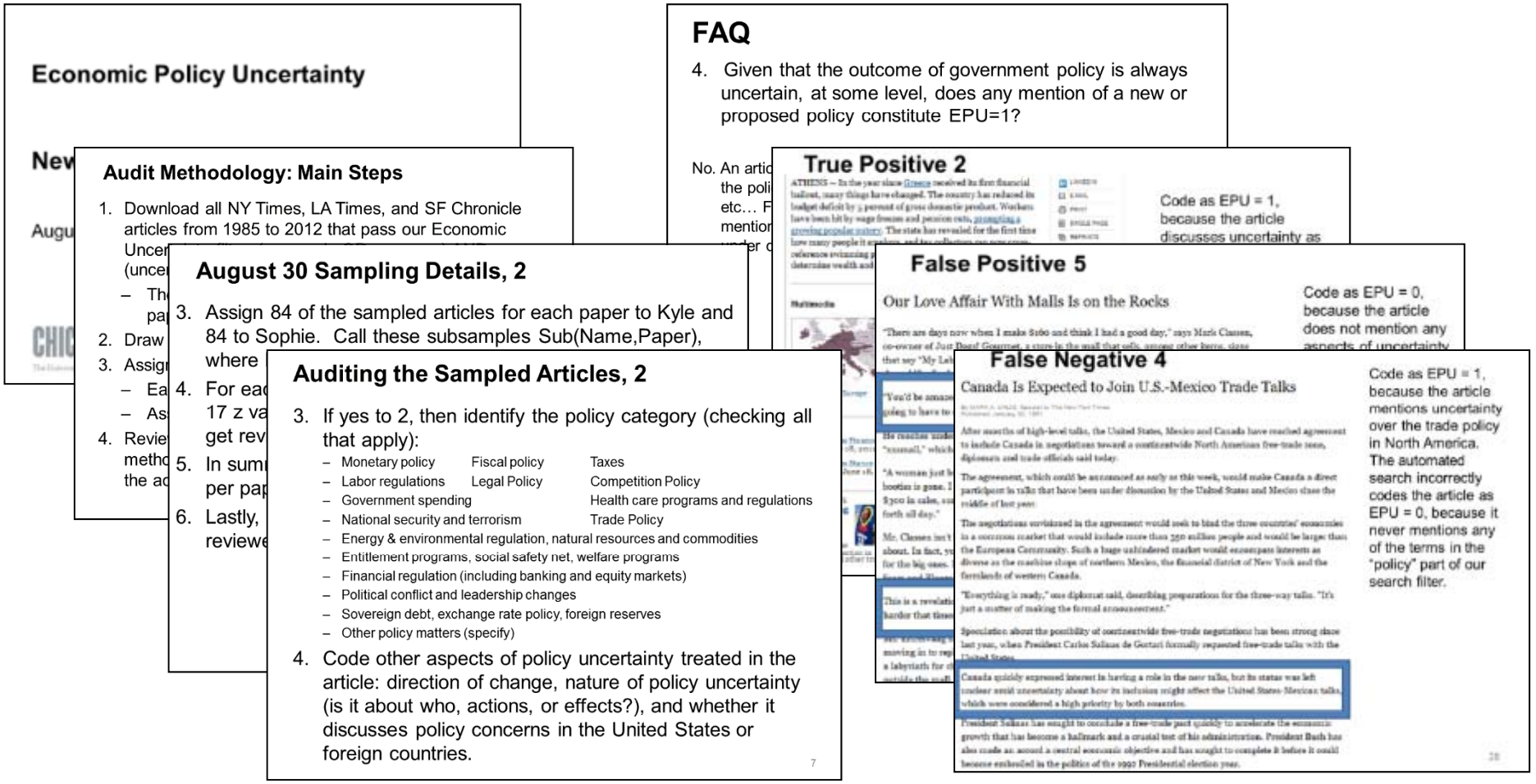
Jan 1985-Aug 2014



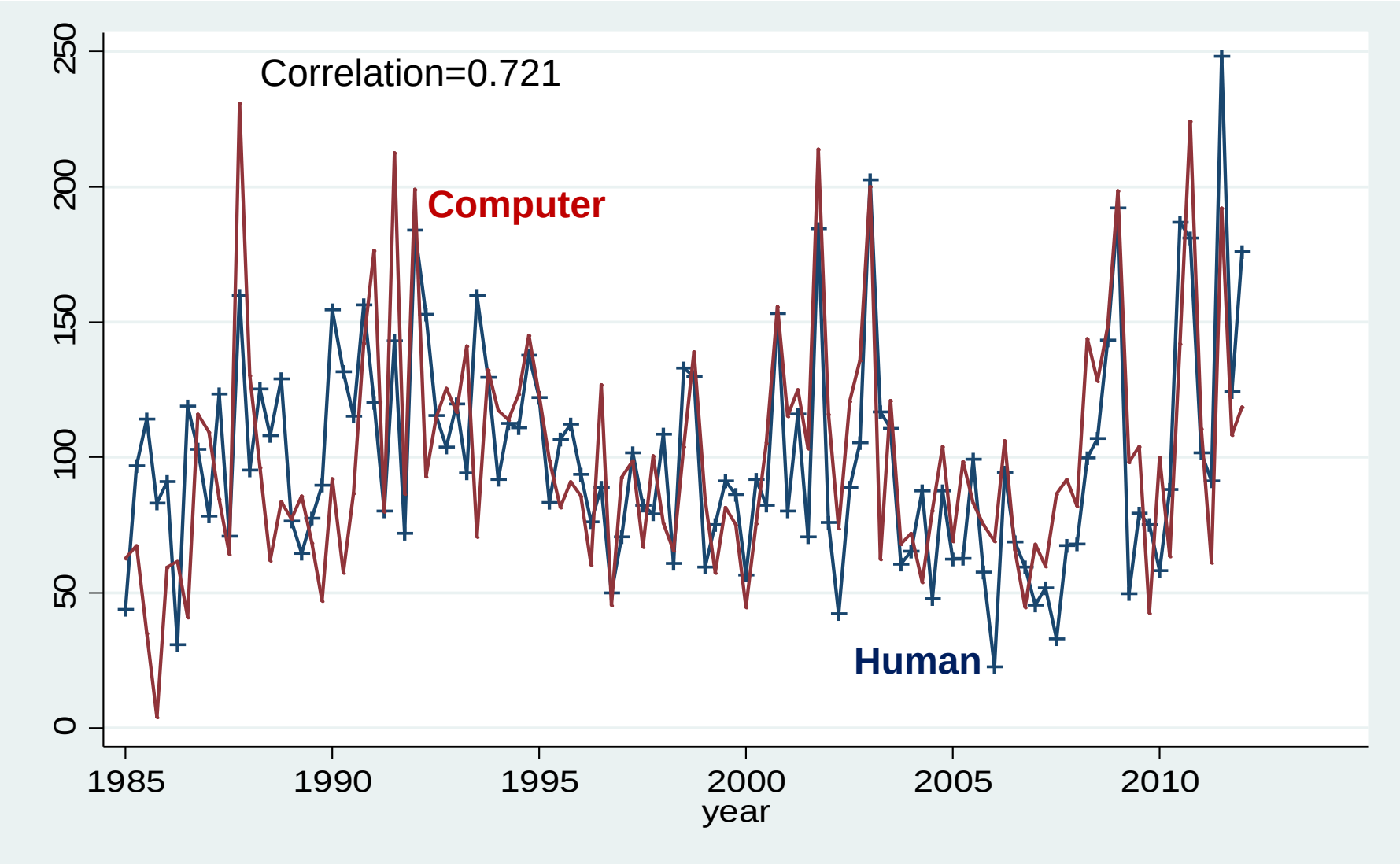
Source: “Measuring Economic Policy Uncertainty” by Scott R. Baker, Nicholas Bloom and Steven J. Davis, all data at www.policyuncertainty.com. Data normalized to 100 prior to 2010.

Worried about using computer news search data?

10 undergraduates read ≈ 10,000 newspaper articles to date using a 63-page audit guide to code articles if they discuss "economic uncertainty" and "economic policy uncertainty"

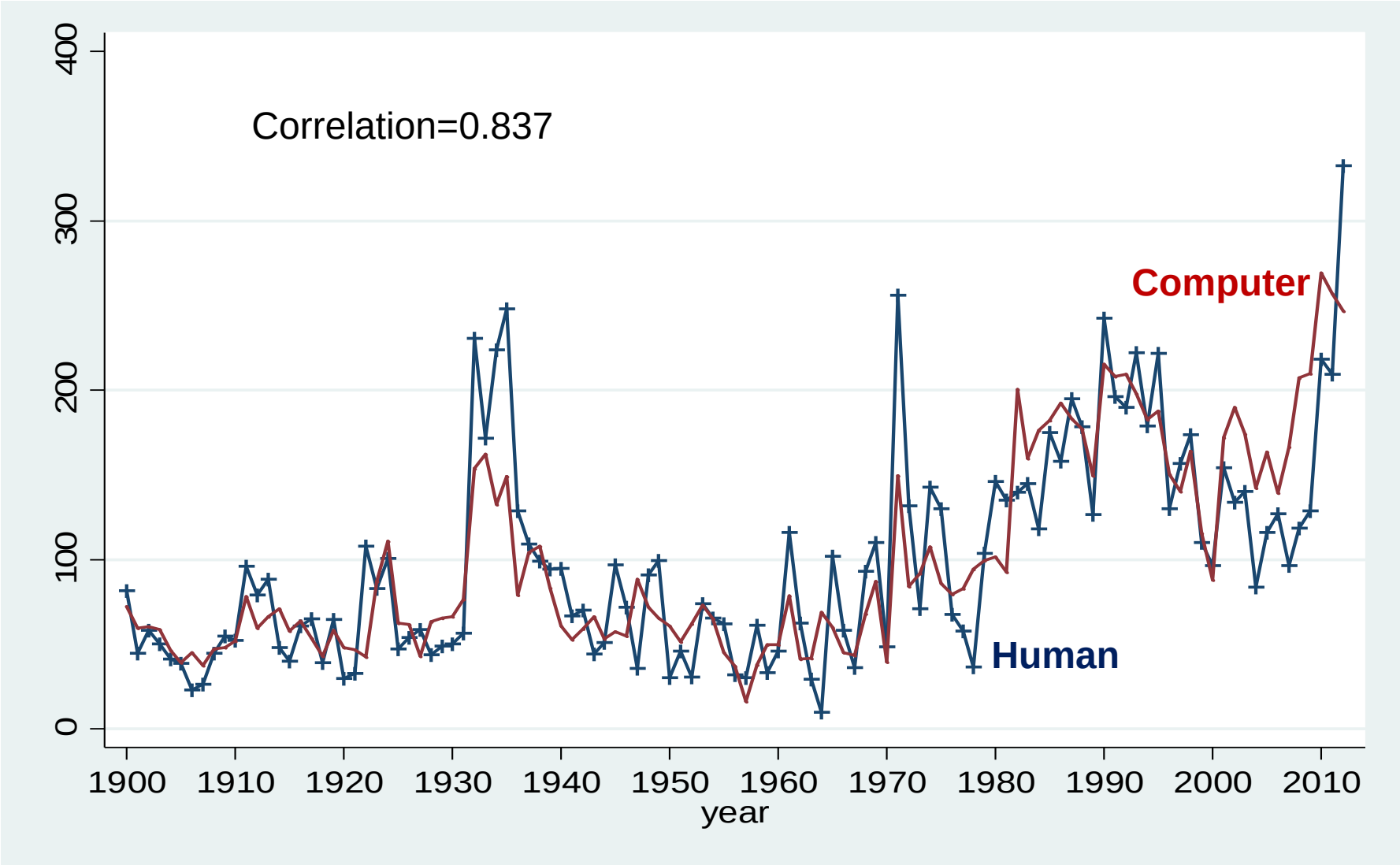


Find humans and computers give similar results in large samples: quarterly from 1985



Human index based on audit of 3891 articles (34.7 per month) in the LA Times, New York Times, Miami Herald and SF Chronicle (the five papers we could audit from 1985 to 2012).

Find humans and computers give similar results in large samples: yearly from 1900



Human index based on audit of 3727 articles (ave=34 per year) in the LA Times and New York Times (the two papers we could audit from 1900 to 2012) versus the historical index for these two papers.

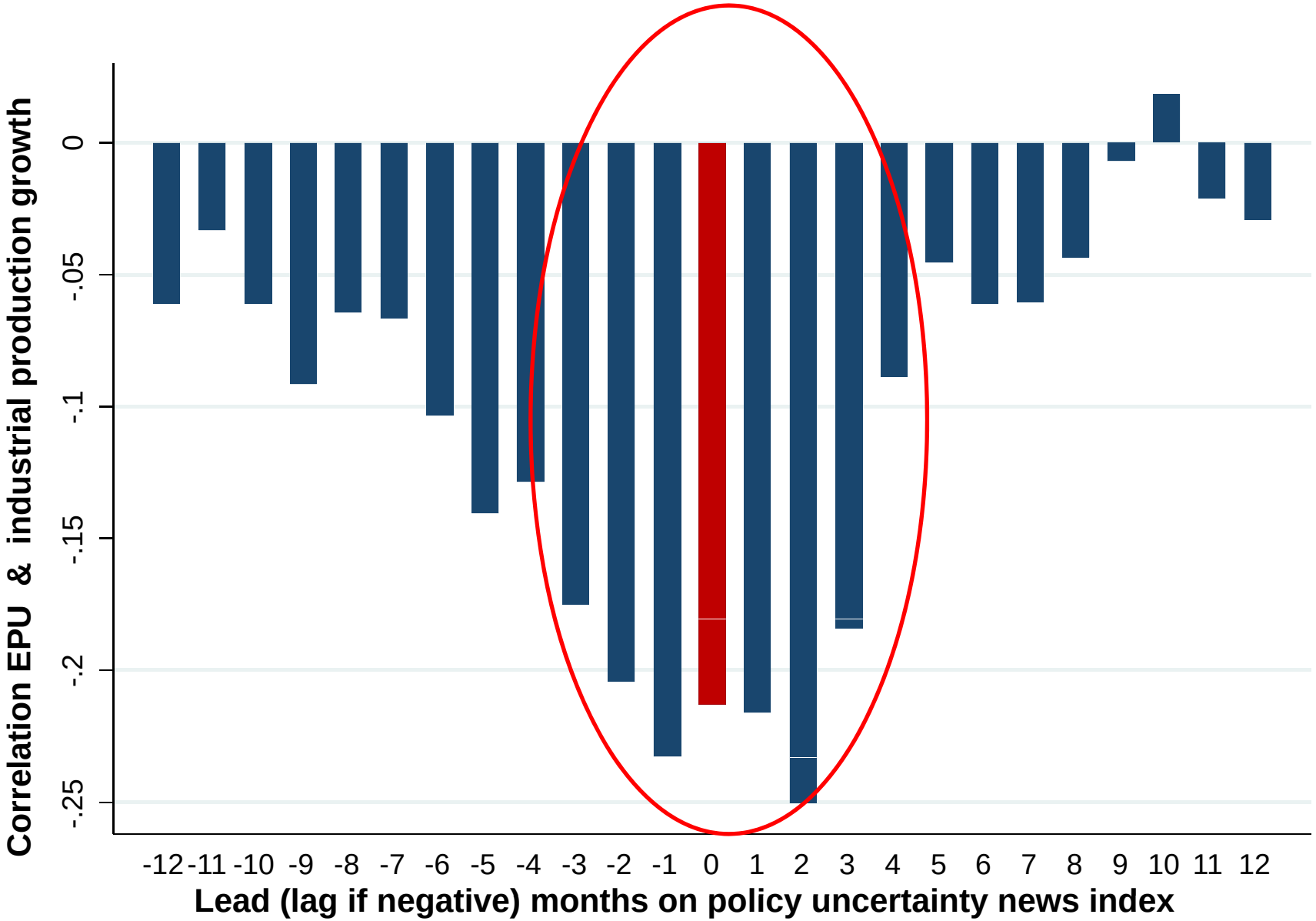
News searches can breakdown uncertainty by topic

SHARE OF POLICY UNCERTAINTY ARTICLES BY TOPIC, %

	1985-2007	2008-2012	Change
Taxes	35.2	61.1	25.9
Health care	12.7	33.3	20.6
Regulation	14.9	28.4	13.6
Social Security	10.3	19.4	9.1
Government spending	15.0	23.9	8.9
Sovereign debt, currency cris	1.4	2.8	1.4
Monetary policy	29.0	27.6	-1.5
National security	25.3	19.9	-5.4

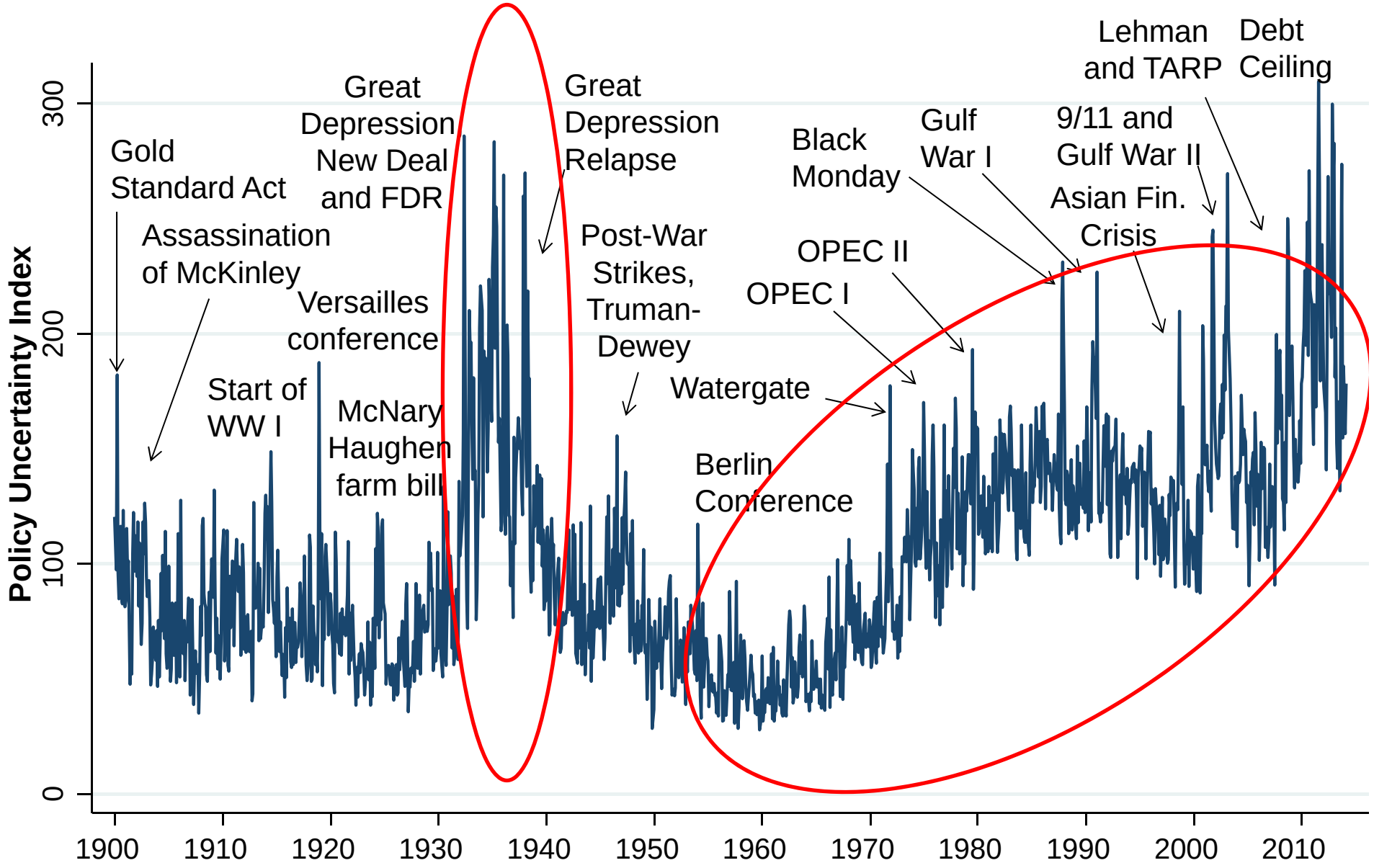
Note: Analysis uses Newsbank coverage of around 1000 US national and local newspapers
See Table 1 in the Baker, Bloom and Davis (2013) for a more detailed analysis.

Policy Uncertainty also leads and lags the cycle



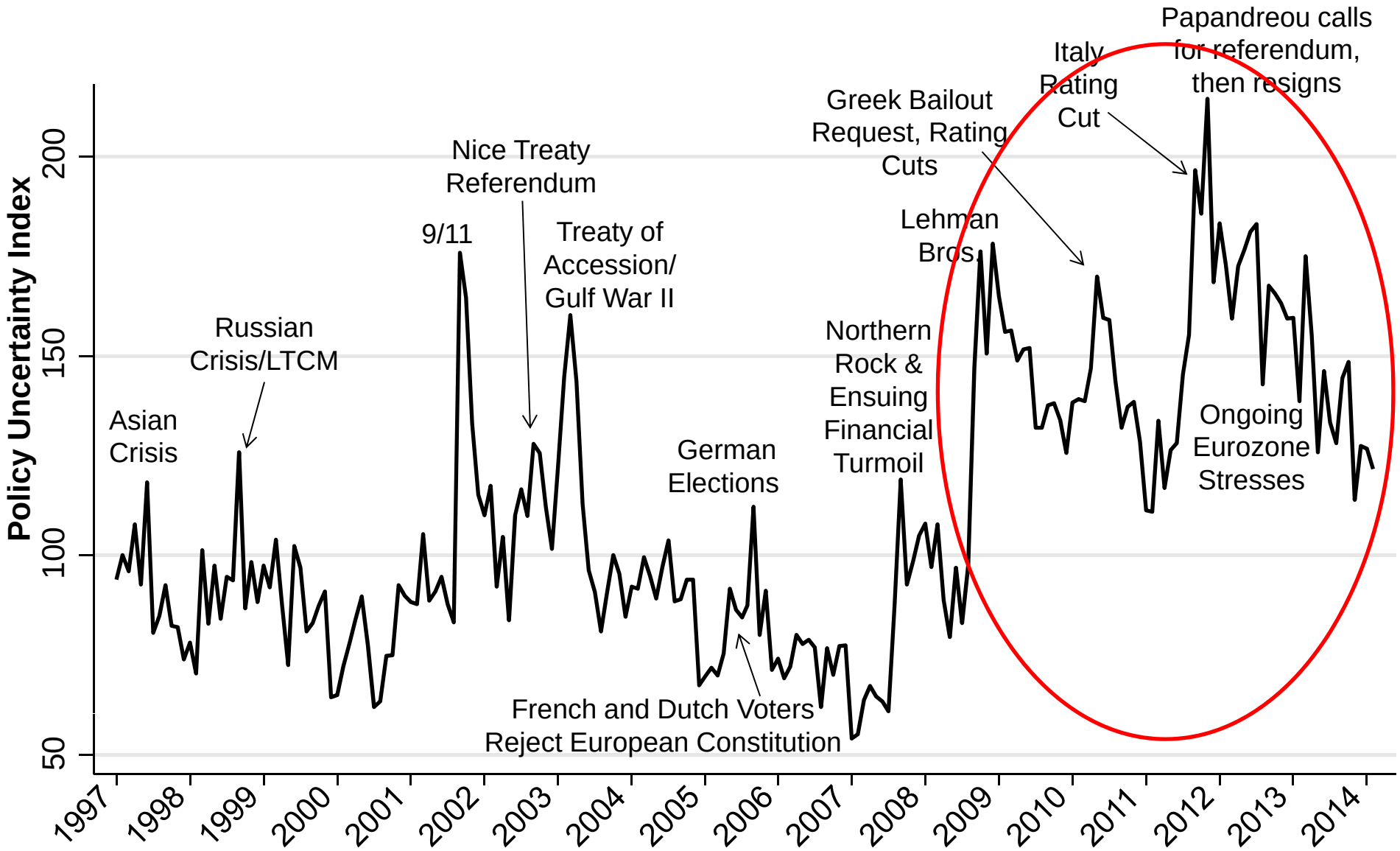
Source: Economic Policy Uncertainty Index from www.policyuncertainty.com. Industrial production monthly data from Federal Reserve Board. Data from 1985 onwards.

News based measures are useful back in time - US



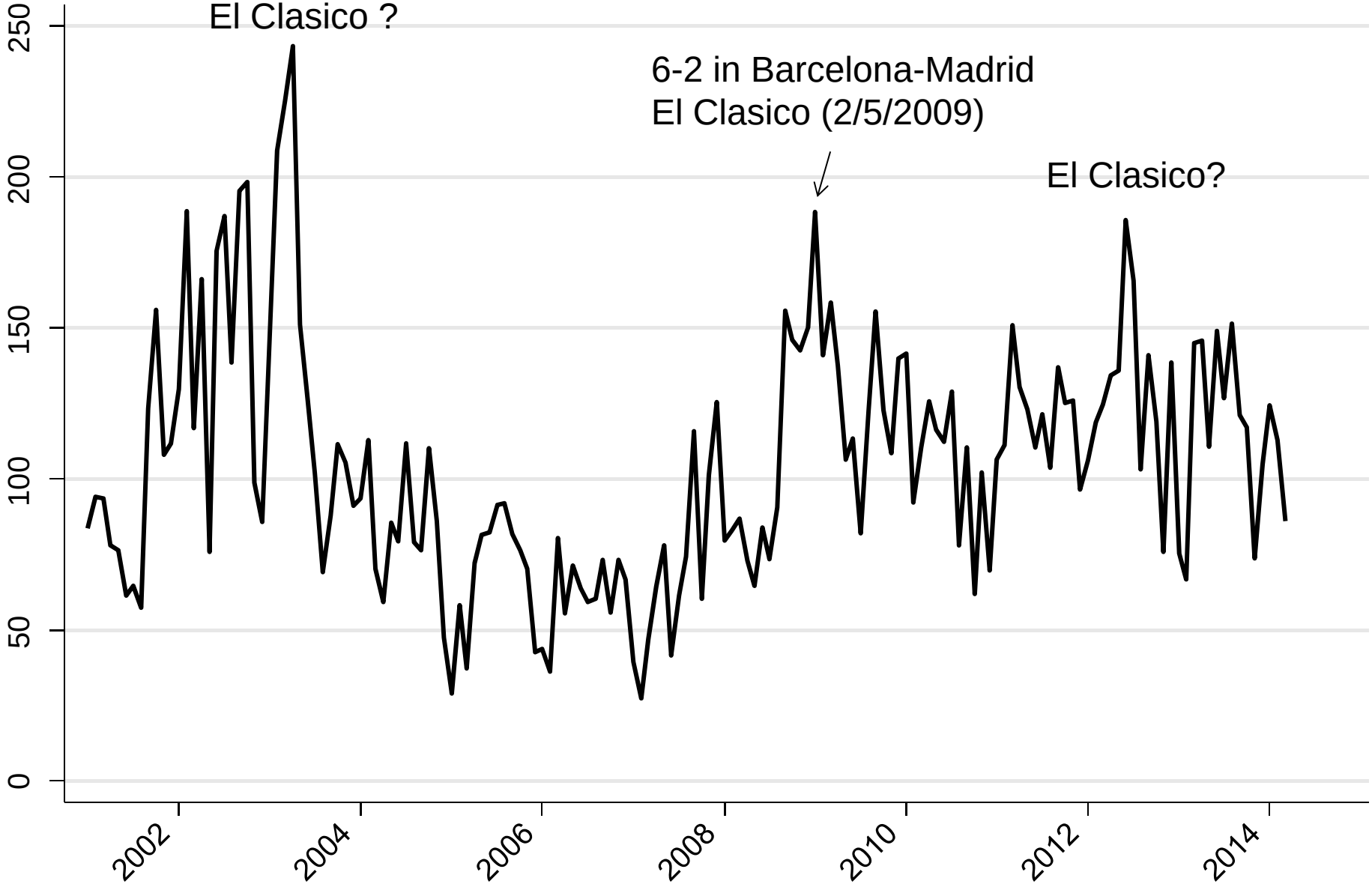
Notes: Index of Policy-Related Economic Uncertainty composed of quarterly news articles containing uncertain or uncertainty, economic or economy, and policy relevant terms (scaled by the smoothed total number of articles) in 5 newspapers (WP, BG, LAT, WSJ and CHT). Data normalized to 100 from 1900-2011.

European Economic Policy Uncertainty Index



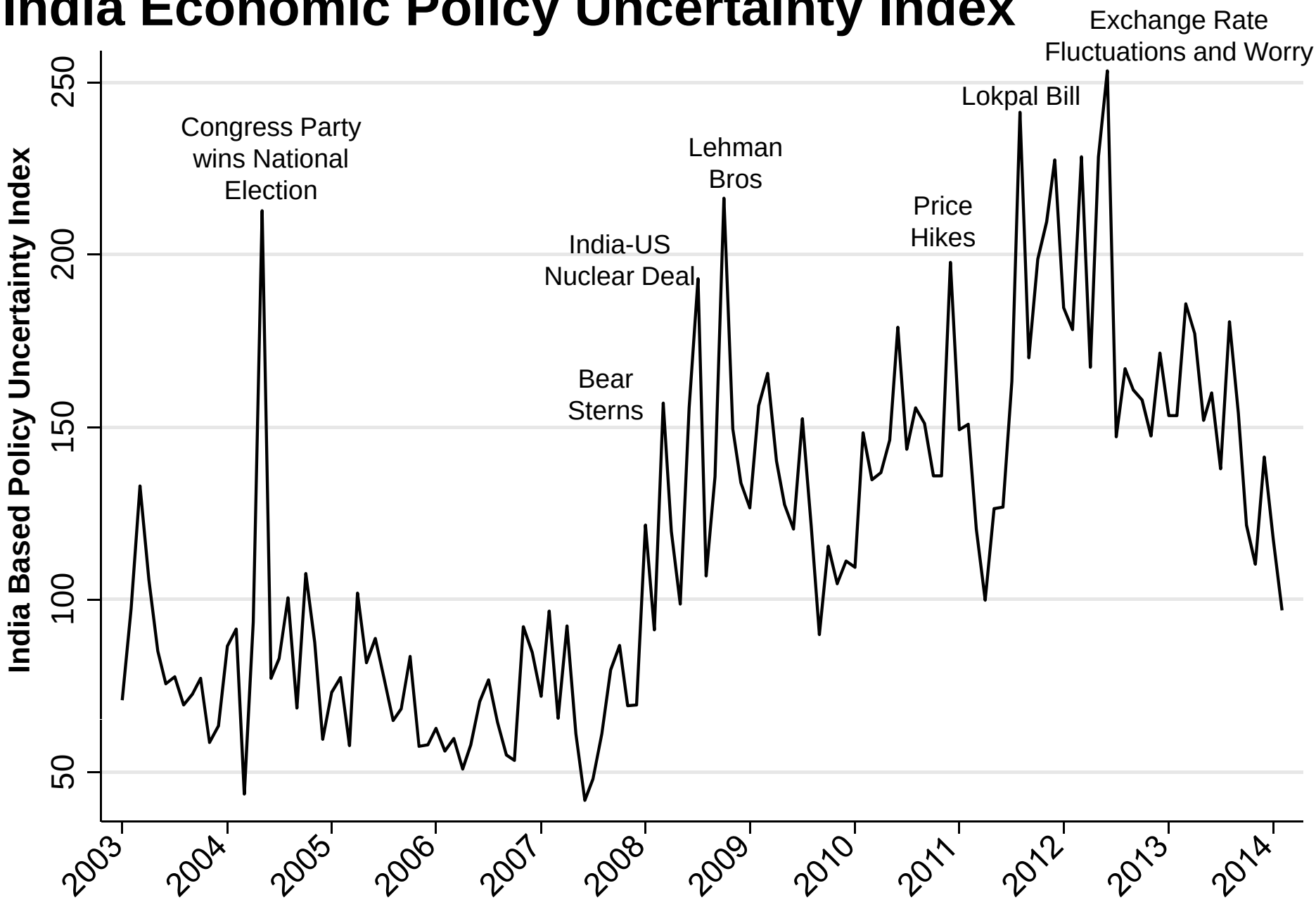
Source: www.policyuncertainty.com. Based on 10 paper (**El Pais, El Mundo**, Corriere della Sera, La Repubblica, Le Monde, Le Figaro, the Financial Times, Times, Handelsblatt, FAZ.)

Spain Economic Policy Uncertainty Index (2 papers)



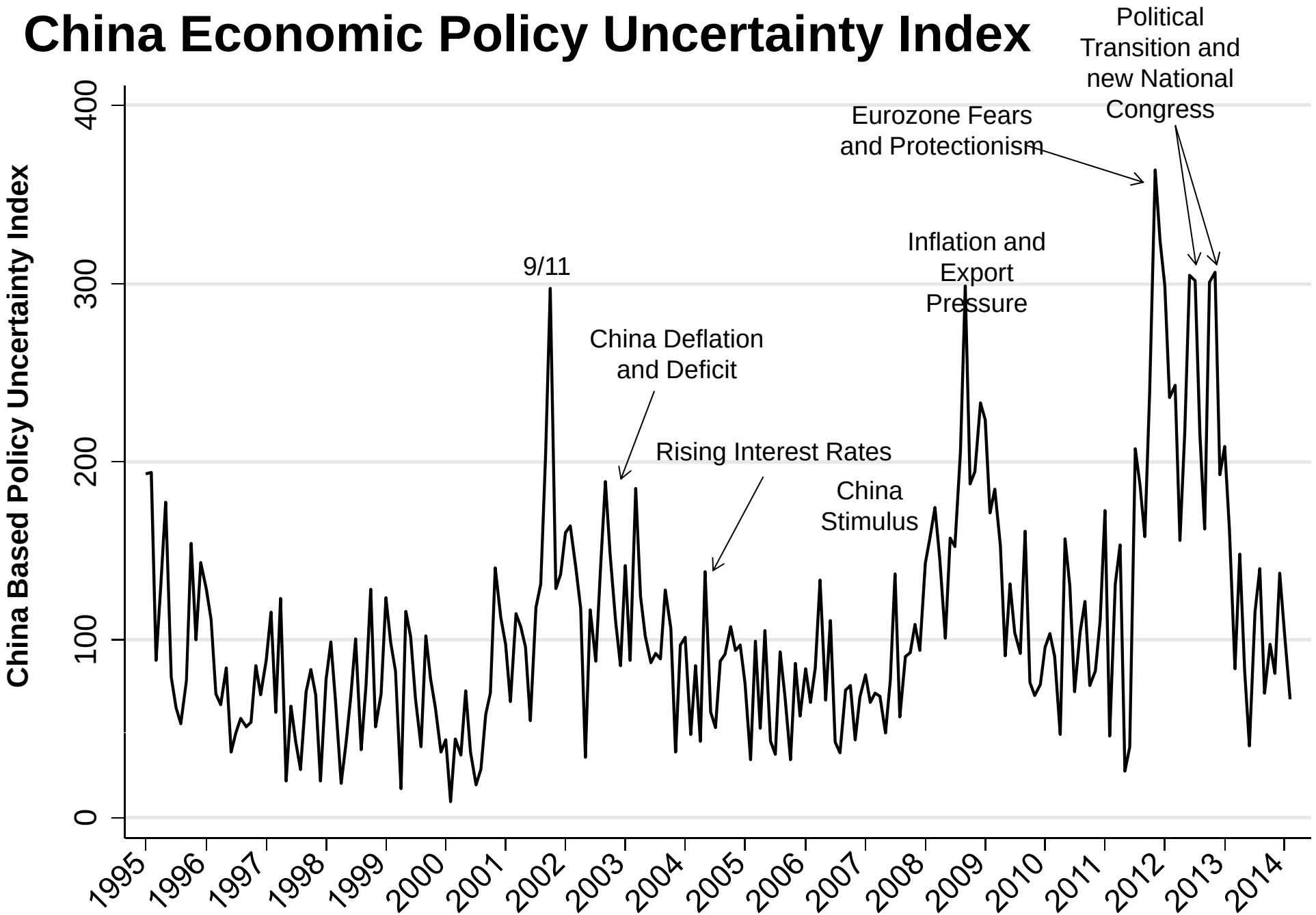
Source: www.policyuncertainty.com. Data until November 2014. Based on newspaper articles from the El Pais and El Mundo.

India Economic Policy Uncertainty Index



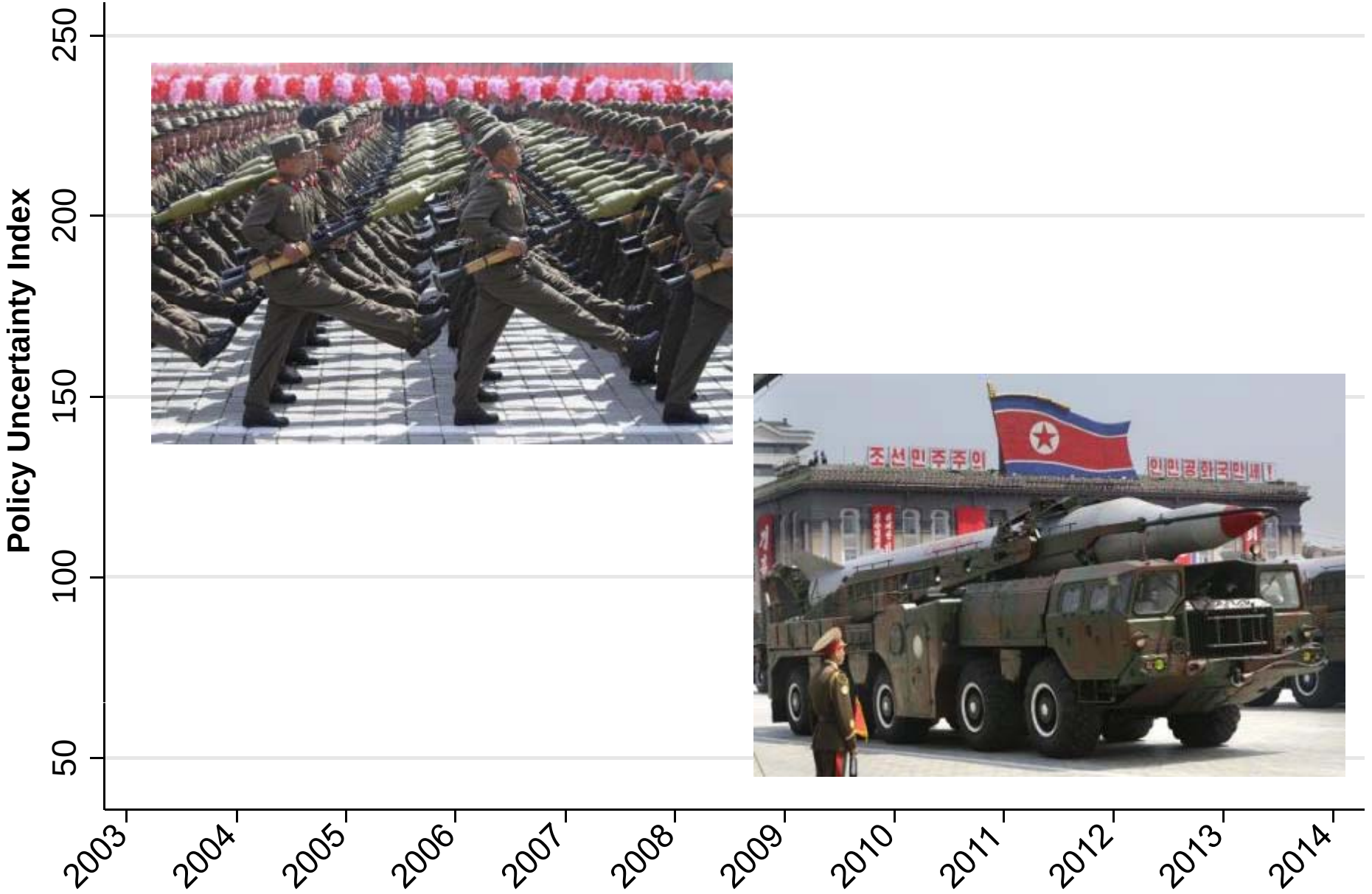
Source: www.policyuncertainty.com. Data from 7 Indian newspapers (Economic Times, Times of India, Hindustan Times, Hindu, Statesman, Indian Express, and Financial Express)

China Economic Policy Uncertainty Index



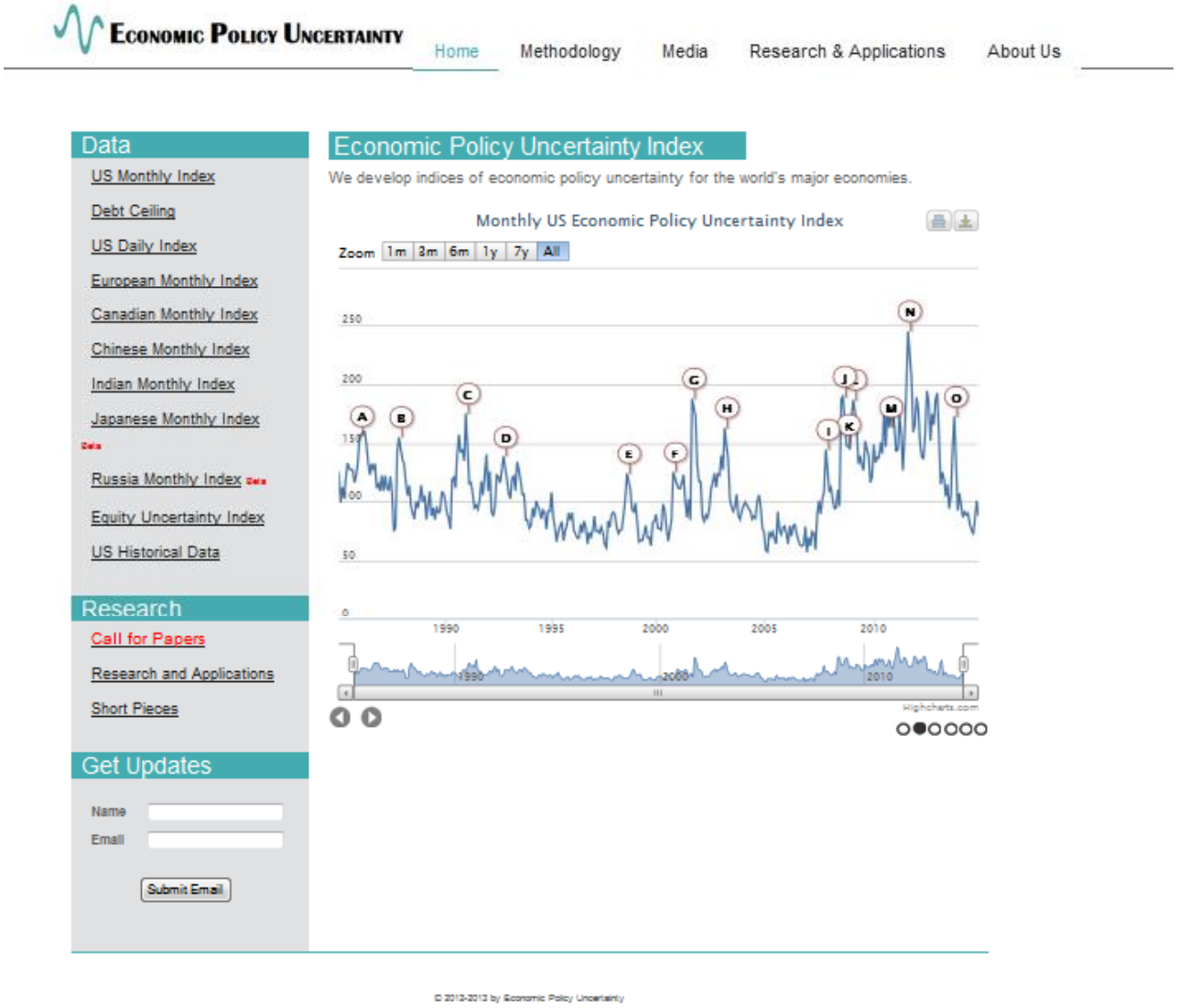
Source: www.policyuncertainty.com. Data until February 2014. Based on newspaper articles from the South China Morning Post.

North Korean Economic Policy Uncertainty Index



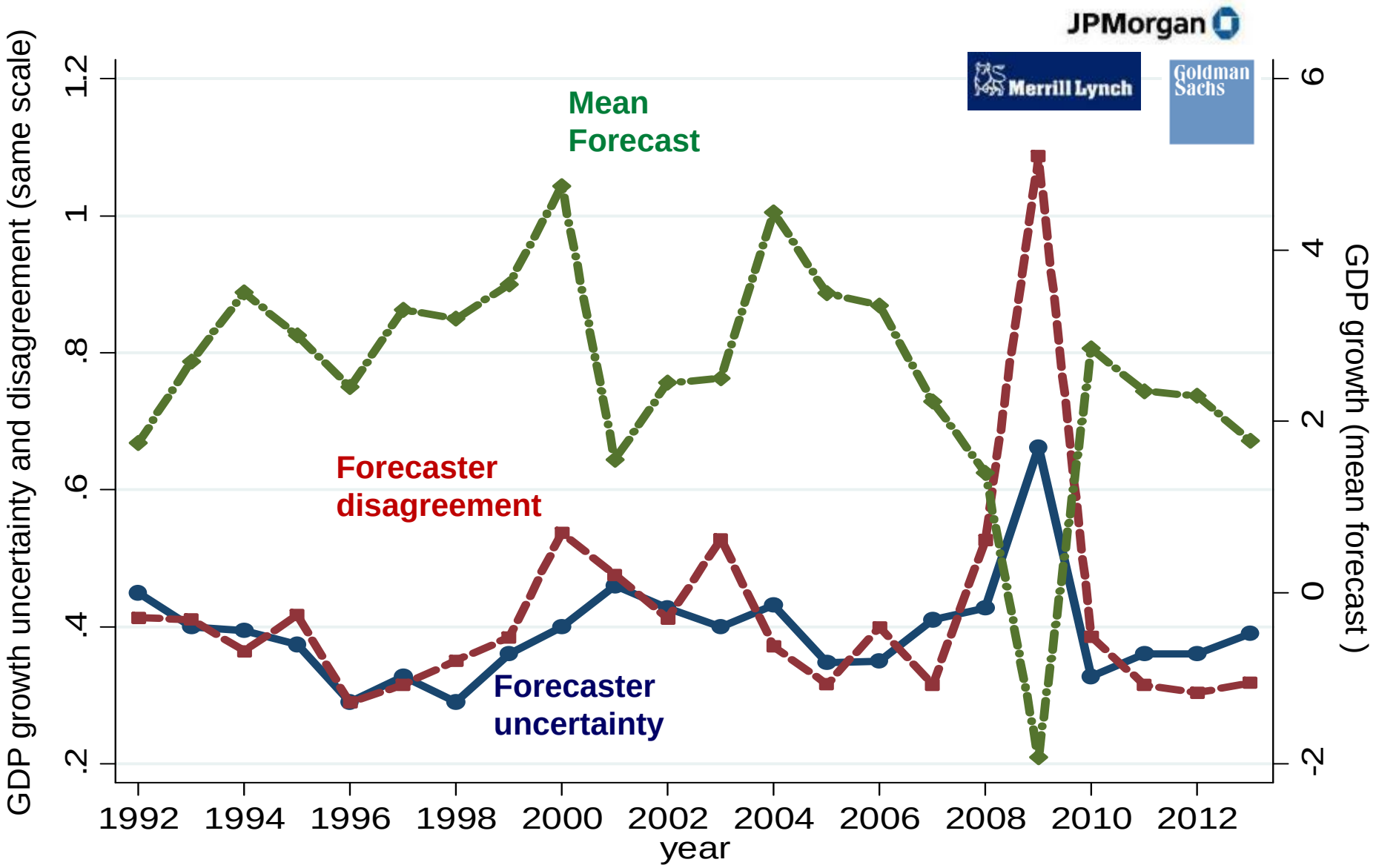
Source: www.policyuncertainty.com. Data from 0 North Korean newspapers

Before turning to other uncertainty measures, I should note the policy uncertainty data is online



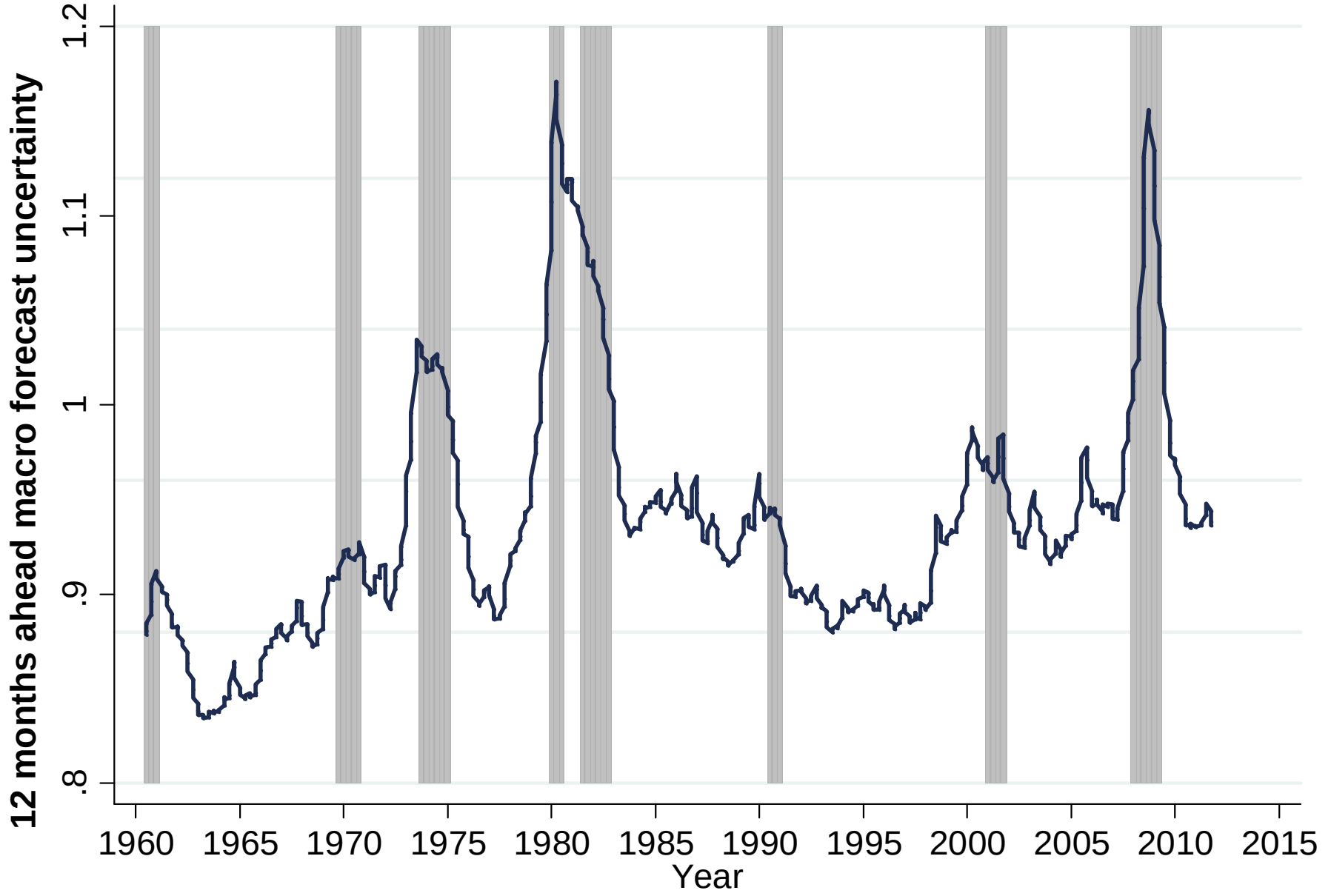
Data available at: www.policyuncertainty.com

Forecaster disagreement and uncertainty: GDP



Notes: Data from the probability changes of GDP annual growth rates from the Philadelphia Survey of Professional Forecasters. **Mean forecast** is the average forecasters expected GDP growth rate, **forecaster disagreement** is the cross-sectional standard-deviation of forecasts, and **forecaster uncertainty** is the median within forecaster subjective variance. Data only available on a consistent basis since 1992 Q1, with an average of 48 forecasters per quarter. Data spans 1992-20013.

Econometric forecast uncertainty

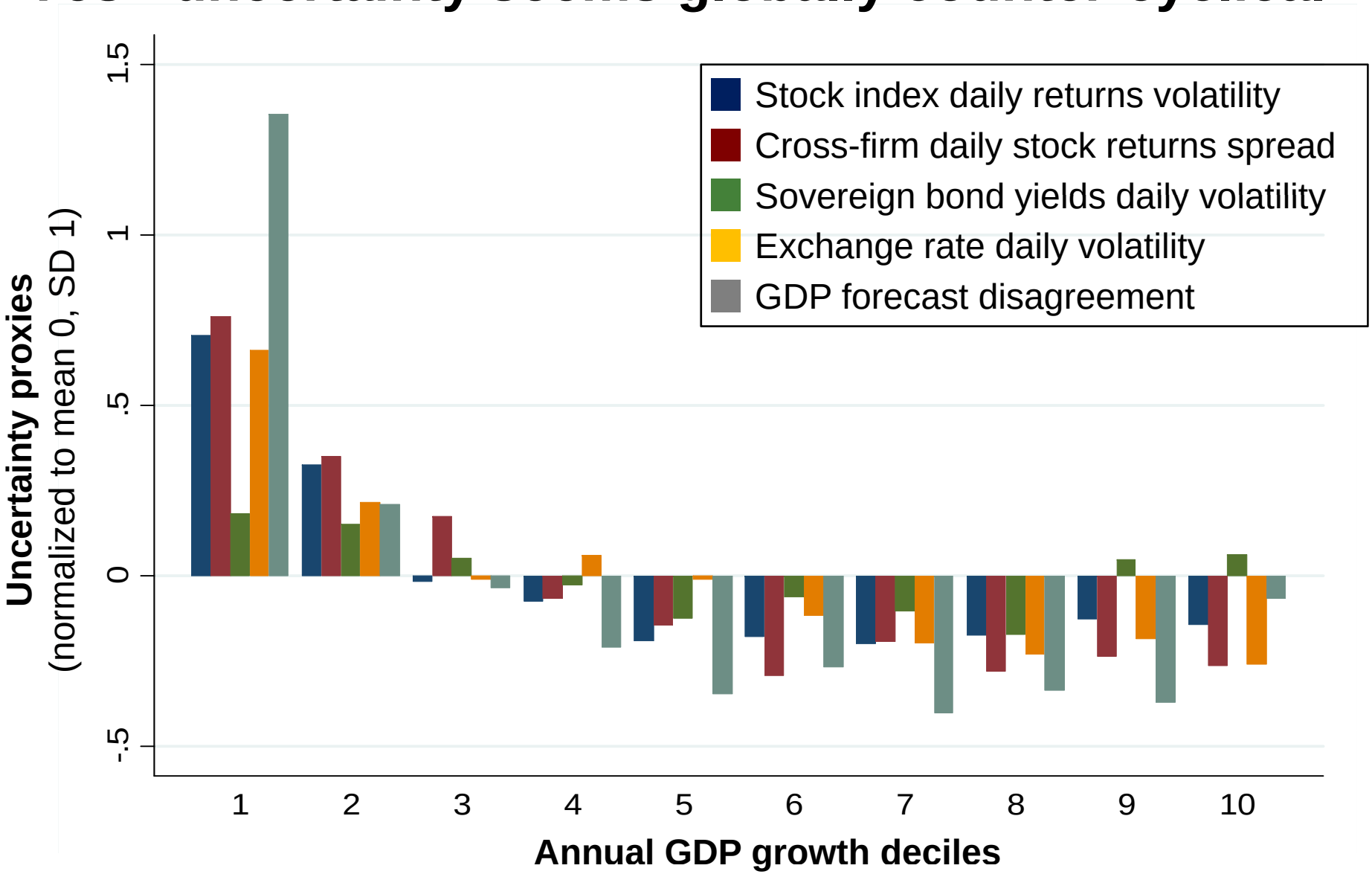


Source: Jurado, Ludvigson and Ng (2013). Forecasts from a bundle of 132 mostly macro series

I have showed you mostly US data

But is uncertainty counter-cyclical globally?

Yes - uncertainty seems globally counter-cyclical



Notes: Source Baker and Bloom (2013). Volatility indicators constructed from the unbalanced panel of data from 1970 to 2012 from 60 countries. Stock index, cross-firm, bond yield and exchange rate data calculated using daily trading data. Forecasts disagreement is calculated from annual forecasts within each year. All indicators are normalized for presentational purposes to have a mean of 0 and a standard-deviation of 1 by country. GDP growth deciles are calculated within each country.

1) Macro uncertainty appears countercyclical

2) Micro firm uncertainty appears countercyclical

3) Higher micro moments appear *not* to be cyclical?

4) Uncertainty is higher in developing countries

The economy is ‘fractal’ - micro uncertainty seems to rise at every level in recessions

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

Idiosyncratic shocks appear more volatile in recessions at all levels:

- industry
- firm
- plant
- product

Data levels

Macro (whole US economy)

Industry (e.g. SIC 2840 "*Soaps & Detergents*")

Firm (e.g. Proctor & Gamble)

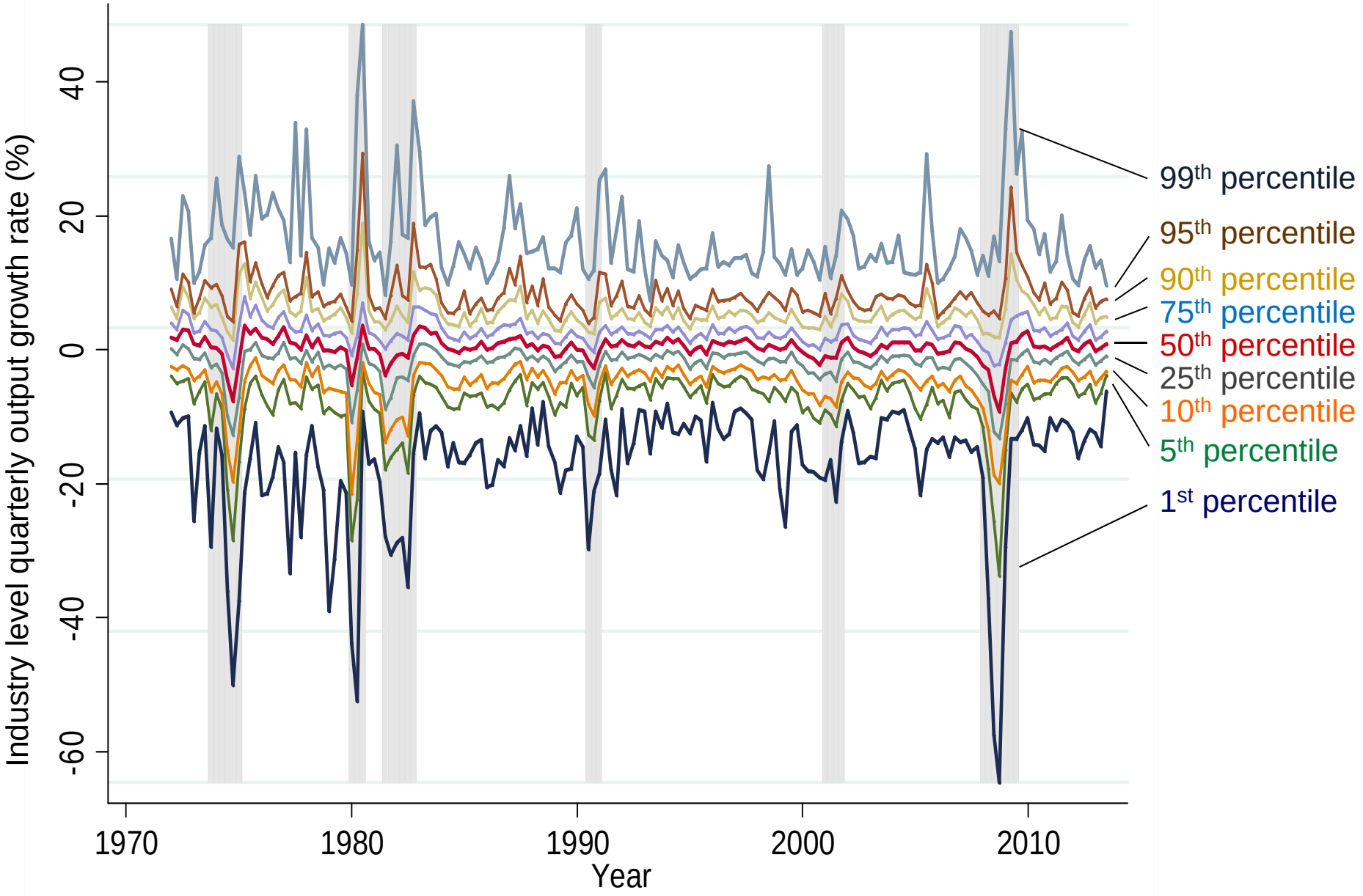
Plant (e.g. Auburn, Maine )

Product (e.g. Tide Detergent 150 fl oz, 

, 

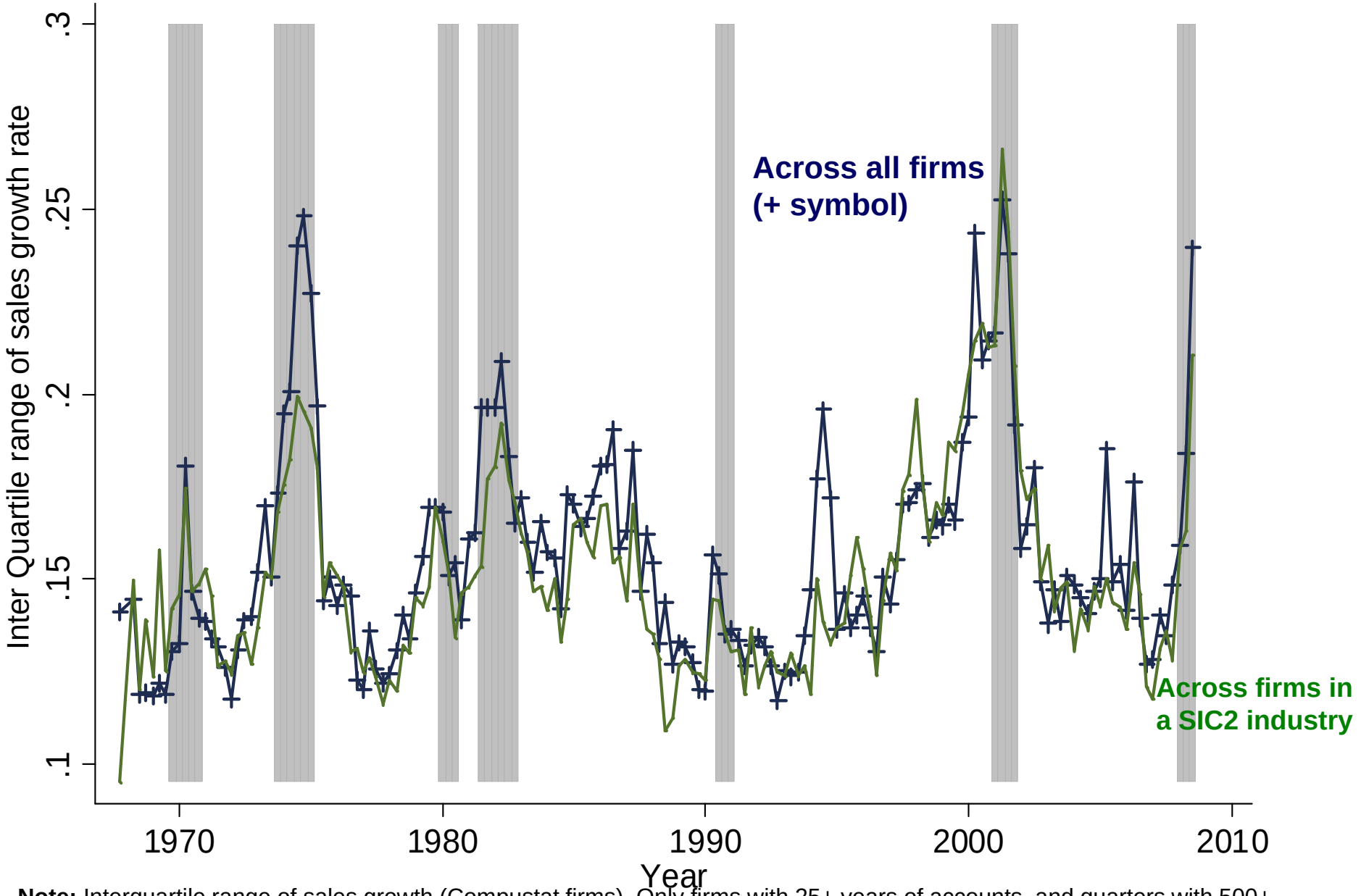
)

Industry growth dispersion (by month)



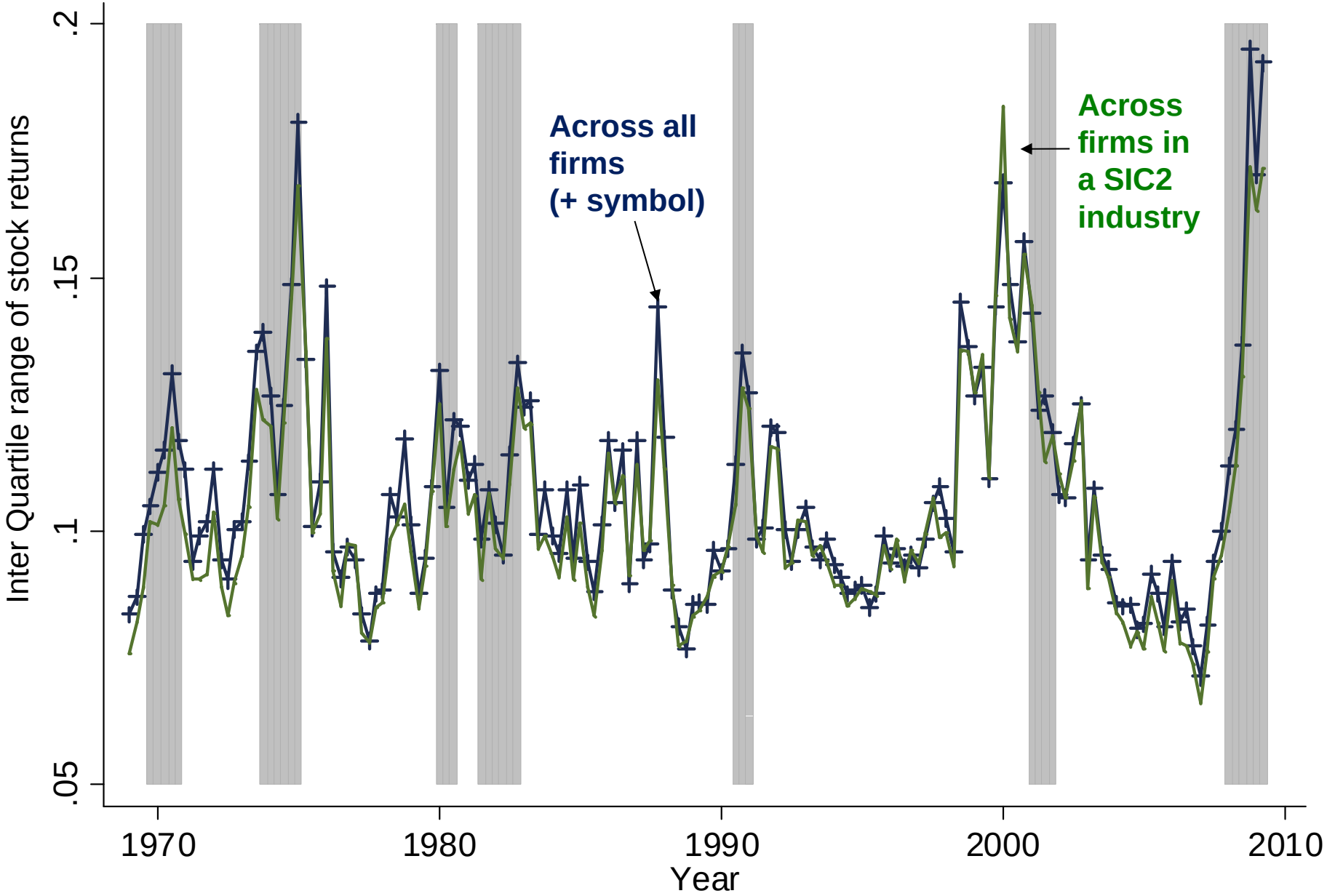
Note: 1st, 5th, 10th, 25th, 50th, 75th, 90th, 95th and 99th percentiles of 3-month growth rates of industrial production within each quarter. All 196 manufacturing NAICS sectors in the Federal Reserve Board database. Source: Bloom, Floetotto and Jaimovich (2009)

Firm sales growth dispersion (by quarter)



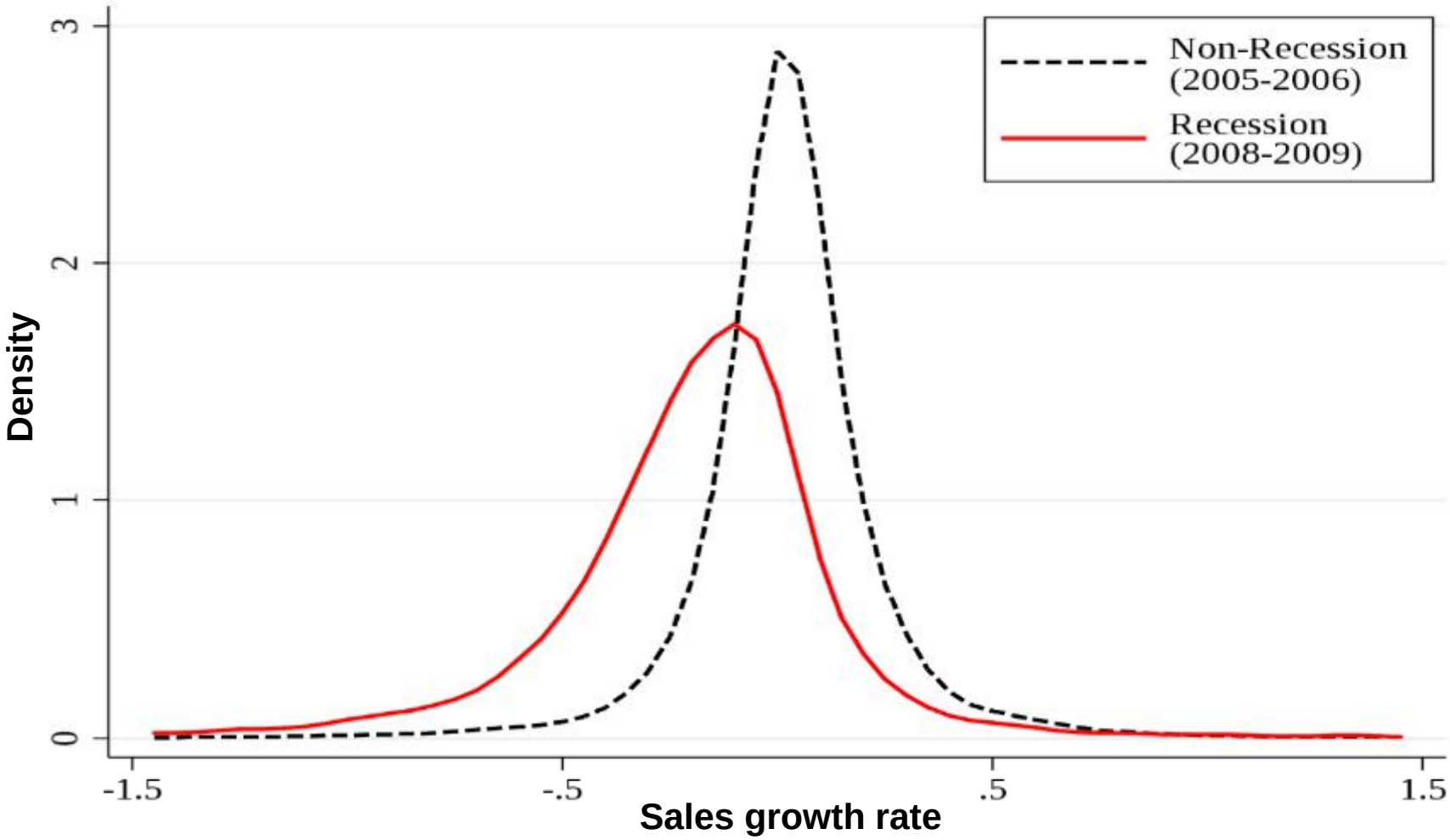
Note: Interquartile range of sales growth (Compustat firms). Only firms with 25+ years of accounts, and quarters with 500+ observations. SIC2 only cells with 25+ obs. SIC2 is used as the level of industry definition to maintain sample size. The grey shaded columns are recessions according to the NBER. Source: Bloom, Floetotto, Jaimovich, Saporta and Terry (2012)

Firm stock returns dispersion (by quarter)



Interquartile range of stock returns (CRSP firms). Only firms with 25+ years of accounts, and quarters with 1000+ observations. SIC2 only cells with 25+ obs. SIC2 is used as the level of industry definition to maintain sample size.

Plant growth dispersion pre & during great recession

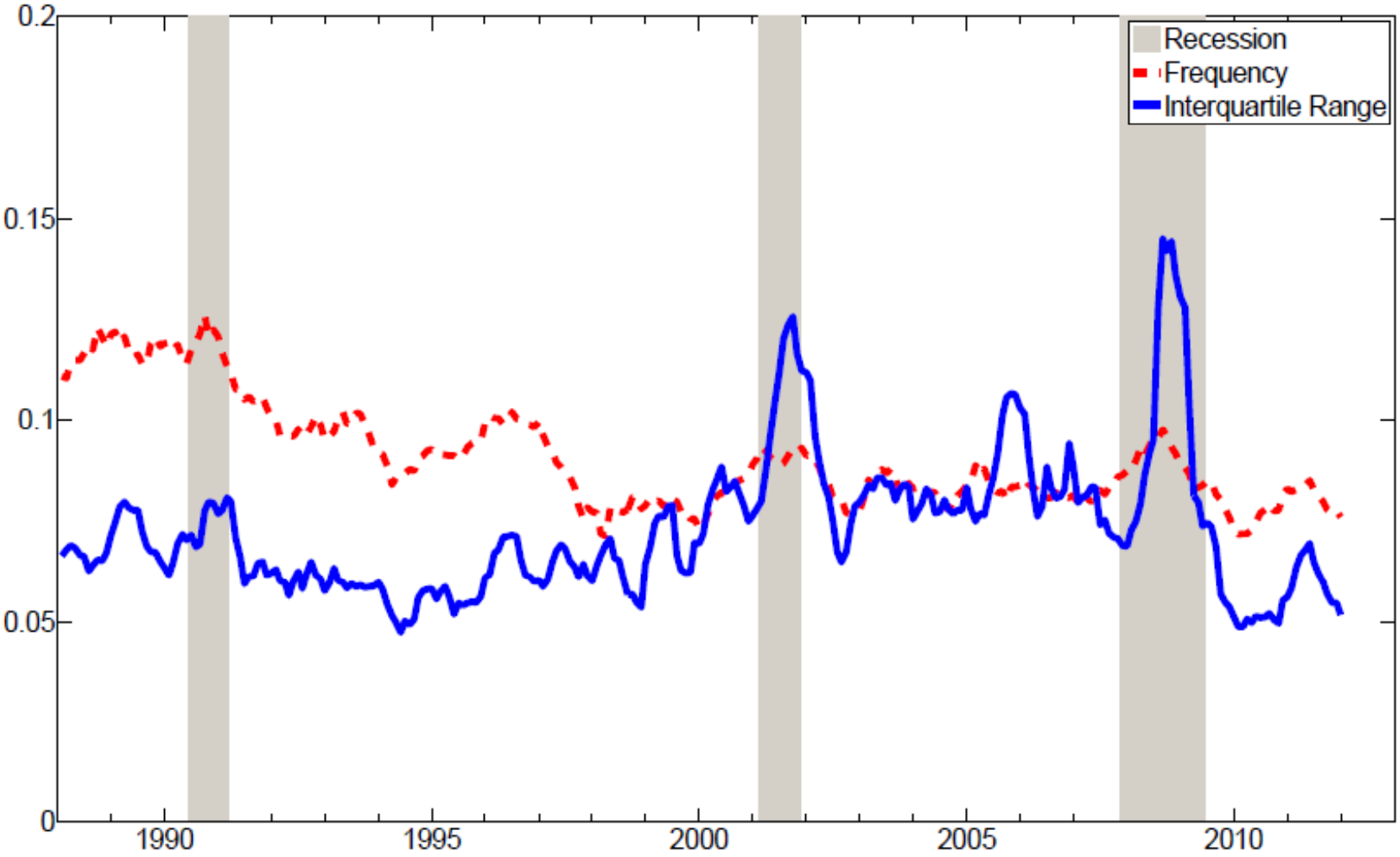


Source: "Really Uncertain Business Cycles" by Bloom, Floetotto, Jaimovich, Saporta and Terry (2012)

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”

1) Macro uncertainty appears countercyclical

2) Micro firm uncertainty appears countercyclical

3) Higher micro moments appear *not* to be cyclical?

4) Uncertainty is higher in developing countries

Use census data to measure multiple moments (including uncertainty) over the cycle

- Micro uncertainty (M2), skewness (M3), kurtosis (M4) hard to measure – need larger samples sizes

- Use Census ASM manufacturing data on about 50,000 plants per year from 1972-2011 (about 2m total obs)
  - Primary sample: plants with 25+ years of data
  - Secondary samples: plants 2+ and 39 years of data

Define uncertainty as the variance of TFP ‘shocks’

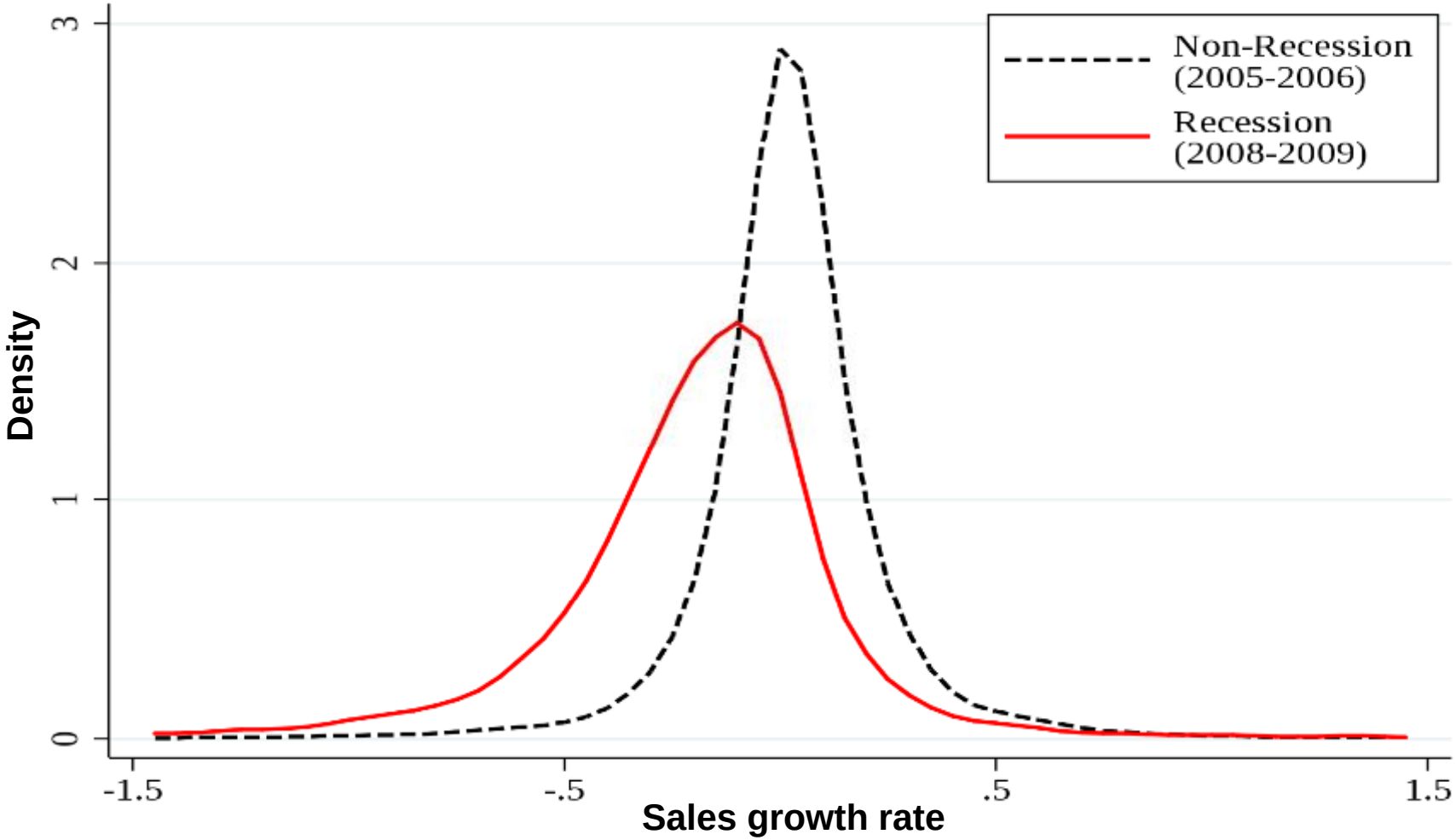
Shocks are the forecast error in TFP, where TFP measured using standard SIC 4-digit factor share approach

$$\log(A_{i,t+1}) = \mu_i + \gamma_t + \rho \log(A_{i,t}) + e_{i,t}$$

log(TFP) | Plant fixed effect | Year fixed effects | Lagged log(TFP) | TFP ‘shock’

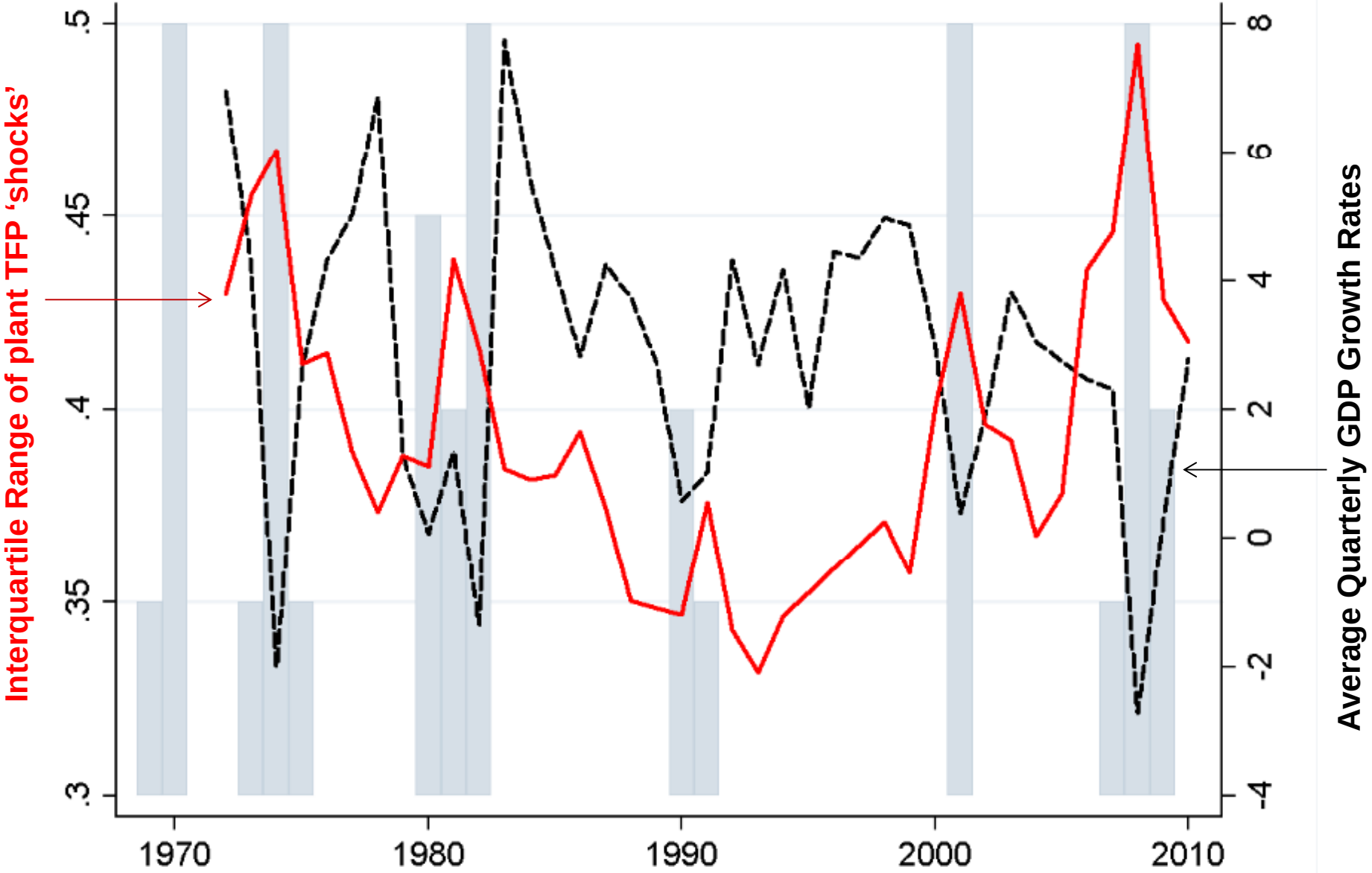
Same idea as Kydland and Prescott (1982) except for firms

The variance of establishment-level TFP shocks increased by 76% in the Great Recession



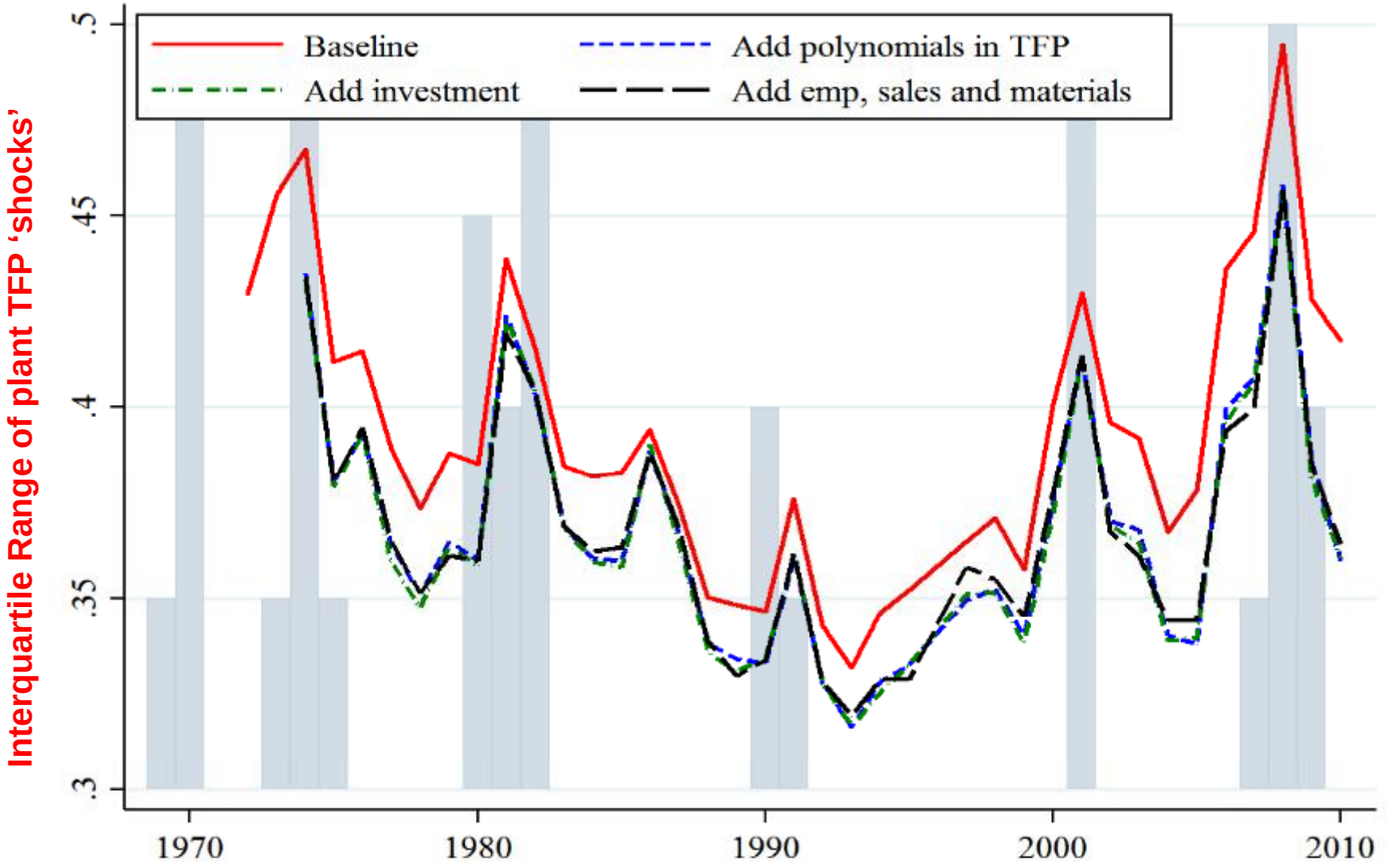
Source: Bloom, Floetotto, Jaimovich, Saporta and Terry (2014).
Notes: Constructed from the Census of Manufactures and the Annual Survey of Manufactures using a balanced panel of all 15,752 establishments active in 2005-06 and 2008-09. Moments of the distribution for non-recession (recession) years are: 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.

TFP ‘shocks’ more dispersed in prior recessions too



Notes: Constructed from the Census of Manufactures and the Annual Survey of Manufactures establishments, using establishments with 25+ years to address sample selection. Grey shaded columns are the share of quarters in recession within a year.

True however you measure TFP ‘shocks’



Notes: Constructed from the Census of Manufactures and the Annual Survey of Manufactures establishments, using establishments with 25+ years to address sample selection. Grey shaded columns are share of quarters in recession within a year. The four lines are: *Baseline*: Interquartile Range of plant TFP ‘shocks’ (as in Figure 3). Add polynomials in TFP: includes the first, second and third lags of log TFP, and their 5 degree polynomials in the AR regression which is used to recover TFP shocks. *Add investment*: includes all the controls from the previous specification plus the first, second and third lags of investment rate, and their 5 degree polynomials. *Add emp, sales and materials*: includes all the controls from the previous specification plus the second and third lags of log employment, log sales, and log materials, as well as their 5 degree polynomials.

Higher moments are noisier (more sensitivity to outliers), but these suggest little cyclical behavior

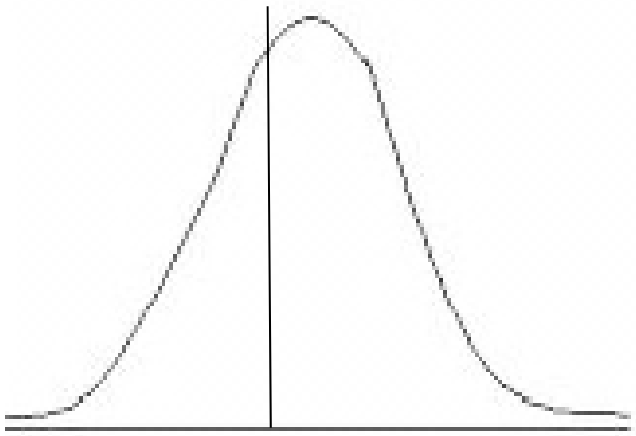
Table 1: Uncertainty is Higher During Recessions

Dependent Variable:	(1) S.D. of log(TFP) shock	(2) Skewness of log(TFP) shock	(3) Kurtosis of log(TFP) shock
Sample:	Establishments (manufacturing)	Establishments (manufacturing)	Establishments (manufacturing)
Recession	0.063***	-0.244	-1.432
	(0.010)	(0.179)	(2.088)
Mean of Dep. Variable:	0.499	-1.527	20.514
Corr. with GDP growth	-0.440***	0.131	0.038
Frequency	Annual	Annual	Annual
Years	1972-2009	1972-2009	1972-2009
Observations	37	37	37
Underlying sample	446,051	446,051	446,051

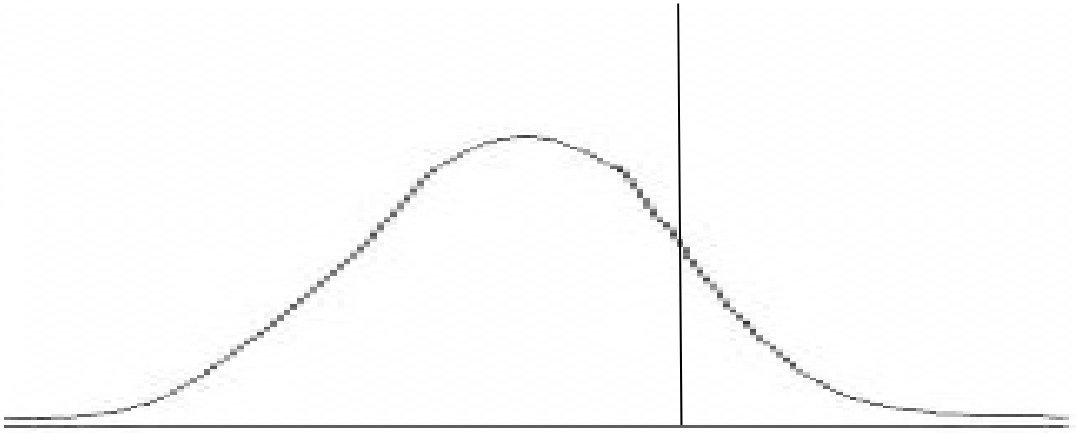
Source: "Really Uncertain Business Cycles" by Bloom, Floetotto, Jaimovich, Saporta and Terry (2012)

Note: Annual Survey of Manufacturing establishments with 25+ years (to reduce sample selection). Shaded columns are share of quarters in recession. Source Bloom, Floetotto, Jaimovich, Saporta and Terry (2011).

So in summary, in <u>firms and plants</u> we see



Normal distribution of TFP shocks



Recessionary distribution of TFP shocks

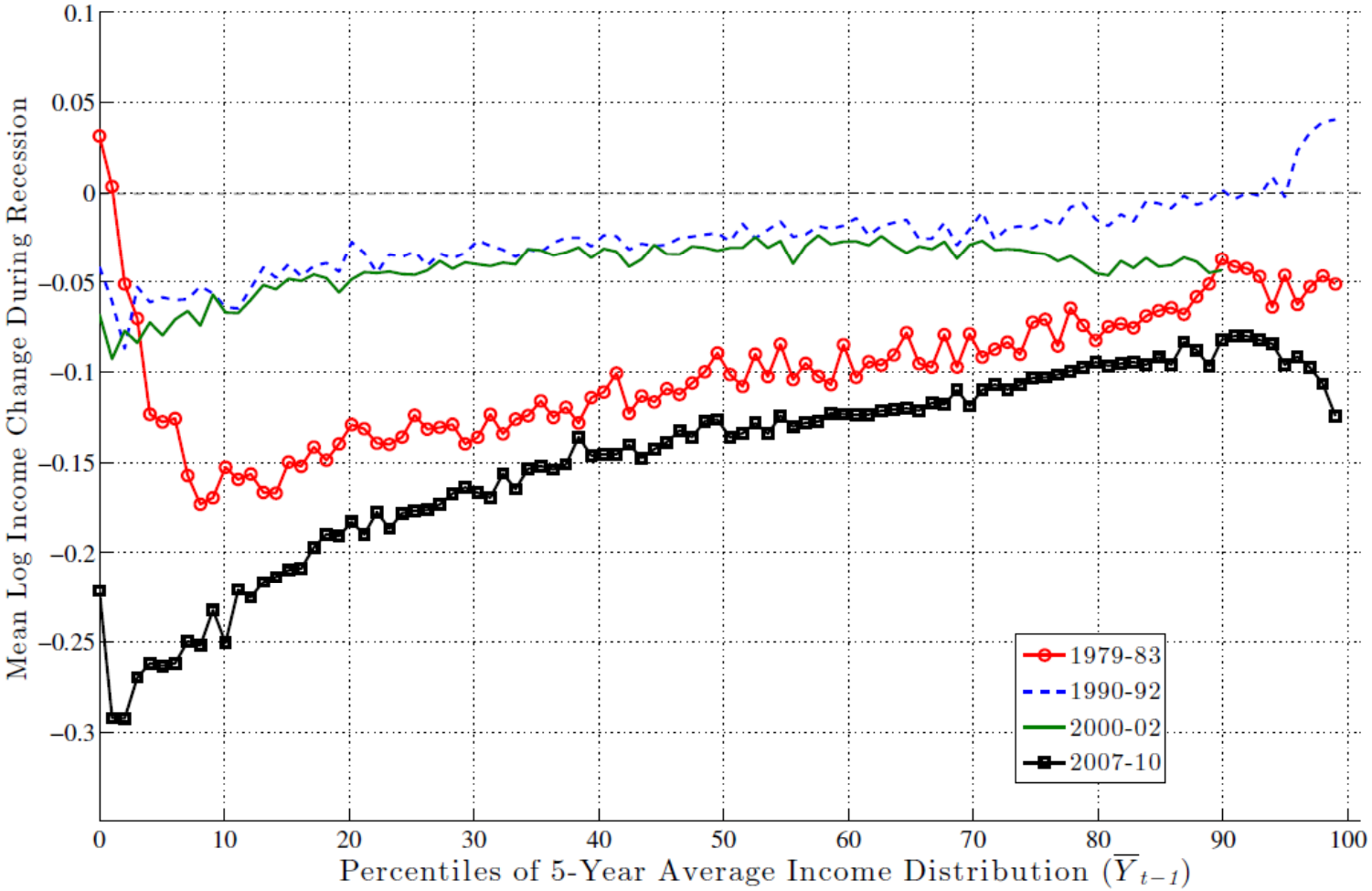
Earlier literature suggested income growth had a similar counter-cyclical second moment

Storesletten, Telmer & Yaron (2004, JPE) show US cohorts that lived through more recessions have more dispersed incomes

Meghir & Pistaferri (2004, Econometrica) show that labor market residuals have a higher standard deviation in recessions

Both used PSID which has about 20k individuals per year

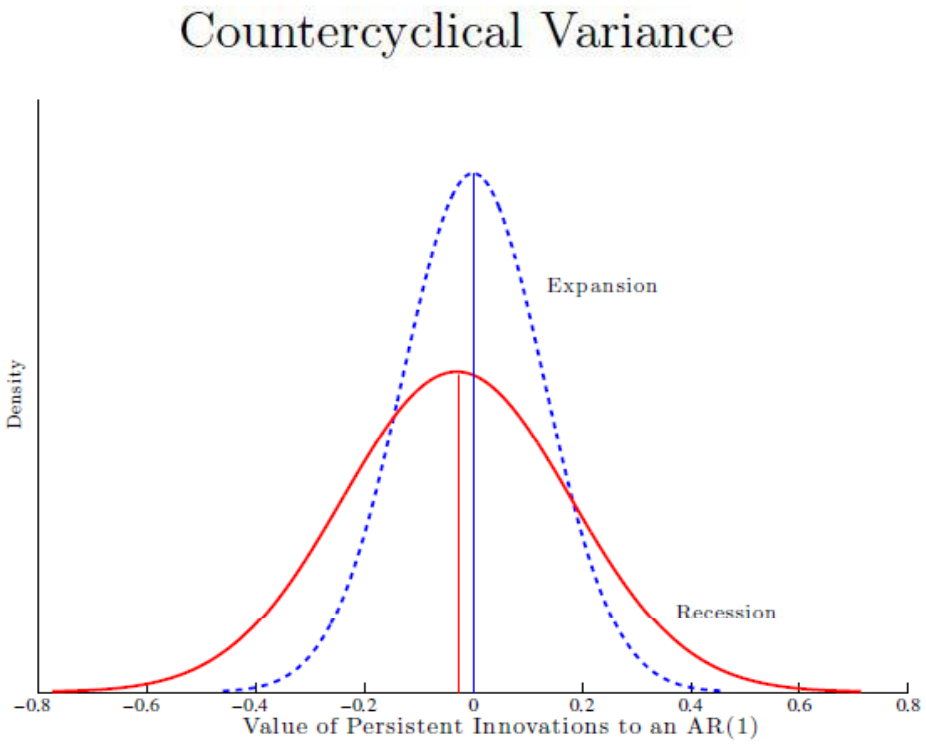
But SSA data on several million individuals shows mainly a rising 3rd moment in recessions

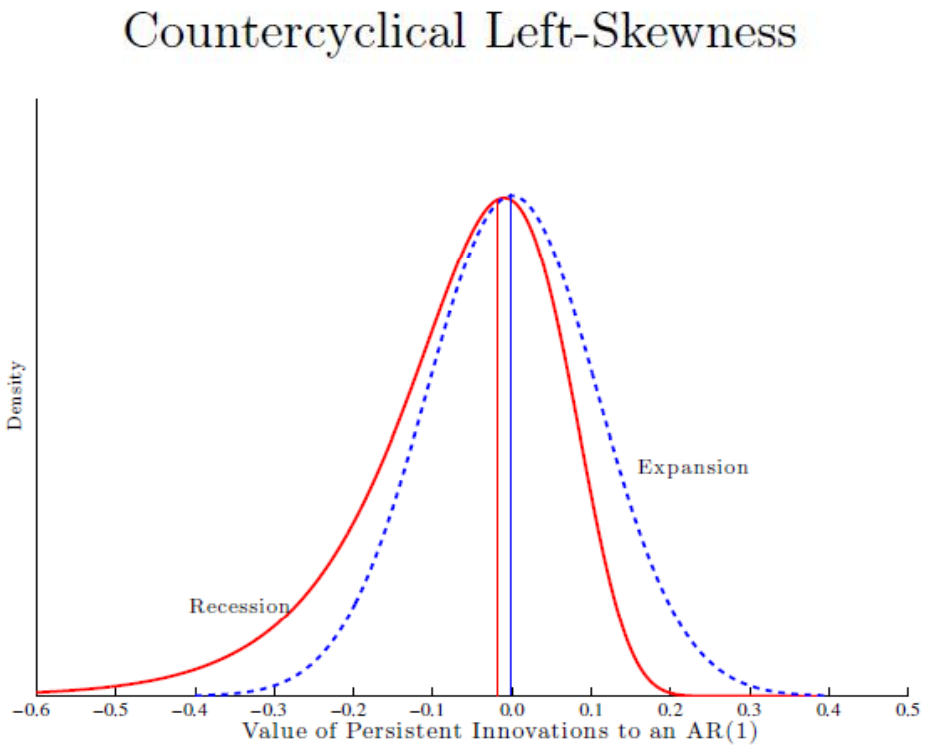


Guvenen, Ozkan & Song, “The nature of countercyclical income risk” (2014, JPE)

Notes: Uses about 5m obs per year from the US Social Security Administration earnings data

So firms and workers seem to differ in higher moments across recessions – not clear why?





Production side
(firms, plants, industries etc)

Consumer side
(wages)

Working with Jae Song, David Price and Fatih Guvenen on this

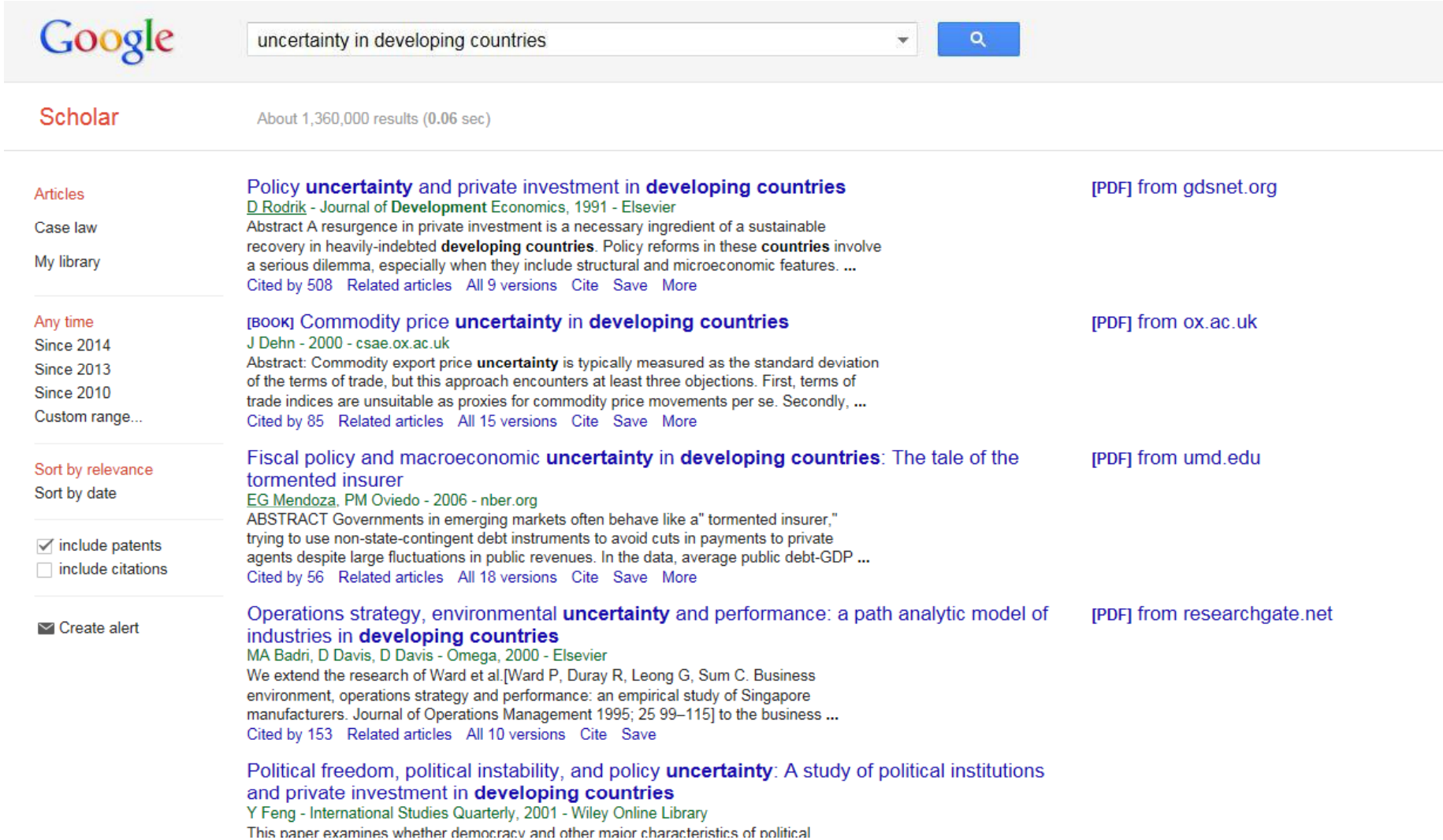
1) Macro uncertainty appears countercyclical

2) Micro firm uncertainty appears countercyclical

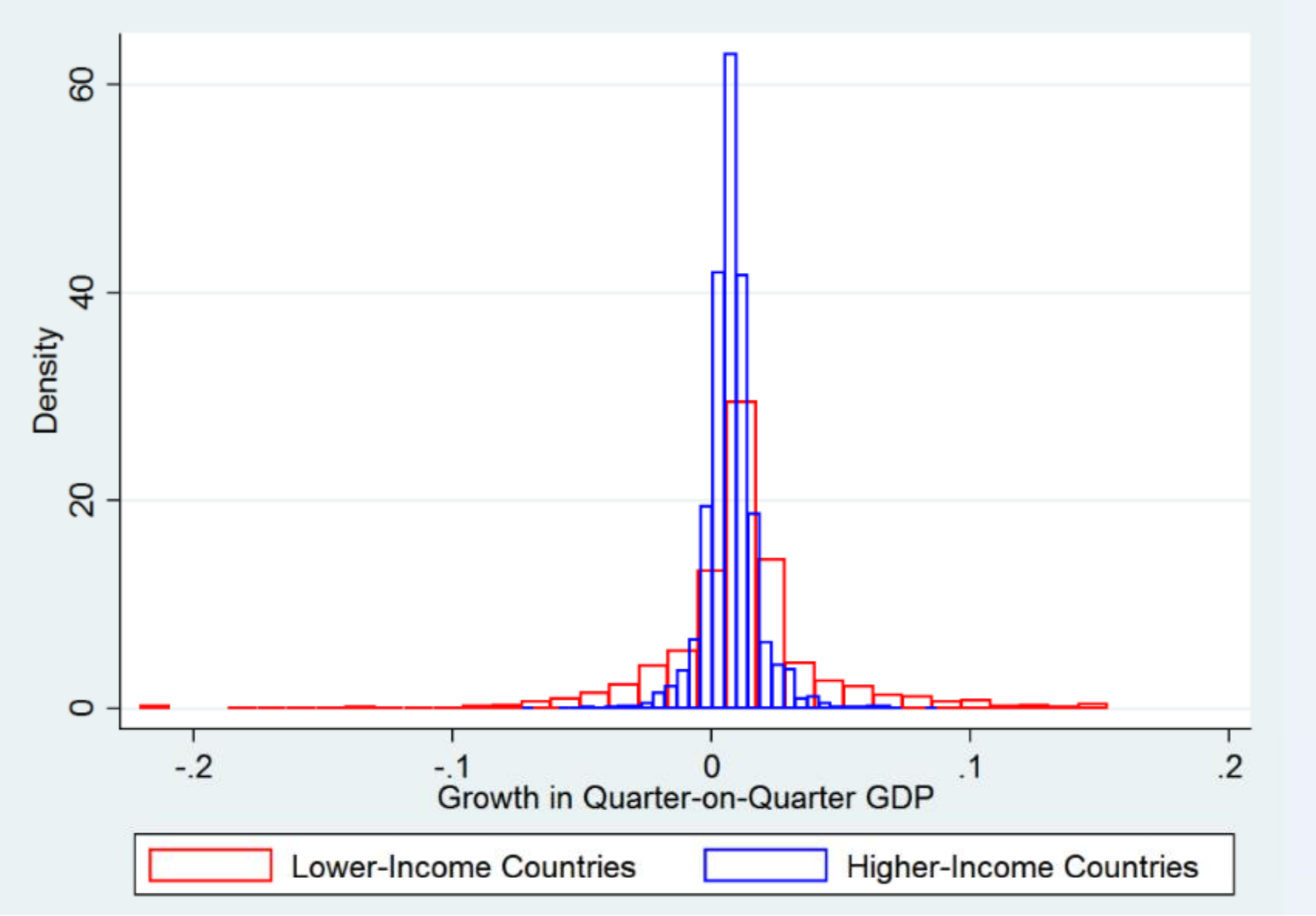
3) Firm skewness and kurtosis appear to be acyclical

4) Uncertainty is higher in developing countries

Literature on uncertainty in developing countries focusing on commodity prices and policy



Developing countries about 50% more volatile GDP



Source: Baker & Bloom (2012) "Does uncertainty reduce growth? Evidence from disaster shocks".
Notes: Rich=(GDP Per Capita>$20,000 in 2010 PPP)

So to recap

Uncertainty hard to measure, but proxies suggest:

- Macro uncertainty rises in recessions in the US and globally
- Micro uncertainty (industries, firms, plants and products) is likewise counter cyclical
- Higher moments are less cyclical
- Developing countries have higher uncertainty

Future Measurement Work: firm-level surveys

Projecting ahead over the next twelve months, please provide the approximate percentage change in your firm's SALES LEVELS for:

- The LOWEST CASE change in my firm's sales levels would be: -9 %
- The LOW CASE change in my firm's sales levels would be: -3 %
- The MEDIUM CASE change in my firm's sales levels would be: 3 %
- The HIGH CASE change in my firm's sales levels would be: 9 %
- The HIGHEST CASE change in my firm's sales levels would be: 15 %

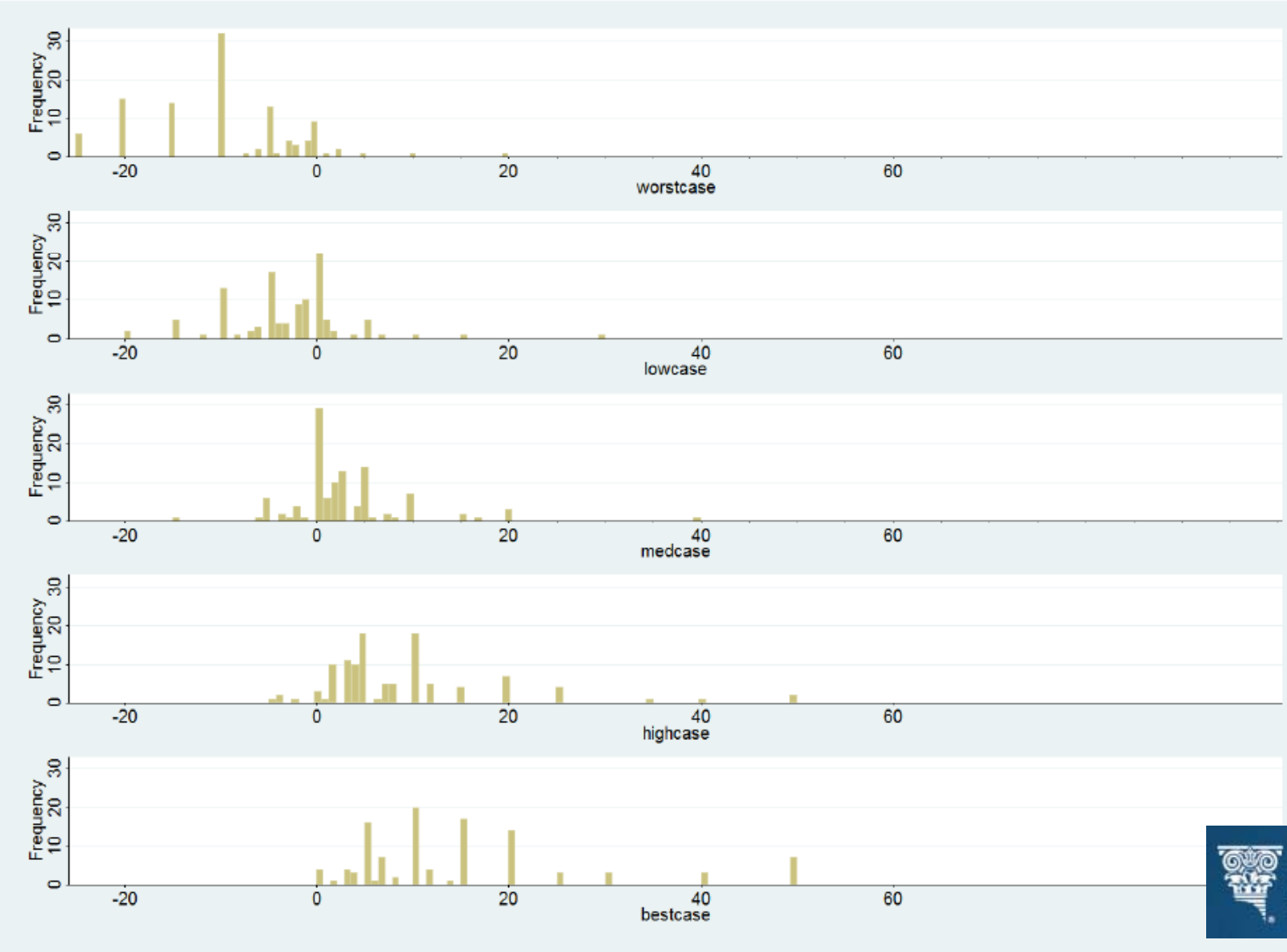
Numbers in red are the average response from the pilot on 300 firms

FEDERAL RESERVE BANK of ATLANTA

United States Census Bureau

U.S. Department of Commerce
Economics and Statistics Administration
U.S. CENSUS BUREAU

Piloting results look good from testing on a monthly survey on 300 firms: change in sales



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Can also ask about probabilities

Please assign a percentage likelihood to these SALES LEVEL changes you selected above (values should sum to 100%)

- 10 % : The approximate likelihood of realizing the LOWEST CASE change
- 18 % : The approximate likelihood of realizing the LOW CASE change
- 40 % : The approximate likelihood of realizing the MEDIUM CASE change
- 23 % : The approximate likelihood of realizing the HIGH CASE change
- 9 % : The approximate likelihood of realizing the HIGHEST CASE change

Numbers in red are the average response from the pilot on 300 firms

FEDERAL RESERVE BANK of ATLANTA

United States Census Bureau

U.S. Department of Commerce
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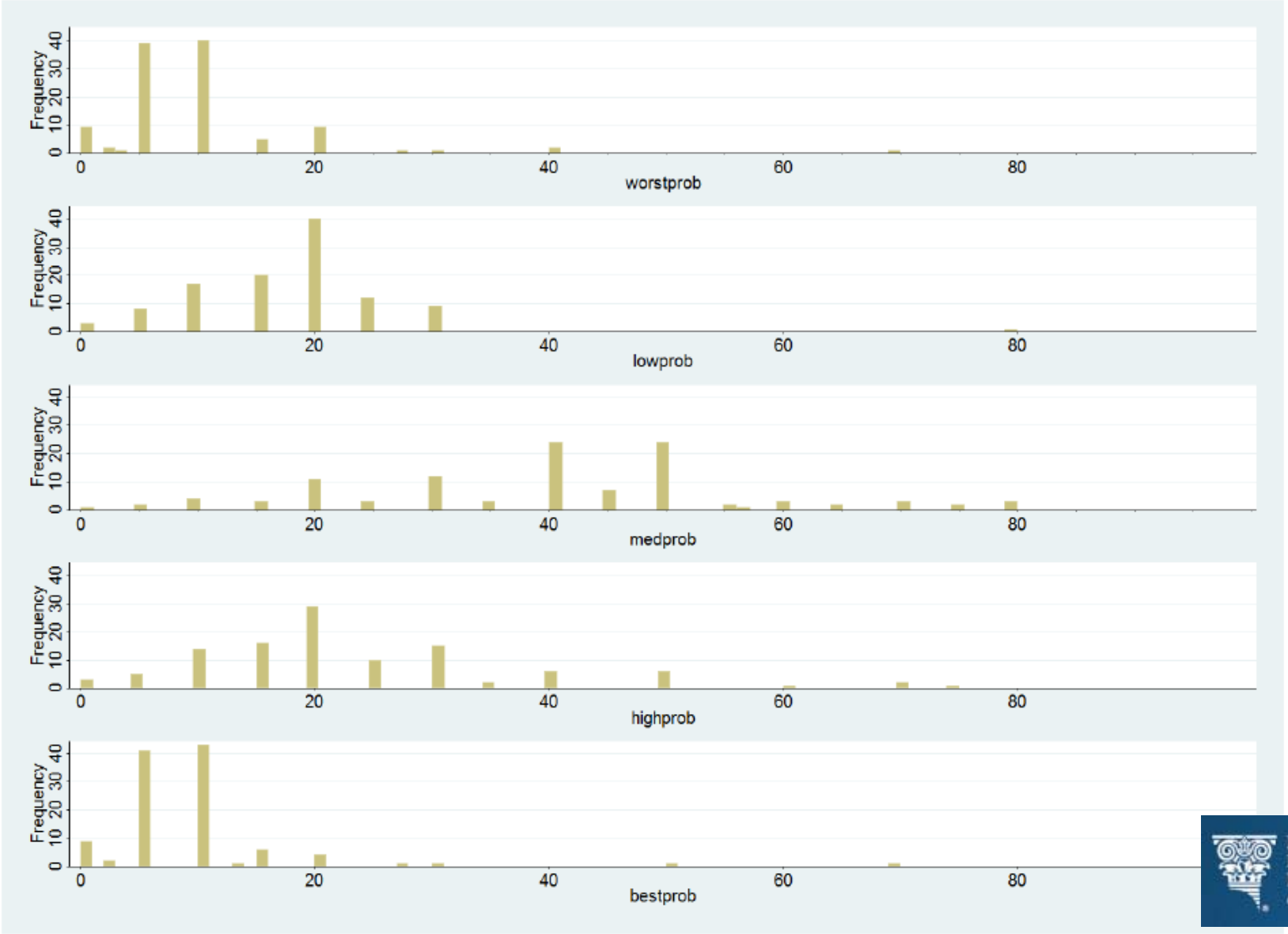
Piloting results look good from testing on a monthly survey on 300 firms: probabilities



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Another text source is company accounts. These have masses of discussion for about 5,000 companies every year since 1996 – e.g. Google

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Google Inc. CIK#: 0001288776 (see all company filings)

SIC: 7370 - SERVICES-COMPUTER PROGRAMMING, DATA PROCESSING, ETC.
State location: CA | State of Inc.: **DE** | Fiscal Year End: 1231
(Assistant Director Office: 3)
Get **insider transactions** for this **issuer**.
Get **insider transactions** for this **reporting owner**.

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MOUNTAIN VIEW CA 94043
650 623 4000

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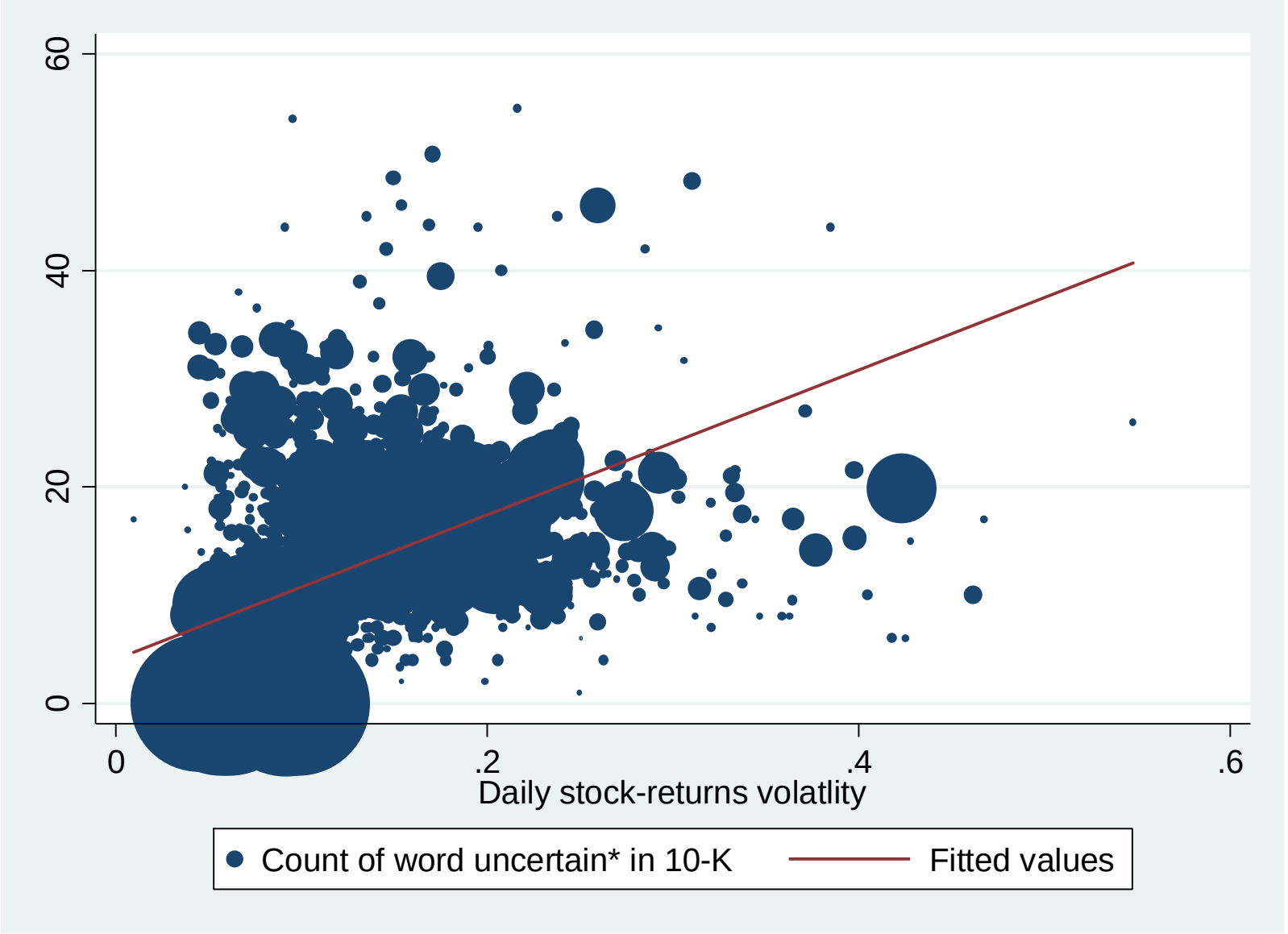
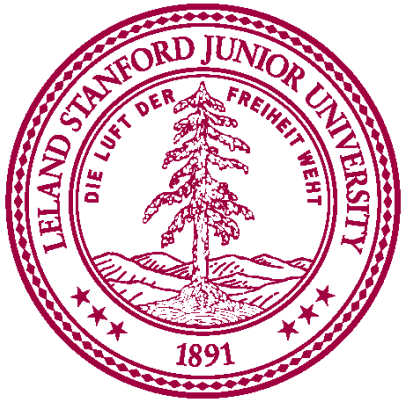
10-K	Documents, Interactive Data	Annual report [Section 13 and 15(d), not S-K Item 405] Acc-no: 0001288776-14-000020 (34 Act) Size: 21 MB	2014-02-12	000-50726 14595629
10-K	Documents, Interactive Data	Annual report [Section 13 and 15(d), not S-K Item 405] Acc-no: 0001193125-13-028362 (34 Act) Size: 13 MB	2013-01-29	000-50726 13556405
10-K/A	Documents	**[Amend]**Annual report [Section 13 and 15(d), not S-K Item 405] Acc-no: 0001193125-12-174477 (34 Act) Size: 772 KB	2012-04-23	000-50726 12771953
10-K	Documents, Interactive Data	Annual report [Section 13 and 15(d), not S-K Item 405] Acc-no: 0001193125-12-025336 (34 Act) Size: 11 MB	2012-01-26	000-50726 12548435
10-K	Documents, Interactive Data	Annual report [Section 13 and 15(d), not S-K Item 405]	2011-02-11	000-50726

As an initial test found the frequency of the word “uncertain*” is correlated with firm stock volatility



End of Lecture 1 (measurement)

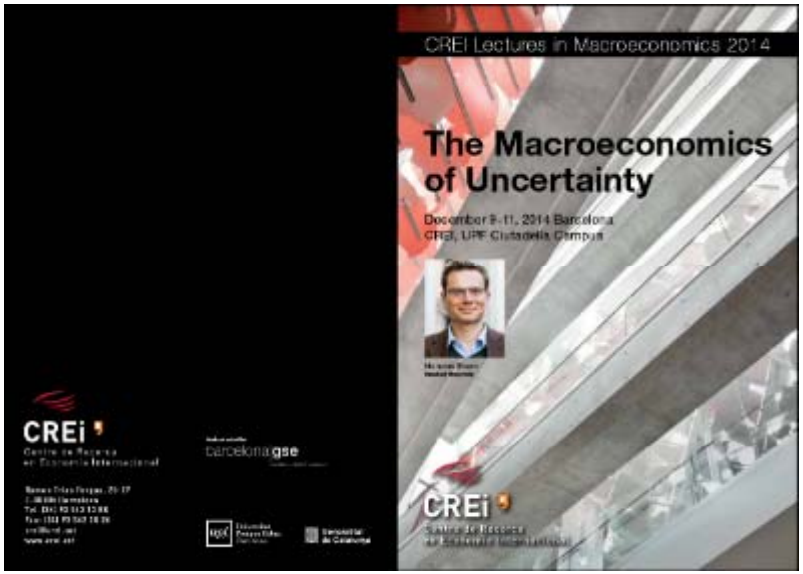
Thanks and questions

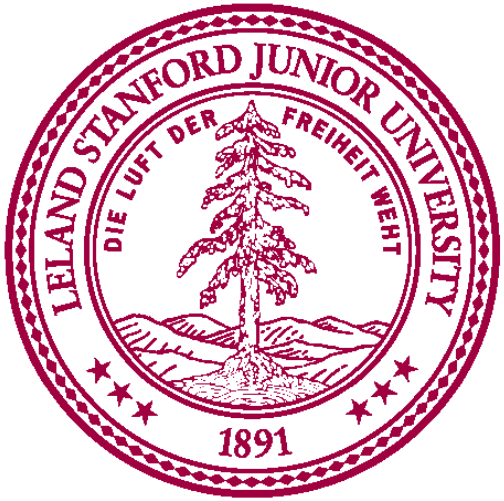


The Macroeconomics of Uncertainty: Lecture 2, Theory

Nick Bloom (Stanford & NBER)

CREI, December 2014

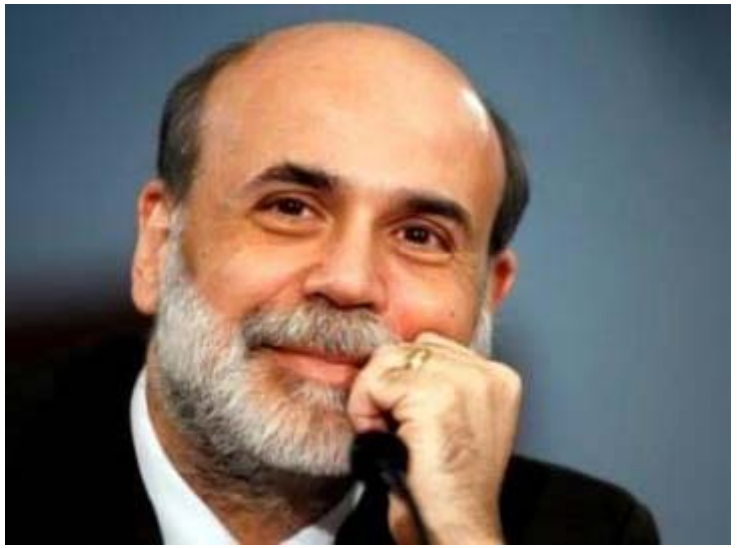




Recap from yesterday

- Rapid increase in recent interest in uncertainty as a driver of business cycles

FOMC (April 2008)
"participants reported that uncertainty about the economic outlook was leading firms to defer spending projects until prospects for economic activity became clearer."

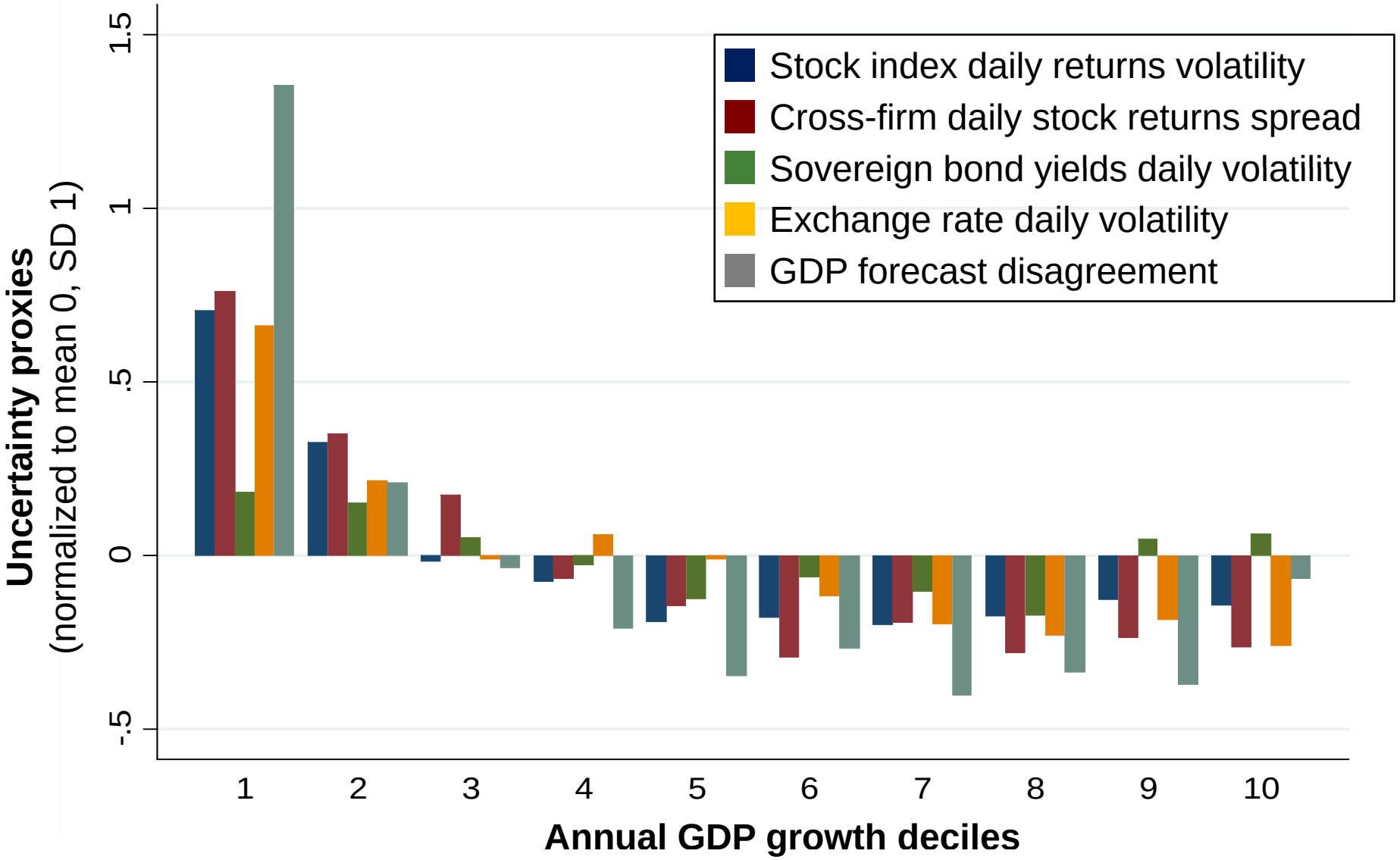


Recap from yesterday

- Rapid increase in recent interest in uncertainty as a driver of business cycles

- Uncertainty appears to rise in recessions
  - Macro uncertainty
  - Micro (industry, firms, plants and products)

Uncertainty is globally counter-cyclical



Notes: Source Baker and Bloom (2013). Volatility indicators constructed from the unbalanced panel of data from 1970 to 2012 from 60 countries. Stock index, cross-firm, bond yield and exchange rate data calculated using daily trading data. Forecasts disagreement is calculated from annual forecasts within each year. All indicators are normalized for presentational purposes to have a mean of 0 and a standard-deviation of 1 by country. GDP growth deciles are calculated within each country.

Recap from yesterday

- Rapid increase in recent interest in uncertainty as a driver of business cycles

- Uncertainty appears to rise in recessions
  - Macro uncertainty
  - Micro (industry, firms, plants and products)

- Uncertainty is higher in developing countries

End of Recap

Todays Lecture is on Theory

Uncertainty needs curvature to matter

- In completely linear systems no role for uncertainty,
  - e.g. for U(C)=a+bC can simply use expected value of C

- Likewise in log-linearized models can again just use certainty equivalence (e.g. Kydland & Prescott, 1982)
  - Hence, in much of the early (pre-2000s) business-cycle literature uncertainty played little role

Wide range of sources of curvature, split by the sign of the uncertainty impact they generate

Negative Uncertainty Effects

- Adjustment costs (real options)
- Utility functions (risk-aversion)
- Financial frictions (lump-sum costs)
- Ambiguity (pessimism)

Positive Uncertainty Effects

- Production functions (Oi-Hartman-Abel effects)
- Bankruptcy (Growth options)

Wide range of sources of curvature, split by the sign of the uncertainty impact they generate

Negative Uncertainty Effects

- **Adjustment costs (real options)** 
- Utility functions (risk-aversion)
- Financial frictions (lump-sum costs)
- Ambiguity (pessimism)

Positive Uncertainty Effects

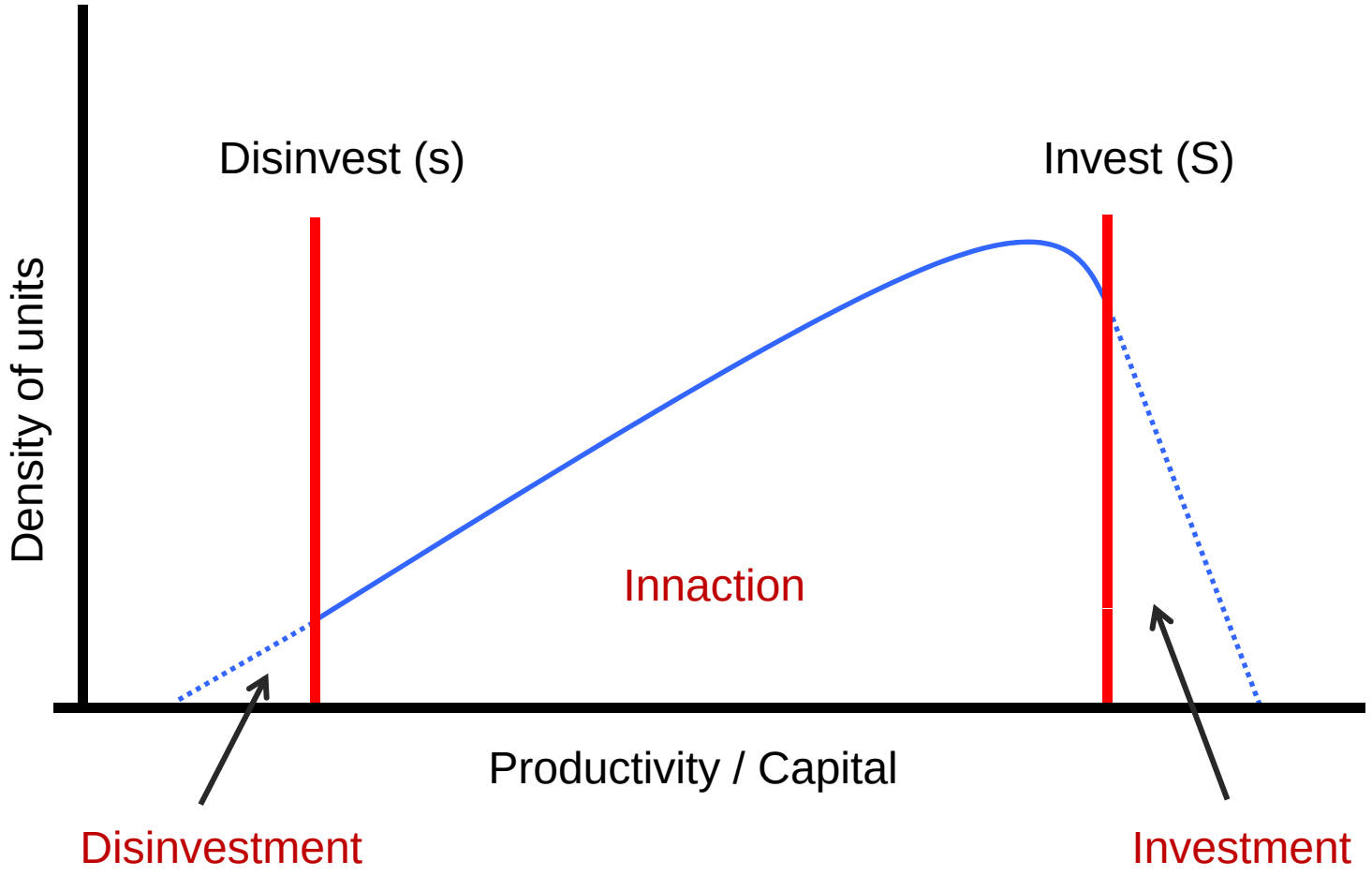
- Production functions (Oi-Hartman-Abel effects)
- Bankruptcy (Growth options)

Real options literature emphasizes that many investment and hiring decisions are irreversible

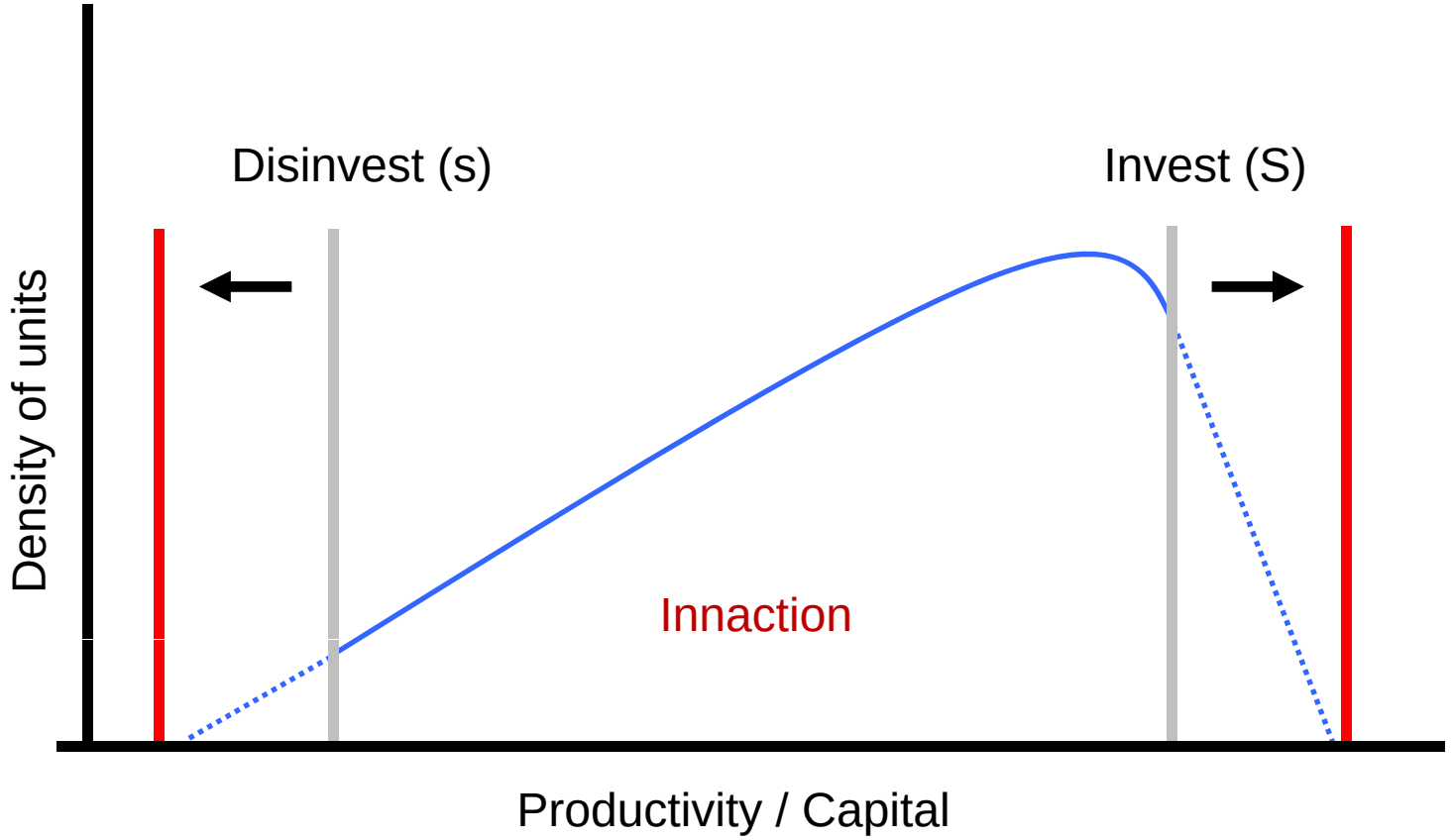
- Key early papers:
  - Capital: Bernanke (1983), McDonald & Siegel (1986), Bertola & Bentolila (1990), Dixit & Pindyck (1994)
  - Labor: Bertola and Bentolila (1990) on labor.

- Also idea behind my paper Bloom (2009) “Impact of uncertainty shocks” doing micro-macro in partial-equilibrium

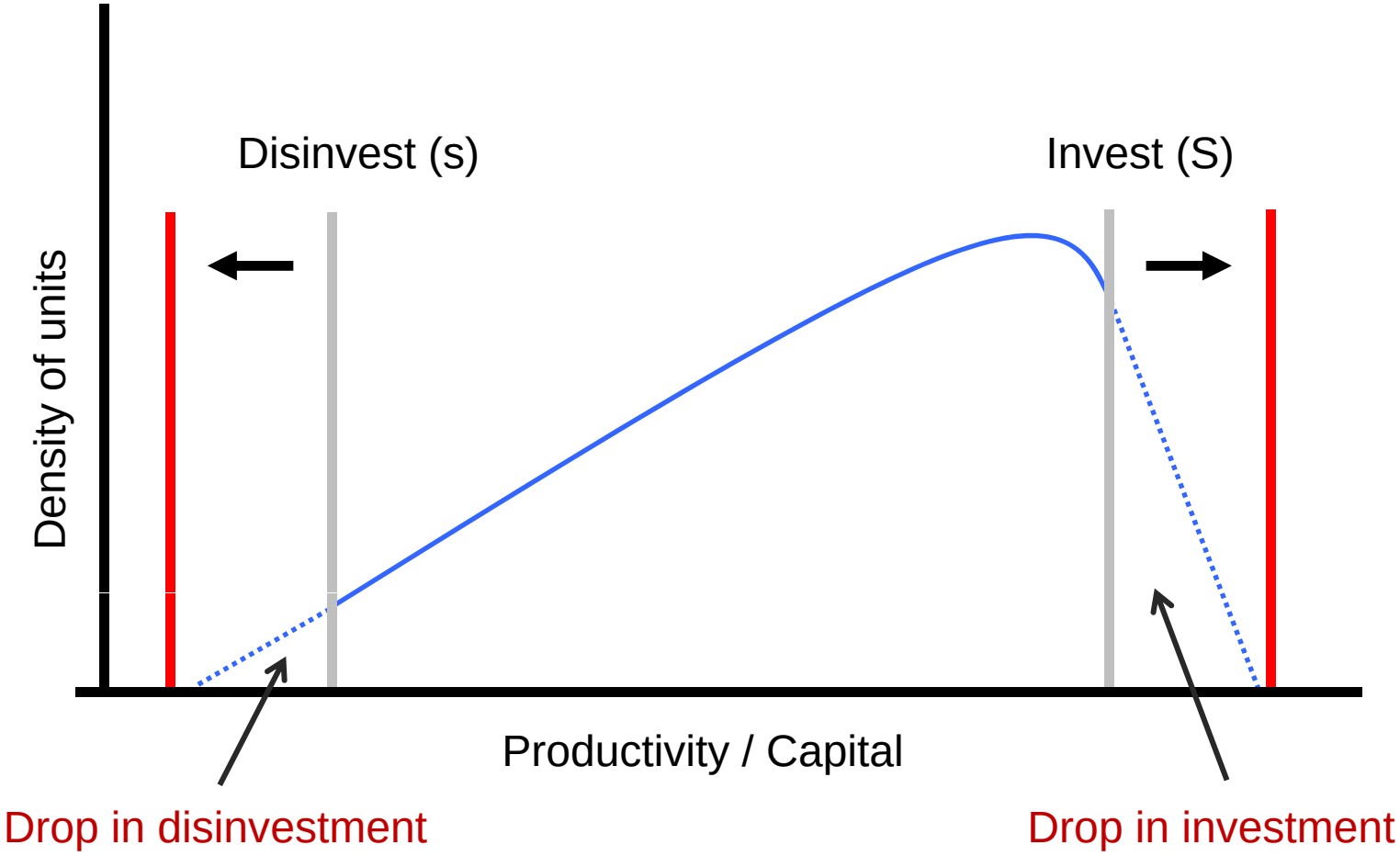
For investment and hiring real options lead to Ss models with investment/disinvestment thresholds



Increased uncertainty makes the SS thresholds move outwards



This leads net investment to fall, because investment drops more than disinvestment

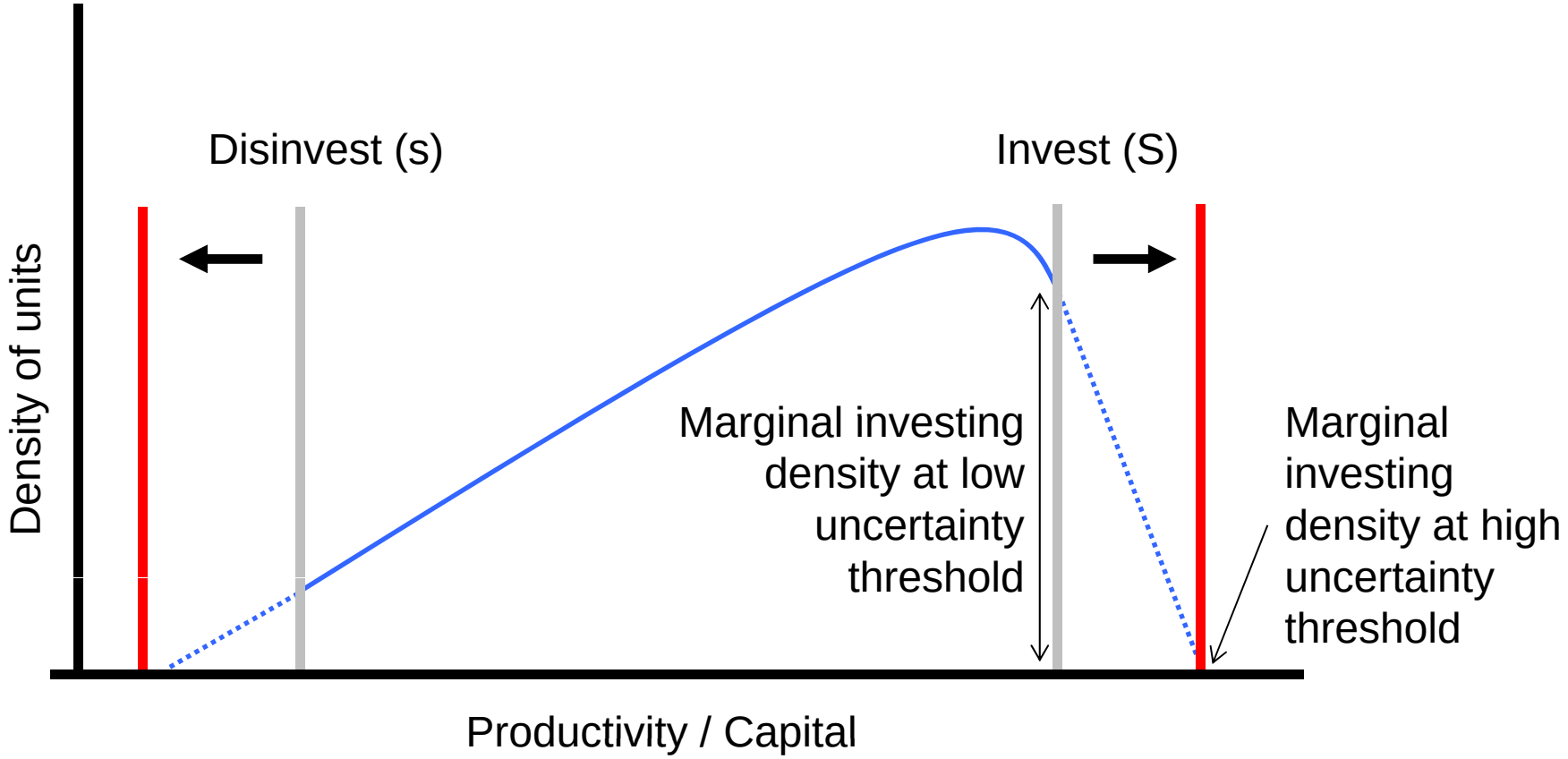


This leads to the:

"***Delay effect***": higher uncertainty leads firms to postpone decisions. So net investment (and hiring) falls

$\partial I/\partial \sigma < 0$ where I=investment or hiring, σ=uncertainty

Higher uncertainty also reduces responsiveness to stimulus (like prices, taxes and interest rates)



This leads to the :

"***Delay effect***": higher uncertainty leads firms to postpone decisions. So net investment and hiring falls

$\partial I/\partial \sigma < 0$ where I=investment or hiring, σ=uncertainty

"***Caution effect***": higher uncertainty reduces firms response to other changes, like prices or TFP

$\partial^2 I/\partial A \partial \sigma < 0$ where I and σ as above, A=prices or TFP

Summarize “Really uncertain business cycles” (Bloom, Floetotto, Jaimovich, Saporta & Terry, 2014)

- Large number of heterogeneous firms

$$y_{j,t} = A_t z_{j,t} k_{j,t}^{\alpha} n_{j,t}^{\nu} \ , \alpha + \nu < 1$$

- Macro productivity and micro productivity follow an AR process with time variation in the variance of innovations

$$\begin{aligned} \log(A_t) &= \rho_A \log(A_{t-1}) + \sigma_{t-1}^{A} \epsilon_t \\ \log(z_{j,t}) &= \rho \log(z_{j,t-1}) + \sigma_{t-1}^{Z} \epsilon_{j,t} \end{aligned}$$

- Uncertainty (σ^A and σ^Z) persistent: 2-point markov chain

Capital and labor adjustment costs

- Capital and labor follow the laws of motion:

$$\begin{aligned} k_{j,t+1} &= (1-\delta_k)k_{j,t} + i_{j,t} \\ n_{j,t} &= (1-\delta_n)n_{j,t-1} + s_{j,t} \end{aligned}$$

where i: investment δ_k: depreciation

s: hiring δ_n: attrition

- Allow for the full range of adjustment costs found in micro data
  - Fixed – lump sum cost for investment and/or hiring
  - Partial – per $ disinvestment and/or per worker hired/fired

Households

- We assume the following functional form for the household's utility function:

$$U(C, 1-N) = \ln(C) - \phi \frac{N^{\chi}}{\chi}$$

  - Separability of preferences yields simple SDF

$$m_{t,s} = \beta^{(s-t)} \frac{C_t}{C_s}$$

  - The FOC for hours worked

$$w_t = \phi N_t^{\chi-1} C_t$$

Firm's value function

$$V(k, n_{-1}, z; A, \sigma^A, \sigma^Z, \mu) =$$

$$\max_{i,n} \left\{ \begin{array}{c} Azk^{\alpha} n^{\nu} - w(A, \sigma^A, \sigma^Z, \mu) n - i - AC^k(k, k') - AC^n(n_{-1}, n) \\ + \\ E\left[m\left(A, \sigma^A, \sigma^Z, \mu; A', \sigma^{A\prime}, \sigma^{Z\prime}, \mu'\right) V(k', n, z'; A', \sigma^{A\prime}, \sigma^{Z\prime}, \mu') \right] \end{array} \right\}$$

- State variables:
  - Firm's capital stock: k
  - Firm's hours stock from last period: n_{-1}
  - Firm's current idiosyncratic productivity+demand: z
  - Aggregate productivity: A
  - Macro uncertainty: σ^A
  - Micro uncertainty: σ^Z
  - The joint distribution of firms over z, k and n_{-1}: μ

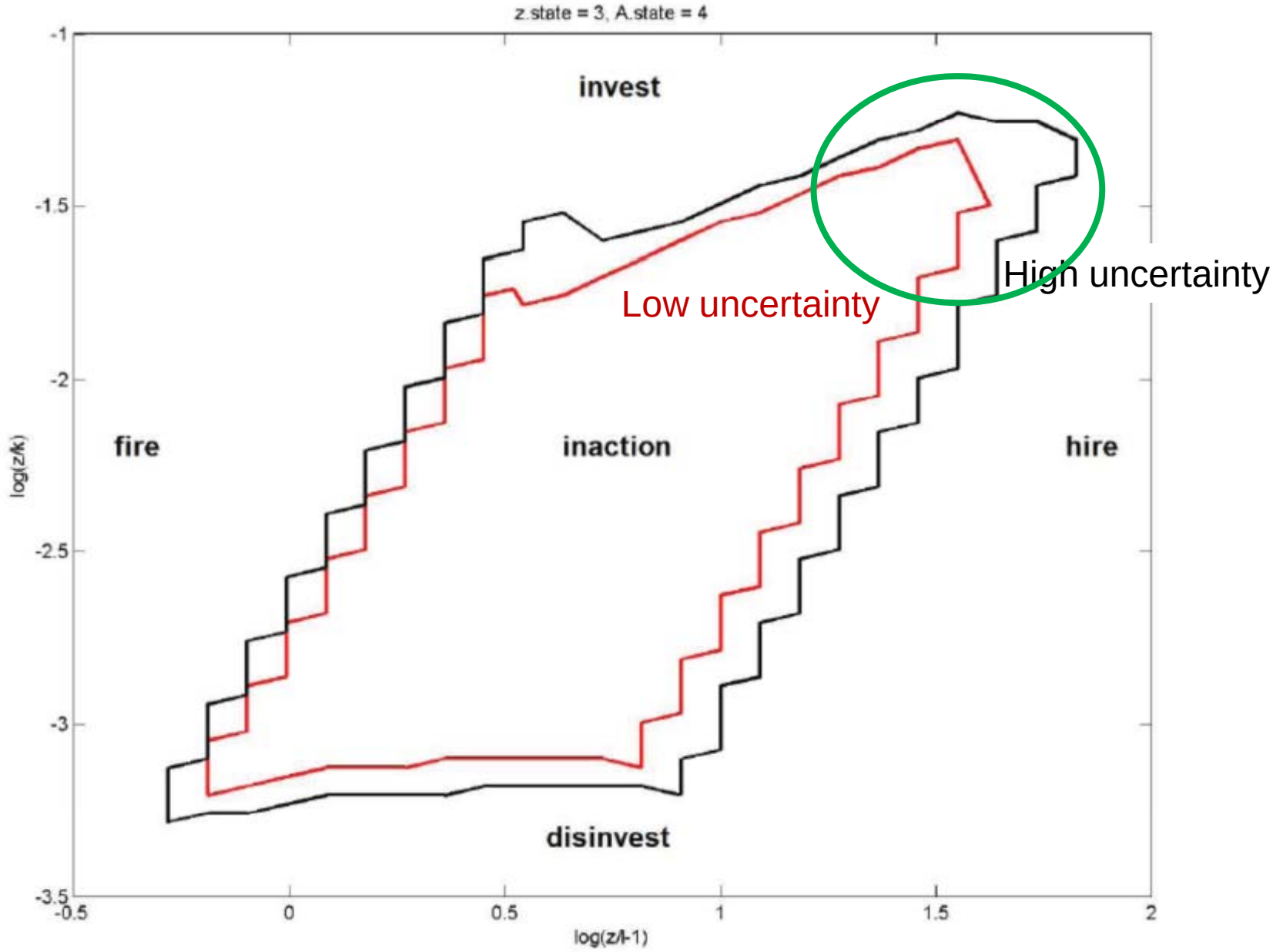
General equilibrium solution overview

- We have a recursive competitive equilibrium
- Solve numerically as no analytical solution
- Numerical solution approximates μ (the firm-level distribution over z, k and n) with moments, building particularly on Krusell and Smith (1998) and Khan and Thomas (2008)

Baseline calibration of the parameters

Table 5: Parameters in the Model		
Preferences and Technology		
β	$.95^{1/4}$	Annual discount factor of 95%
η	1	Unit elasticity of intertemporal substitution (Kahn and Thomas 2008)
θ	2	Leisure preference, households spend 1/3 of time working
χ	1	Infinite Frisch elasticity of labor supply (Kahn and Thomas 2008)
α	0.25	CRS production, isoelastic demand with 33% markup
ν	0.5	CRS labor share of 2/3, capital share of 1/3
ρ^A	0.95	Quarterly persistence of aggregate productivity (Kahn and Thomas 2008)
ρ^Z	0.95	Quarterly persistence of idiosyncratic productivity (Kahn and Thomas 2008)
Adjustment Costs		
δ_k	2.6%	Annual depreciation of capital stock of 10%
δ_n	8.8%	Annual labor destruction rate of 35% (Shimer 2005)
F^K	0	Fixed cost of changing capital stock (Bloom 2009)
S	34.0%	Resale loss of capital in % (Bloom 2009)
F^L	2.1%	Fixed cost of changing hours in % of annual wage bill (Bloom 2009)
H	1.8%	Per worker hiring/firing cost in % of annual wage bill (Bloom 2009)
Uncertainty Process		
σ^A_L	0.58%	Quarterly standard deviation of innovations to aggregate productivity
σ^A_H	$1.91 * \sigma^A_L$	Volatility in high aggregate uncertainty state
σ^Z_L	3.9%	Quarterly standard deviation of innovations to idiosyncratic productivity
σ^Z_H	$3.33 * \sigma^Z_L$	Volatility in high idiosyncratic uncertainty state
π^σ_{LH}	5.0%	Quarterly transition probability from low to high uncertainty
π^σ_{HH}	92.0%	Quarterly transition probability of remaining in high uncertainty

Since this model has 2-factors with adjustment costs it has a 2-dimensional response box



We simulate an uncertainty shock

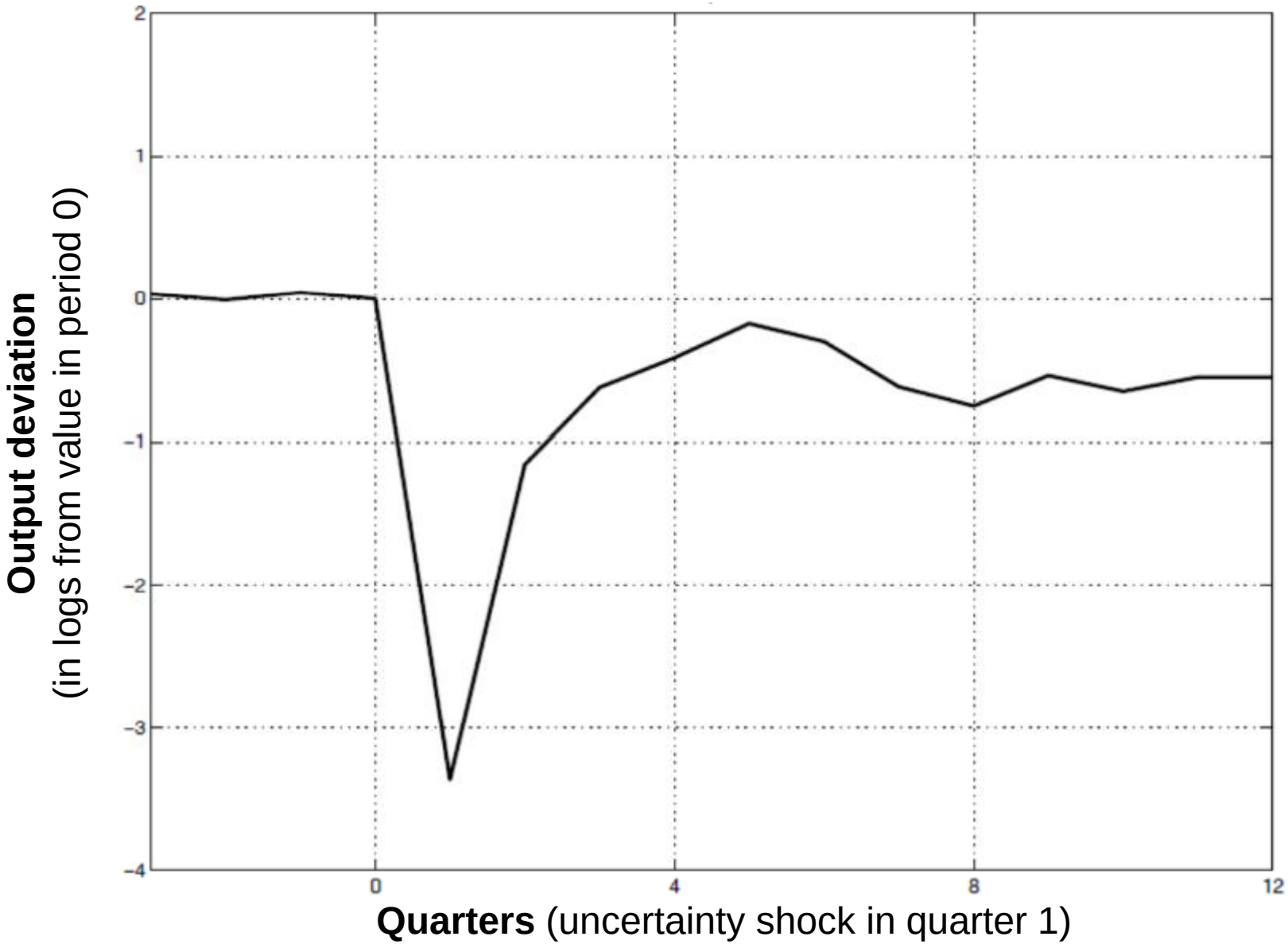
Simulation:

- Simulate the economy with 20,000 firms
- Repeat this 500 times and take the average

Shock:

- Let the model run for 100 periods
- Then move to high uncertainty in period 1, then allow uncertainty to evolve as normal – an uncertainty shock.

An uncertainty shock causes an output drop of about 3.5%, and a recovery to almost level within 1 year



Source: "Really Uncertain Business Cycles" by Bloom, Floetotto, Jaimovich, Saporta and Terry (2014)

Labor and investment drop and rebound, while TFP slowly drops and rebounds

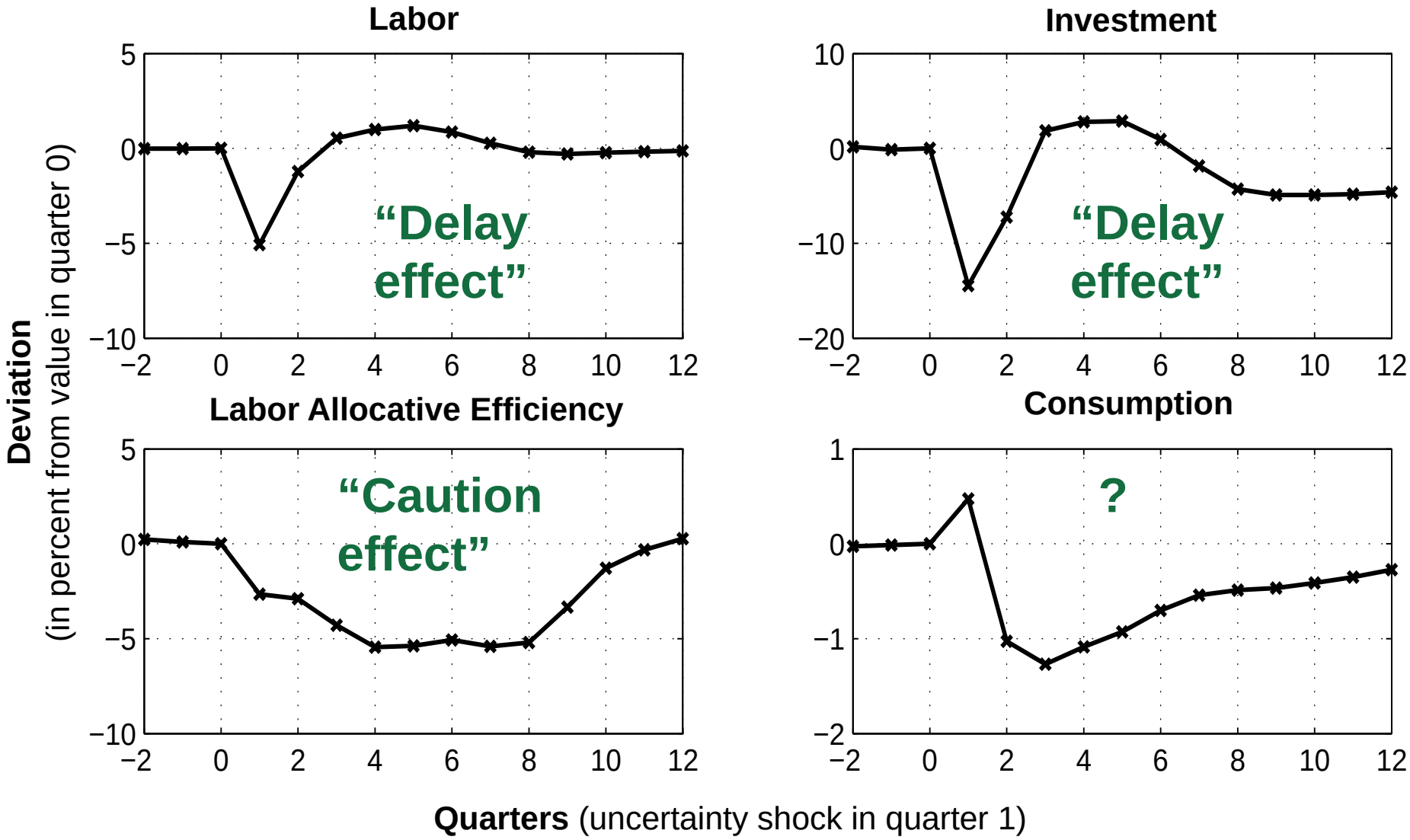
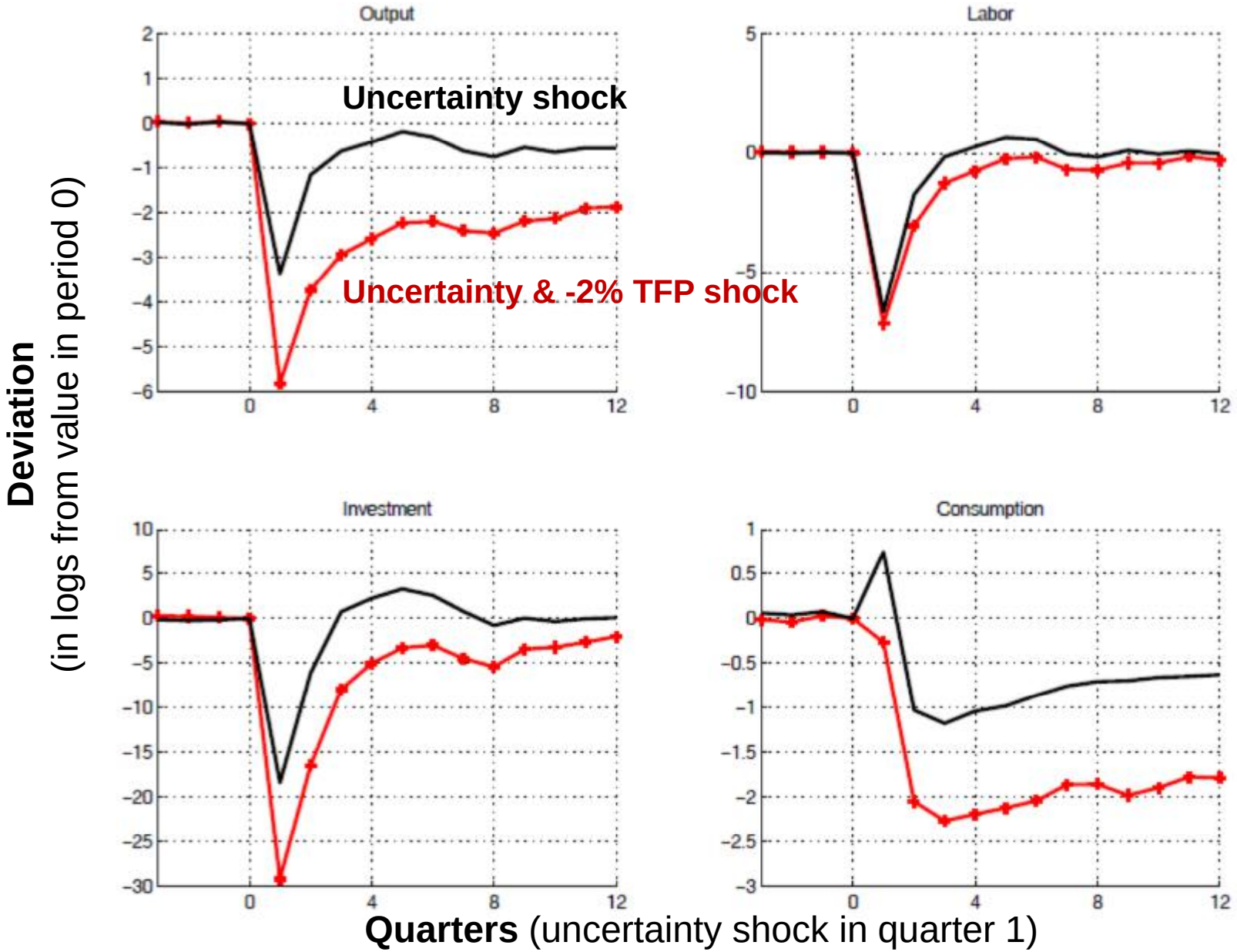
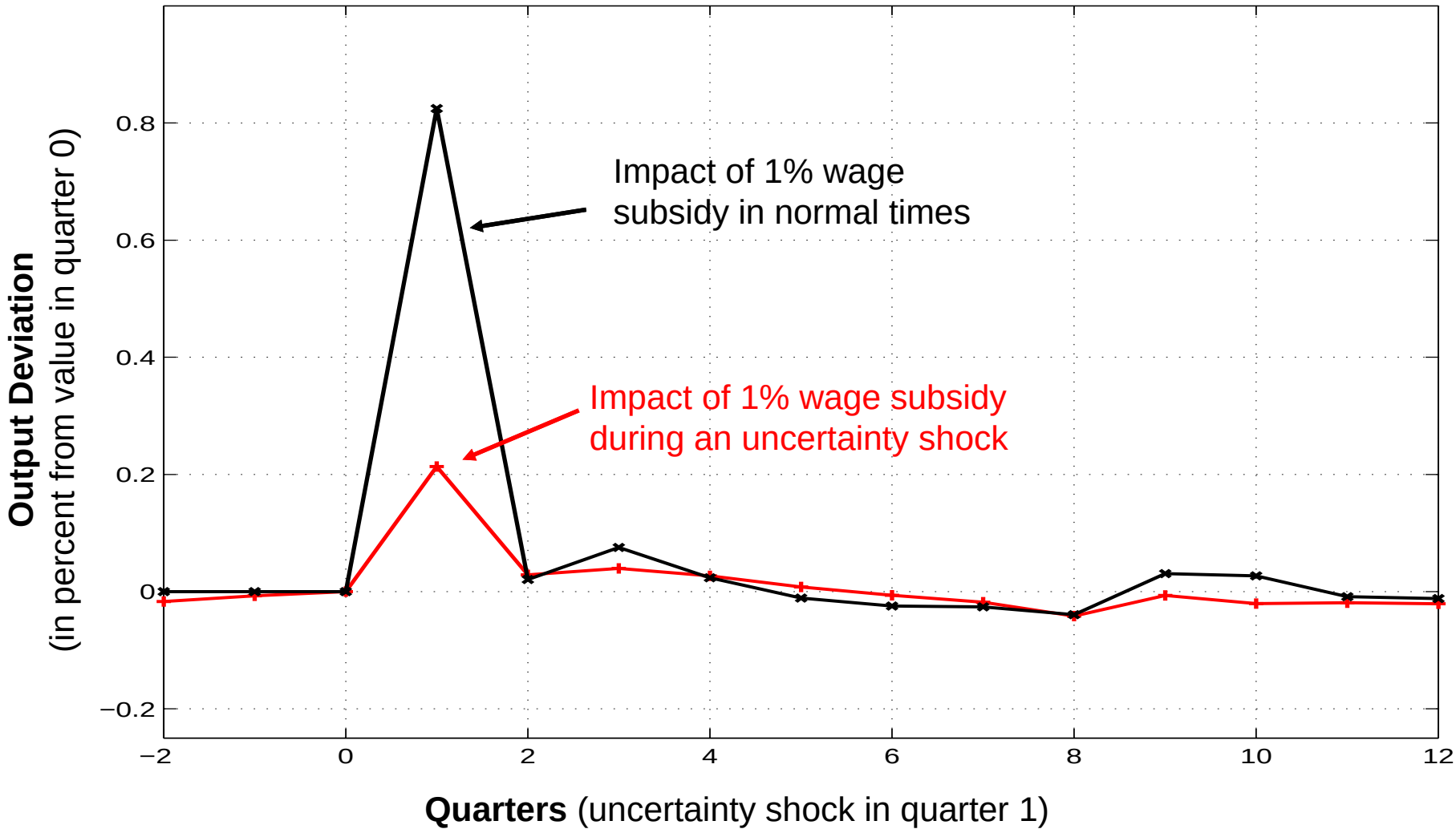


Figure 5: Adding a -2% first moment shocks increases the duration and helps to address consumption and firing issues



Also find rising uncertainty in a real options model makes policy less effective – this is the "caution effect"



Notes: Based on independent simulations of 2500 economies of 100-quarter length. For a wage subsidy in normal times (x symbols), we provide an unanticipated 1% wage bill subsidy to all firms in the quarter labelled 1, allowing the economy to evolve normally thereafter. We also simulate an economy with no wage subsidy in quarter 1, plotting the percentage difference between the cross-economy average subsidy and no subsidy output paths in each period. For the wage subsidy with an uncertainty shock (+ symbols), we repeat the experiment but simultaneously impose an uncertainty shock in quarter 1.

How general are these results? Real option effects only arise under certain conditions

1. You can wait – rules out now or never situations (e.g. patent races, first-mover games, auctions etc)

2. Investing now reduces returns from investing later – rules out perfect competition and constant returns to scale

3. You can act 'rapidly' – rules out big delays, which Bar-Ilan & Strange (1996) show generate offsetting growth options

4. Requires non-convex adjustment costs – fixed or partial irreversibility (rather than only quadratic) adjustment costs

Also uncertainty has to be rising (rather than permanently high)

- The early literature (e.g. Dixit and Pindyck, 1996) focused on constant uncertainty and did comparative statics on σ
- Reason is the maths of dealing with stochastic volatility (so a time varying σ_t) is very hard
- But steady-state impact of high uncertainty is actually very small (e.g. Abel and Eberly, 1999).
  - Intuition is all investment is delayed, so do last period's now and do this period's next period

For consumption there is also a real-options effect on durable expenditure

For consumers (like firms) sunk investments have option values if they can delay

The classic example is buying a car – you can always delay. If uncertainty is high the option value of waiting may be so high you do not purchase this period

Note: Non-durables do not satisfy the "Investing now reduces returns from investing later" criteria, so no option value of delay. e.g. Eating next year no substitute for eating this year

For consumption there is also a real-options effect on durable expenditure

Classic papers include:

Romer (1990) who showed a big drop of durable/non-durable expenditure during the Great Depression arguing this is due to Uncertainty

Eberly (1994) looked at US car purchases, showing higher uncertainty led to a *caution effect* (Ss bands moved out).

Wide range of potential sources of curvature, which are also theoretically ambiguous in sign

Negative Uncertainty Effects

- Adjustment costs (real options)
- **Utility functions (risk-aversion)** 
- Financial frictions (lump-sum costs)

Positive Uncertainty Effects

- Production functions (Oi-Hartman-Abel effects)
- Bankruptcy (Growth options)

Consumer risk aversion has seen an increase in interest recently

Classic idea is higher risk requires higher returns, reducing investment and hiring

Fernandez-Villaverde, Guerron, Rubio-Ramirez and Uribe (2011) use numerical methods to solve complex realistic models and find significant negative impacts

Gourio (2011) has higher-moment (left-tail) concerns that again generate drops in output

Ilut and Schneider (2012) use *ambiguity aversion* to demonstrate large negative effects (fear of the worst case)

Manager risk aversion is another channel as managers are typically not well diversified

While investors may be diversified (at least for publicly quoted firms) managers typically are not.

Managers hold human-capital in the firm (firm-specific training etc) and often financial capital (shares)

As a result they have a risk-return trade-off for the firm. So higher uncertainty should induce more cautious behavior, typically meaning less investment and hiring, Panousi and Papanikolaou (2011)

Wide range of potential sources of curvature, which are also theoretically ambiguous in sign

Negative Uncertainty Effects

- Adjustment costs (real options)
- Utility functions (risk-aversion)
- **Financial frictions (lump-sum costs)** 

Positive Uncertainty Effects

- Production functions (Oi-Hartman-Abel effects)
- Bankruptcy (Growth options)

Recent financial crisis have emphasized the role of uncertainty and finance

The 2007-2009 crisis clearly highlighted the issues of both finance and uncertainty, and natural to ask do they interact?

Many recent papers (e.g. Arrellano, Bai & Kehoe 2011, Gilchrist, Sim & Zakrajsek 2011, and Christiano, Motto & Rostango, 2011) emphasize uncertainty-finance interaction

They have an empirical and theory component – both suggest financial frictions and uncertainty amply each other

Wide range of potential sources of curvature, which are also theoretically ambiguous in sign

Negative Uncertainty Effects

- Adjustment costs (real options)
- Utility functions (risk-aversion)
- Financial frictions (lump-sum costs)

Positive Uncertainty Effects

- **Production functions (Oi-Hartman-Abel effects)** ⟵
- Bankruptcy (Growth options)

Non-linear revenue functions can also induce uncertainty effects (1/2)

- The Oi-Hartman-Abel effect (sometimes Hartman-Abel effect) based on the impact of uncertainty on revenue. Based on Oi (1961), Hartman (1972) and Abel (1983)

- The basic idea is that if capital and labor are costlessly adjustable variability is good for average revenue
  - When demand is high expand
  - When demand is low contract

Non-linear revenue functions can also induce uncertainty effects (2/2)

For example, for Cobb-Douglas if profits are:

$$\Pi = AK^{\alpha}L^{\beta} - rK - wL$$

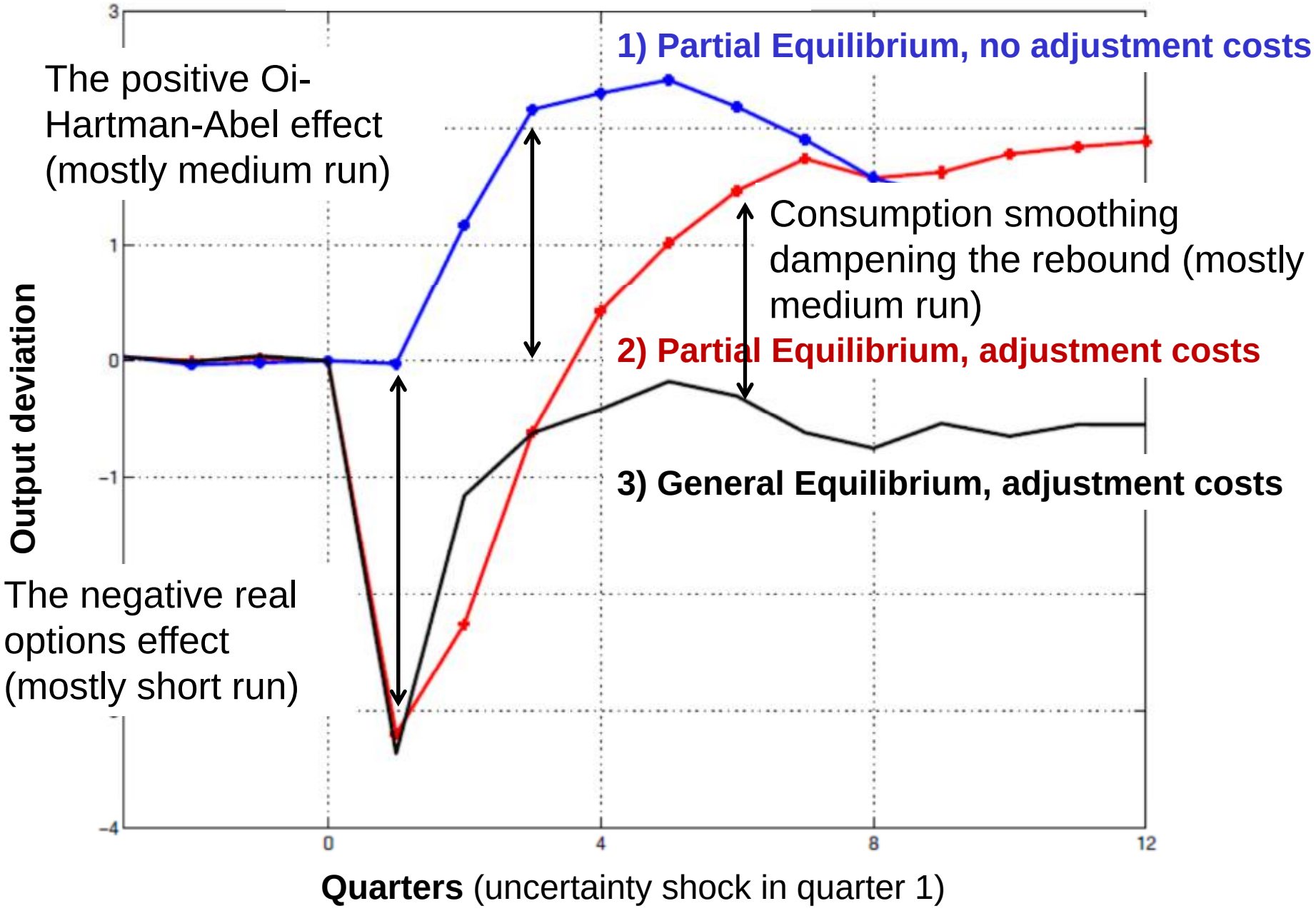
Then you obtain for optimal (flexible) capital and labor

$$K^* = \lambda_K A^{1/(1-\alpha-\beta)} \qquad L^* = \lambda_L A^{1/(1-\alpha-\beta)}$$

where λ_K and λ_L are constants

As a result K* and L* are convex in A, so a higher variance in A leads to higher average K and L

Decomposing the impact of uncertainty on output



Wide range of potential sources of curvature, which are also theoretically ambiguous in sign

Negative Uncertainty Effects

- Adjustment costs (real options)
- Utility functions (risk-aversion)
- Financial frictions (lump-sum costs)

Positive Uncertainty Effects

- Production functions (Oi-Hartman-Abel effects)
- **Bankruptcy (Growth options)** 

Growth options literature assumes a prior stage – invest to get the option to invest again

Examples include:

- Oil exploration may provide a production option (Paddock, Siegel & Smith, 1988, QJE).
- Investing in R&D which yields an option to produce the potential invention.
- Internet start-ups as option on the technology

UBER

Bar-Ilan and Strange (1996, AER) formalized this:

- if investment pay-off is uncertain & delayed
- growth-options increase in value with uncertainty

To summarize - uncertainty needs curvature to matter and many potential sources

Negative Uncertainty Effects

- Adjustment costs (real options)
- Utility functions (risk-aversion)
- Financial frictions (lump-sum costs)

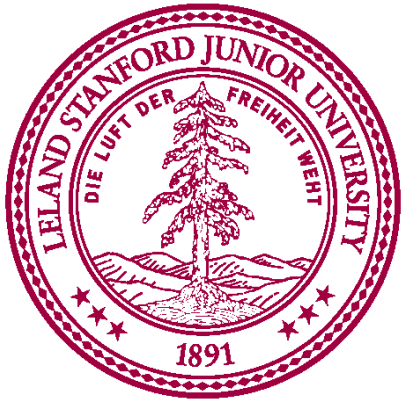
Positive Uncertainty Effects

- Production functions (Oi-Hartman-Abel effects)
- Bankruptcy (Growth options)

Given ambiguous impact what does the data say: empirics

End of Lecture 2 (theory)

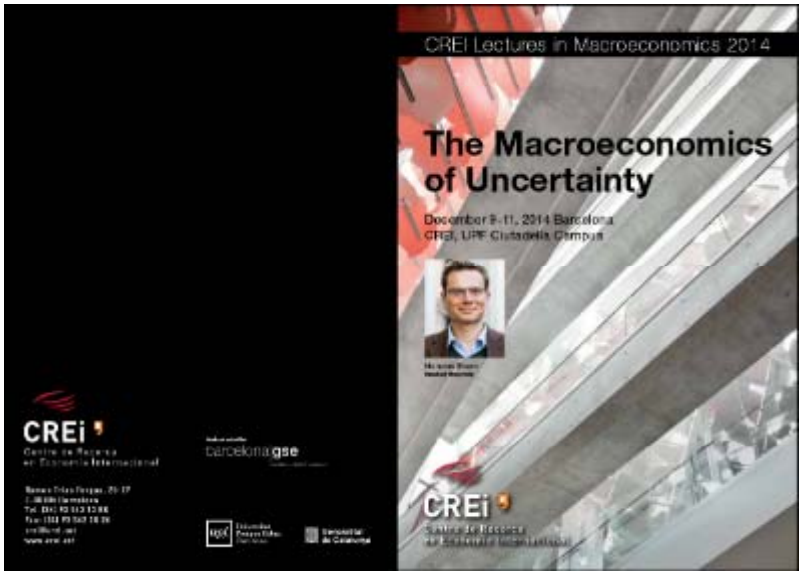
Thanks and questions

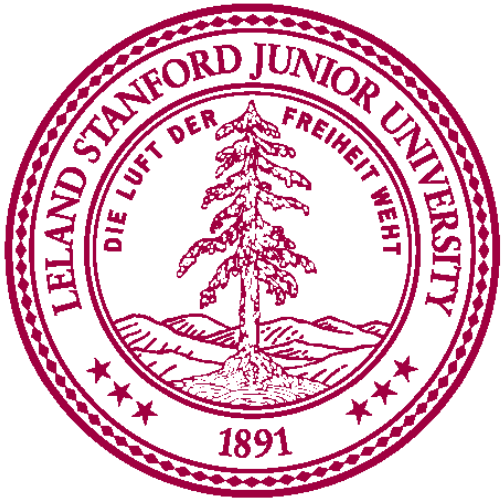


The Macroeconomics of Uncertainty: Lecture 3, Empirics

Nick Bloom (Stanford & NBER)

CREI, December 2014





Recap from last two days

Recent interest in uncertainty as a driver of business cycles

Lecture 1: Measuring uncertainty:

- Evidence that micro and macro is countercyclical

Lecture 2: Theory requires curvature for uncertainty to matter

- “Real-options” (adjustment costs): Negative channel and probably best known (e.g. Dixit and Pindyck, 1996)
- “Financial” & “risk aversion”: other major negative channels
- “Oi-Hartman-Abel” & “Growth Options”: positive channels

So *net* impact of uncertainty is an empirical question

End of Recap

Todays Lecture is on Empirics

In summary the empirical evidence on uncertainty is weaker than the theory

Measurement: not ideal, a lot of proxies exist but none of them is ideal – hence why I show so many measures…

Identification: very hard to get a clear causal relationship, indicative but few/any papers get beyond that

So obviously a great area to work in…..

Impact of uncertainty on growth

Micro evidence

Macro evidence

Identification and reverse causality

Micro papers on firms typically find negative effects of uncertainty on investment, e.g.

- Leahy and Whited (1996,JMCB) classic in the literature.
  - Build a firm-by-year panel (Compustat)
  - Regresses investment on Tobin's Q and stock-return volatility (using daily data within each year)
  - Used lagged values as instruments for identification

- Find a significant negative effect of uncertainty on investment, but nothing for covariance

Classic negative uncertainty result (Leahy and Whited, 1996 JMCB)

TABLE 2

THE EFFECT ON ONE-PERIOD UNCERTAINTY FORECASTS ON INVESTMENT: FULL SAMPLE

Tobin's q	0.024 (0.009)	—	0.022 (0.023)	—	0.025 (0.010)	—	−0.061 (0.208)
Variance	—	−0.538 (0.276)	−0.054 (0.536)	—	—	−0.768 (0.388)	−2.51 (5.80)
Covariance	—	—	—	−0.057 (0.087)	0.153 (0.155)	0.153 (0.155)	0.413 (0.867)

NOTES: The sample consists of six[illegible]ufacturing firms from the COMPUSTAT database from the 1982 to 1987. The dependent variable is Investment/C[illegible]rd errors, calculated using the procedure in Newey (1984), are in parentheses.

"Delay effect"

Other papers have also found good micro-data evidence of negative uncertainty impacts

- Guiso and Parigi (1999, QJE) used Italian survey data on firms expectations of demand

- Bloom, Bond and Van Reenen (2007,REStud) build a model and estimated on UK data using GMM

- Both find evidence of
  - "delay effect" reducing investment levels
  - "caution effect: reducing investment responsiveness

Review of Economic Studies (2007) **74**, 391–415 0034-6527/07/00140391$02.00

Uncertainty and Investment Dynamics

NICK BLOOM
Stanford University, Centre for Economic Performance, and NBER

STEPHEN BOND
Institute for Fiscal Studies and University of Oxford

and

JOHN VAN REENEN
London School of Economics,
Centre for Economic Performance, and CEPR

First version received February 2001; *final version accepted September* 2006 (*Eds.*)

This paper shows that with (partial) irreversibility higher uncertainty reduces the *responsiveness* of investment to demand shocks. Uncertainty increases real option values making firms more cautious when investing or disinvesting. This is confirmed both numerically for a model with a rich mix of adjustment costs, time-varying uncertainty, and aggregation over investment decisions and time and also empirically for a panel of manufacturing firms. These "cautionary effects" of uncertainty are large—going from the lower quartile to the upper quartile of the uncertainty distribution typically halves the first year investment response to demand shocks. This implies the responsiveness of firms to any given policy stimulus may be much weaker in periods of high uncertainty, such as after the 1973 oil crisis and September 11, 2001.

TABLE 5

Econometric estimates using U.K. company data

Dependent variable: $(I_{it}/K_{i,t-1})$	(1)	(2)	(3)	(4)	(5)
Sales growth (Δy_{it})	0·259	0·151	0·382	0·400	0·413
	(0·072)	(0·059)	(0·136)	(0·139)	(0·139)
Cash flow $(C_{it}/K_{i,t-1})$	0·206	0·263	0·260	0·255	0·272
	(0·135)	(0·132)	(0·124)	(0·126)	(0·125)
Lagged cash flow $(C_{i,t-1}/K_{i,t-2})$	0·303	0·269	0·272	0·288	0·273
	(0·086)	(0·082)	(0·075)	(0·075)	(0·076)
Error correction term $(y-k)_{i,t-1}$	0·062	0·056	0·054	0·0	53
	(0·030)	(0·030)	(0·026)	(0·0	26)
Sales growth squared $(\Delta y_{it})^2$		0·481	0·513	0·4	00
		(0·175)	(0·152)	(0·1	51)
Change in uncertainty $(\Delta \mathrm{SD}_{it})$			−0·023	−0·012	
			(0·012)	(0·008)	
Lagged uncertainty $(\mathrm{SD}_{i,t-1})$			−0·015		
			(0·011)		
Uncertainty × sales growth $(\mathrm{SD}_{it} * \Delta y_{it})$			−0·162		
			(0·067)		
Goodness of fit—Corr$(I/K, \widehat{I/K})^2$	0·259	0·287	0·285	0·285	0·307
Serial correlation (p-value)	0·047	0·102	0·069	0·078	0·091
Sargan–Hansen (p-value)	0·510	0·709	0·699	0·629	0·560

"Delay effect"

"Caution effect"

Some recent work has taken a more structural approach estimating the impact of uncertainty

Kellogg (2014, AER) for example uses oil drilling data and shows that firms pause drilling activity when oil price uncertainty jumps (“delay effect”).

Also shows taking uncertainty into account increases firm values by about 25% - so this matters

Given this – maybe not surprising that oils firms use derivatives data to forecast future oil price uncertainty

Impact of uncertainty on growth

Micro evidence

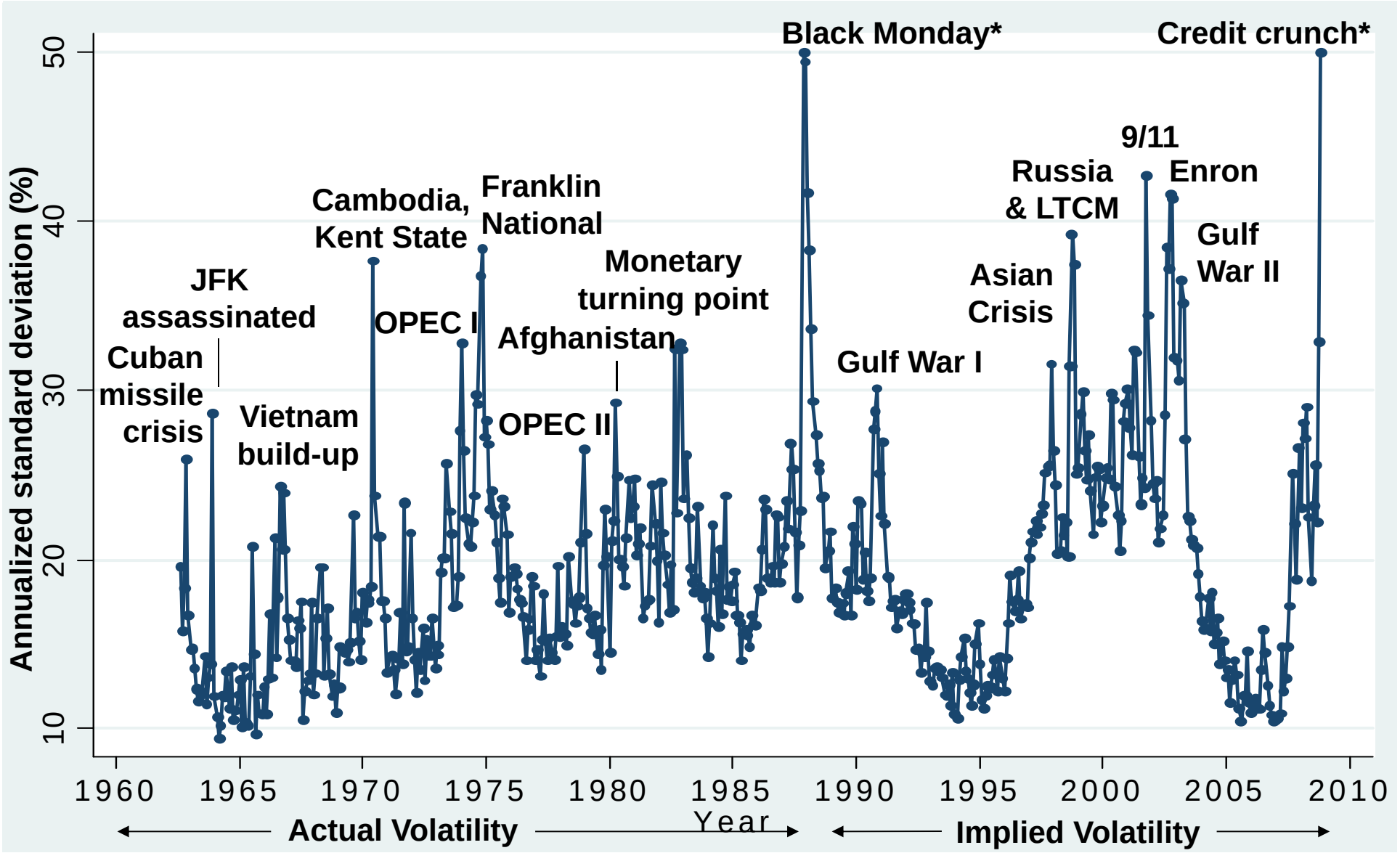
Macro evidence

Identification and reverse causality

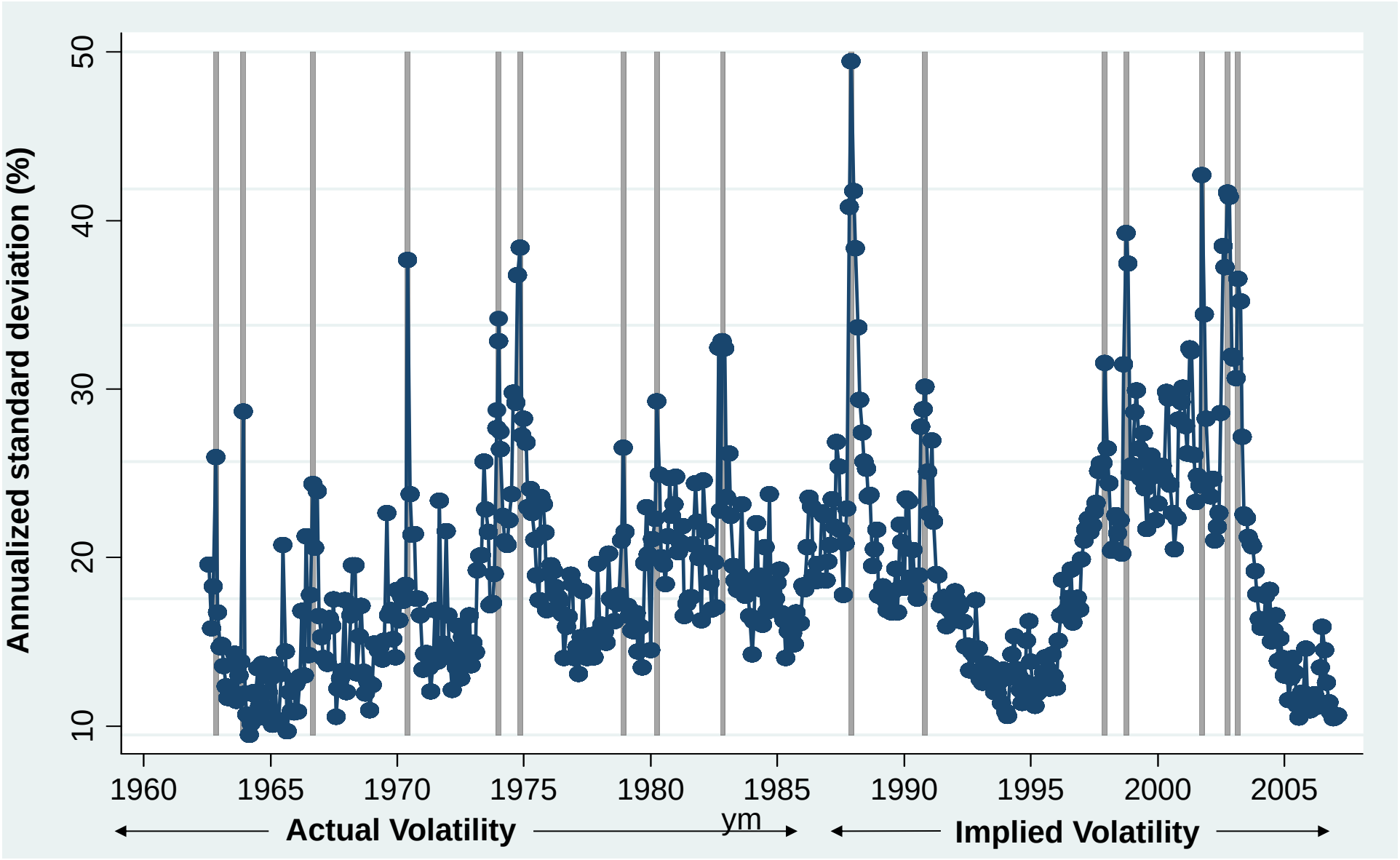
Early papers used a cross-country approach

- Ramey and Ramey (1995, AER) provided evidence on volatility and growth, using Government expenditure as an instrument for volatility, and strong negative relationship
- Engel and Rangel (2008, RFS) update this using large cross-country panel and a better volatility measures, and again find a large negative correlation with growth
- Broadly speaking in both the cross-section and time-series volatility is associated with lower growth

Other papers use high-frequency VARs on uncertainty shocks, Bloom (2009, Econometrica)



For greater exogeneity I used 1/0 indicators for big jumps (in robustness just the 11 oil/war/terror jumps)



Found reasonably large impacts of uncertainty (controlling for the 1st moment via stock-prices)

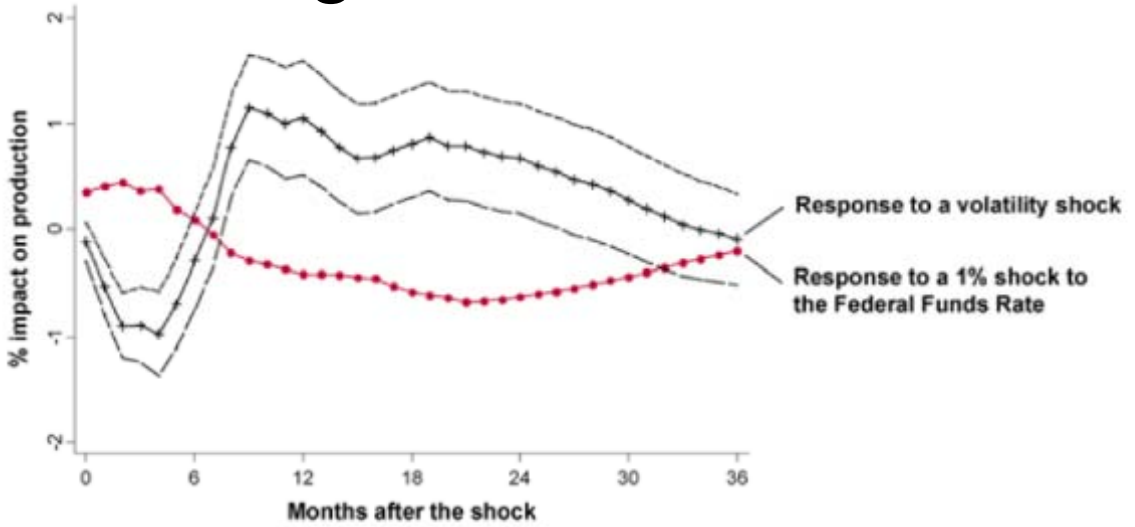


FIGURE 2.—VAR estimation of the impact of a volatility shock on industrial production. *Notes*: Dashed lines are 1 standard-error bands around the response to a volatility shock.

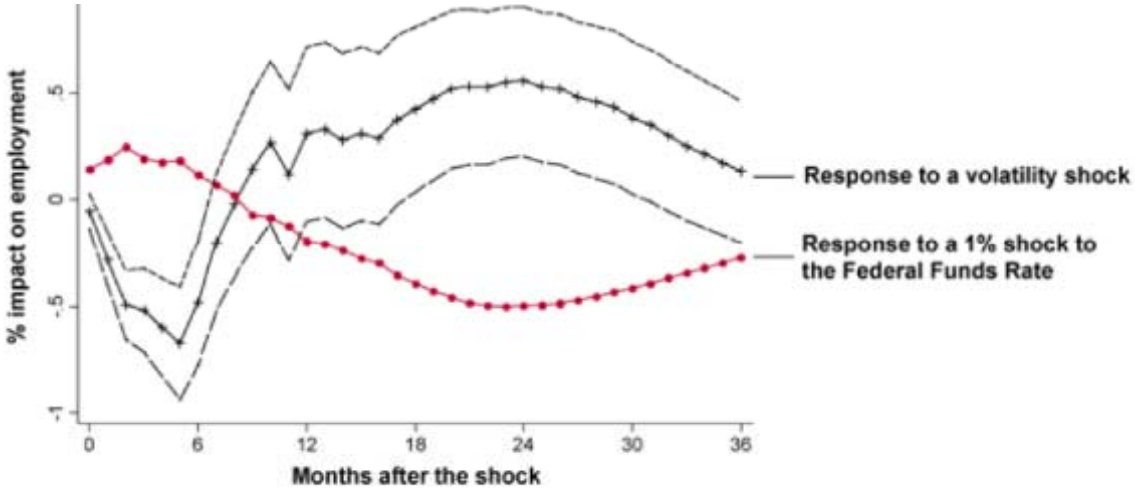
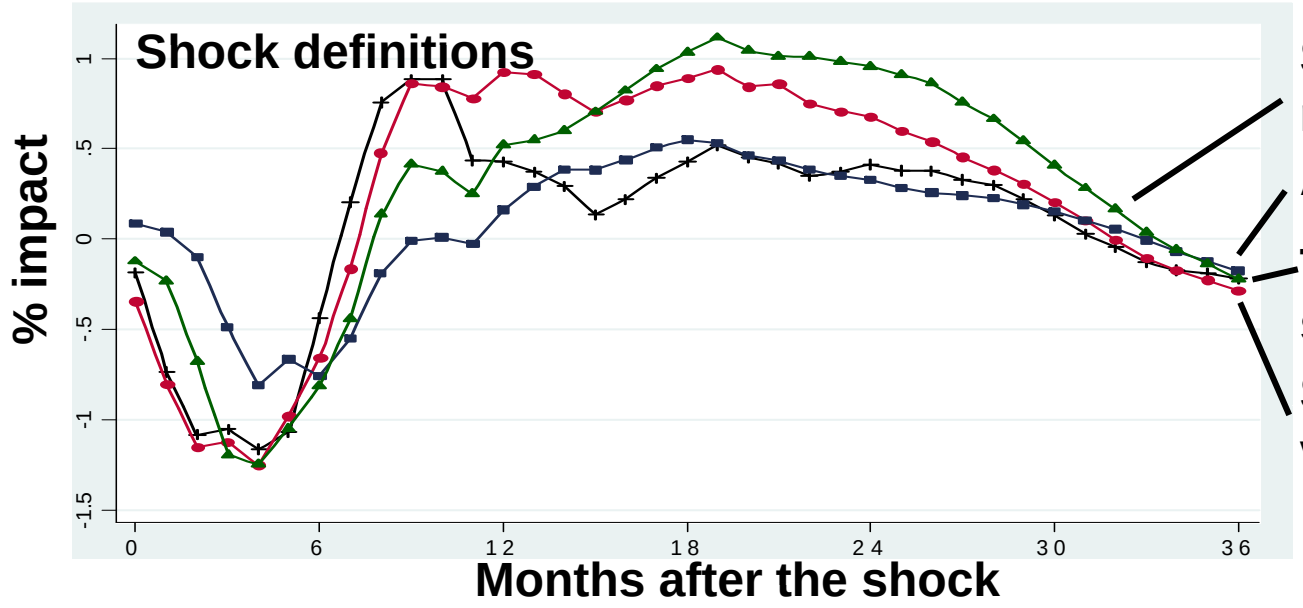


FIGURE 3.—VAR estimation of the impact of a volatility shock on employment. *Notes*: Dashed lines are 1 standard-error bands around the response to a volatility shock.

Source: Cholesky VAR estimates using monthly data from June 1962 to June 2008, variables in order include stock-market levels, VIX, FFR, log(ave earnings), log (CPI), hours, log(employment) and log (IP). All variables HP detrended (lambda=129,600). Reults very robust to varying VAR specifications (i.e. ordering, variable inclusion detrending etc).
Source: Bloom (2009)

Also VAR seems robust to shocks and ordering….



Shocks dated by first month

Actual volatility series

Terror, War and Oil shocks only

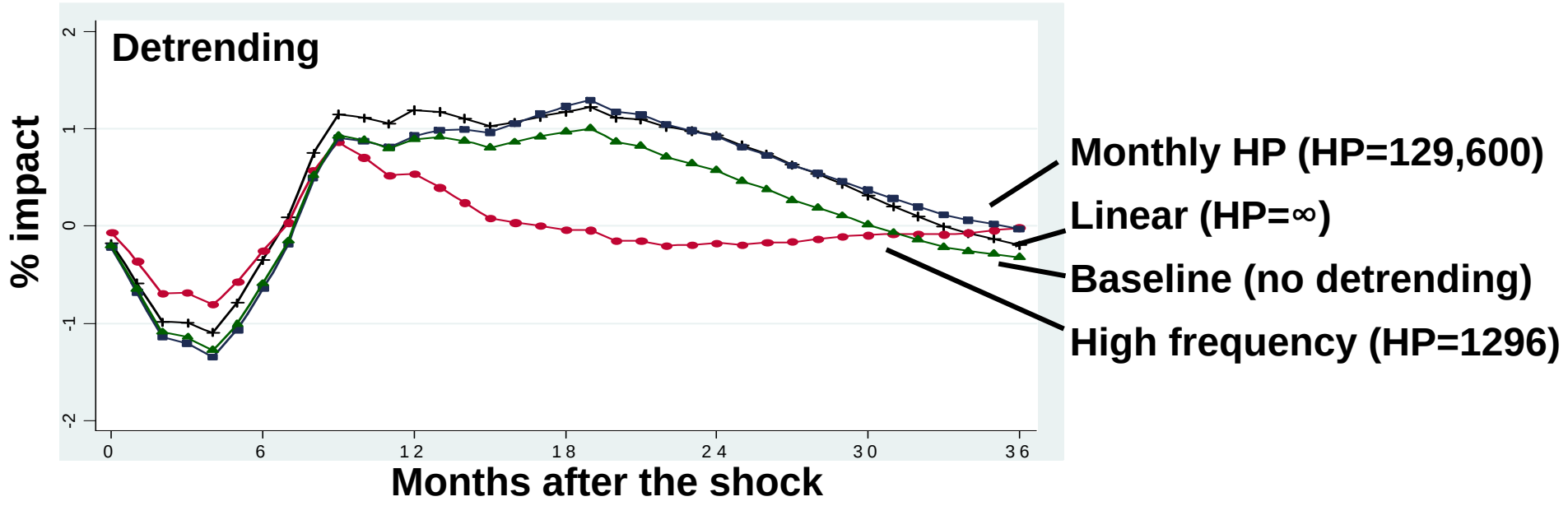
Shocks scaled by actual volatility

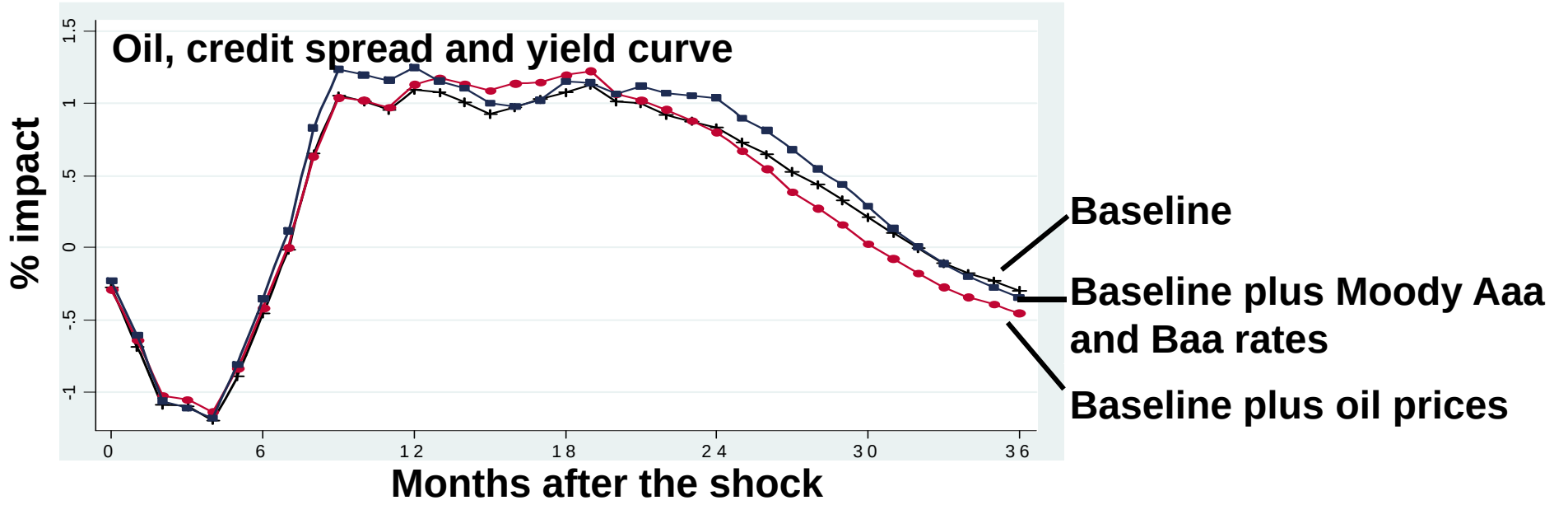
Trivariate (shocks, employment & production)

Reverse trivariate (production, employment & shocks)

Bivariate (shocks and production)

….as well as detrending and variable inclusion





This result -output drops after rises in uncertainty - seems to have survived the test of time in other papers (e.g. from last week)

What Drives Business Cycle Fluctuations: Aggregate or Idiosyncratic Uncertainty Shocks?

Mohan Bijapur [a]

London School of Economics

November 2014

Abstract

We study jointly the roles of aggregate and idiosyncratic uncertainty shocks in driving business cycle fluctuations. By decomposing total stock return volatility of over 20,000 publicly-listed US firms from 1962 to 2012, we construct separate indices for aggregate and idiosyncratic uncertainty, and run a horse race between them in an otherwise standard macroeconomic VAR. We find that idiosyncratic

FIGURE 9: IMPULSE RESPONSE FUNCTIONS (EFFECTS OF SHOCKS ON INDUSTRIAL PRODUCTION)

The figure depicts the impulse responses of real industrial production growth to a one standard deviation orthogonalized shock to all variables.

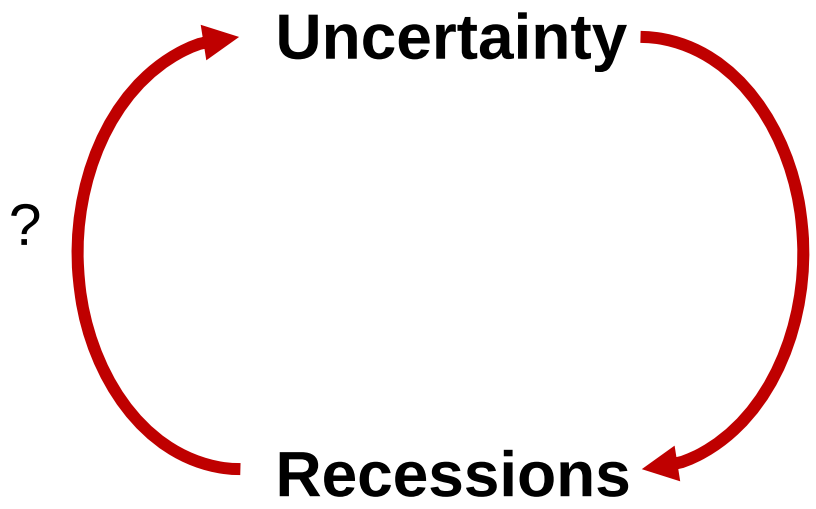
Impact of uncertainty on growth

Micro evidence

Macro evidence

Identification and reverse causality

Question is what causes what?



Focus of the theory discussed earlier and also my work (e.g. Bloom et al. 2014)

Good reasons to worry about reverse causality, e.g.

- “Krugman story”: recessions a good time for Governments to try new policies, as in Pastor and Veronesi (2012)

- Learning: Fajgelbaum, Schaal & Taschereau-Dumouchel (2014) activity generating information, so recessions increase uncertainty and visa-versa (the “uncertainty trap”)
  - builds on Chamley and Gale (1994), and Van Nieuwerburgh and Veldkamp (2006)

- Forecasting: Orlik and Veldkamp (2014) argue recessions impede forecasting future outcomes

The evidence on causality between uncertainty and recessions is weak, and an active research area

- In Baker and Bloom (2012) use disasters as instruments and find a negative causal impact of uncertainty on growth

- Stein and Stone (2013) use energy and currency instruments in firm data finding a large causal impact of uncertainty on investment, hiring and advertising but positive on R&D

But still an open and very interesting research question

The Effect of Uncertainty on Investment, Hiring, and R&D:
Causal Evidence from Equity Options

Luke C.D. Stein
Arizona State University

Elizabeth C. Stone*
Analysis Group

October 4, 2013 (this version)

There is wide debate over the impact of uncertainty on firm behavior, due to the difficulty both of measuring uncertainty and of identifying causality. This paper takes three steps that attempt to address these challenges. First, we develop an instrumental variables strategy that exploits firms' differential exposure to energy and currency prices and volatility. For example, airlines are negatively affected by high oil prices while oil refiners benefit from them, but both are sensitive to oil price volatility; retailers, in comparison, are not particularly sensitive to either the level or volatility of oil prices. Second, we use the expected volatility of stock prices as implied by equity options to obtain forward-looking measures of uncertainty over firms' business conditions. Finally, we examine how uncertainty affects a range of outcomes: capital investment, hiring, research and development, and advertising. We find that uncertainty depresses capital investment, hiring, and advertising, but encourages R&D spending. This perhaps surprising result for R&D is consistent with

Stein & Stone (2013) find a negative effect of uncertainty on investment, hiring and advertising…

Table 3: IV estimates—Capital investment

	(1) OLS	(2) IV Baseline	(3) IV Real. vol	(4) IV Compustat	(5) IV Quarterly
Implied vol_{t-1}	-0.0523***	-0.0893***			-0.0691***
	(0.0181)	(0.0262)			(0.0194)
Realized vol_{t-1}			-0.0499***	-0.0395**	
			(0.0134)	(0.0198)	
Tobin's q_{t-1}	0.0170***	0.0279***	0.0266***	0.0213***	0.00957***
	(0.00146)	(0.00519)	(0.00559)	(0.00675)	(0.00163)
Observations	20789	20789	20789	46665	88684
F: vol first stg		32.6	507.2	13.9	9.1
F: q first stg		18.4	18.4	50.8	4.4

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. Dependent variable in all regressions is I_t/K_{t-1}, and all include firm and time fixed effects (annual in columns 1–4, quarterly in column 5). Standard errors two-way clustered by period and year reported in parentheses.

Note: Estimation samples are as described in Appendix B: columns 1–3 use the main annual sample, column 4 does not require the availability of lagged implied volatility, and column 5 uses the quarterly sample. Variables are calculated as described in Appendix A. Instruments are energy/currency price and volatility exposures using sensitivities from 1996–2000

…but, Stein & Stone (2013) find a positive effect of uncertainty on R&D (growth options?)

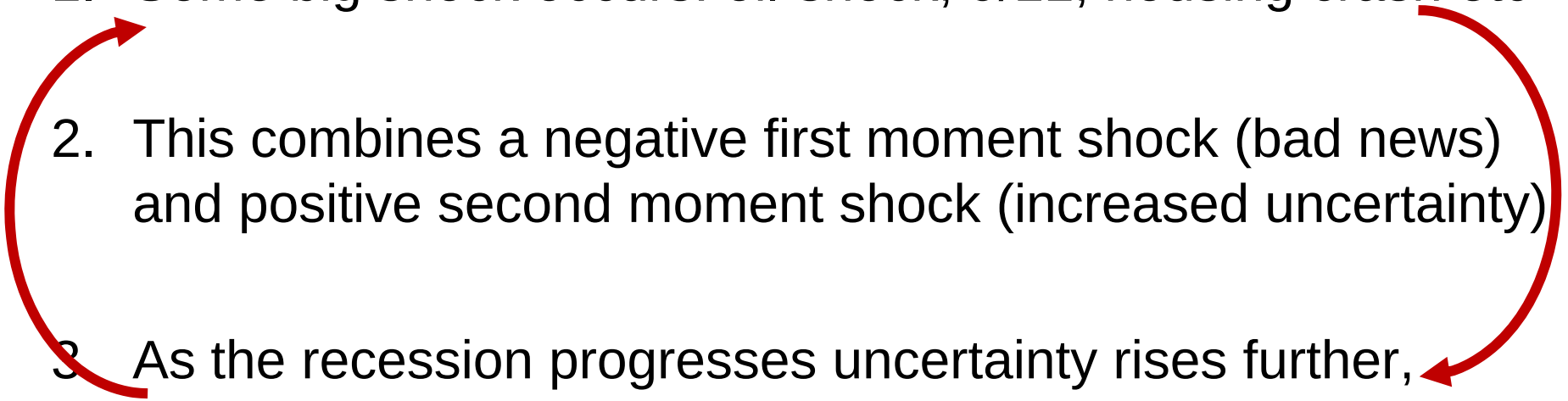
Table 5: IV estimates—Research and development

	(1) OLS	(2) IV Baseline	(3) IV Real. vol	(4) IV Compustat	(5) IV Alt q
Implied vol$_{t-1}$	-0.00168	0.0961***			0.142***
	(0.0200)	(0.0296)			(0.0324)
Realized vol$_{t-1}$			0.0514***	0.0772***	
			(0.0193)	(0.0251)	
Tobin's q_{t-1}	0.00776***	0.0218***	0.0229***	0.0261***	
	(0.00125)	(0.00315)	(0.00325)	(0.00240)	
"R&D q"$_{t-1}$ (log)					0.0836***
					(0.0105)
Observations	8810	8810	8810	17877	8748
F: vol first stg		56.5	9.9	23.5	86.1
F: q first stg		10.9	10.9	25.7	59.1

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. Dependent variable in all regressions is R_t/G_{t-1}, and all include firm and annual fixed effects. Standard errors two-way clustered by year and year reported in parentheses.

My view is uncertainty is both a cause and effect

1. Some big shock occurs: oil-shock, 9/11, housing crash etc
2. This combines a negative first moment shock (bad news) and positive second moment shock (increased uncertainty)
3. As the recession progresses uncertainty rises further, deepening and lengthening the slowdown



Hence, I see uncertainty as both an:

- Impulse
- Amplification and propagation mechanism

Wide range of open questions

- Modelling: Combining together cause and effect in models, and splitting out short and long run (e.g. cycles vs growth)

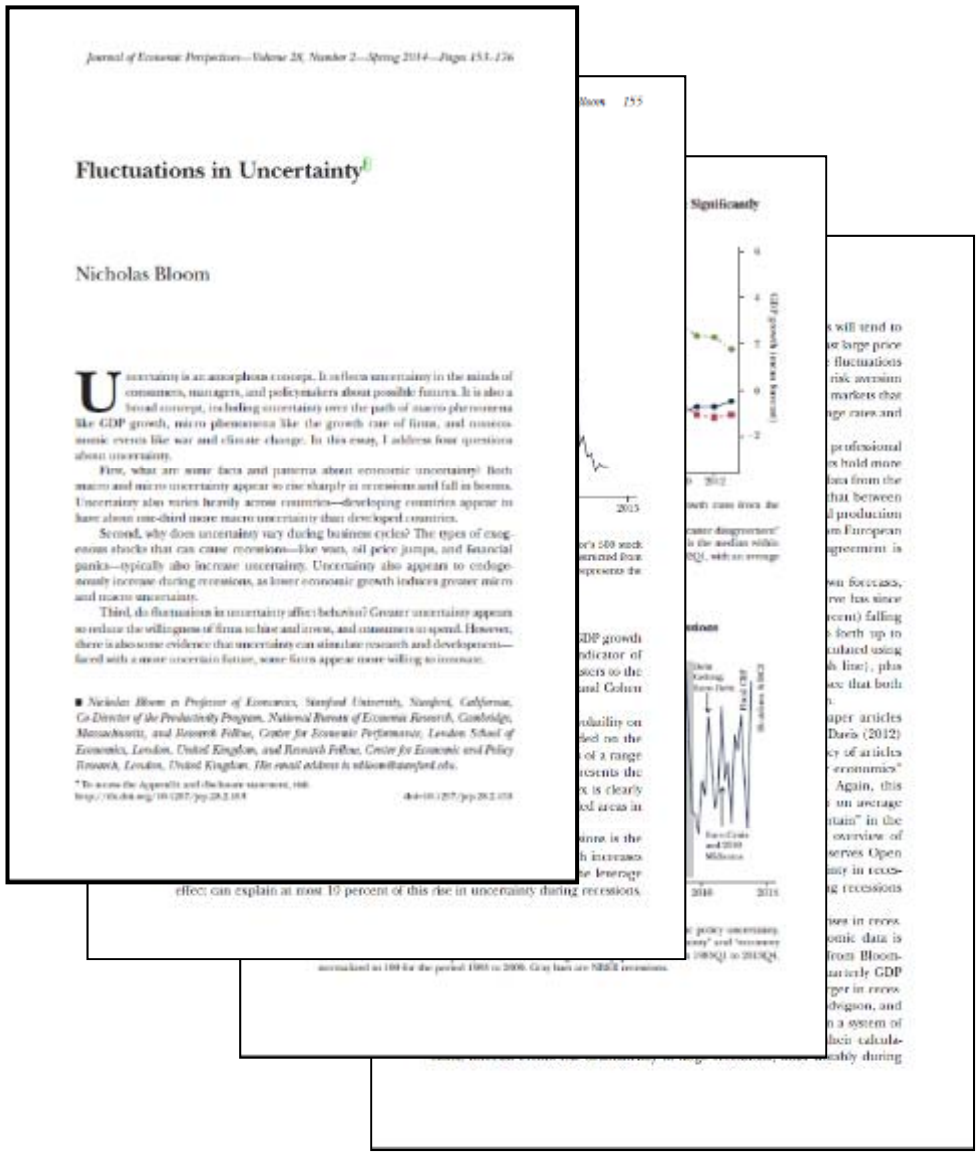
- Measurement: of macro and micro uncertainty over time and space (countries, regions, industries and firms).

- Impact: identifying cause vs effect (e.g. natural experiments or more structural work)

- Mechanisms: many theory channels but which matter most?

- Computation: include higher-moments in micro-macro models with other focuses (finance, consumers, reallocation etc)

Further reading JEP survey and draft JEL survey (with Fernandez-Villaverde and Schneider)….



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Fluctuations in Uncertainty

Nicholas Bloom

Uncertainty is an amorphous concept. It reflects uncertainty in the minds of consumers, managers, and policymakers about possible futures. It is also a broad concept, including uncertainty over the path of macro phenomena like GDP growth, micro phenomena like the growth rate of firms, and microeconomic events like war and climate change. In this essay, I address four questions about uncertainty.

First, what are some facts and patterns about economic uncertainty? Both macro and micro uncertainty appear to rise sharply in recessions and fall in booms. Uncertainty also varies heavily across countries—developing countries appear to have about one-third more macro uncertainty than developed countries.

Second, why does uncertainty vary during business cycles? The types of exogenous shocks that can cause recessions—like wars, oil price jumps, and financial panics—typically also increase uncertainty. Uncertainty also appears to endogenously increase during recessions, as lower economic growth induces greater micro and macro uncertainty.

Third, do fluctuations in uncertainty affect behavior? Greater uncertainty appears to reduce the willingness of firms to hire and invest, and consumers to spend. However, there is also some evidence that uncertainty can stimulate research and development—faced with a more uncertain future, some firms appear more willing to innovate.

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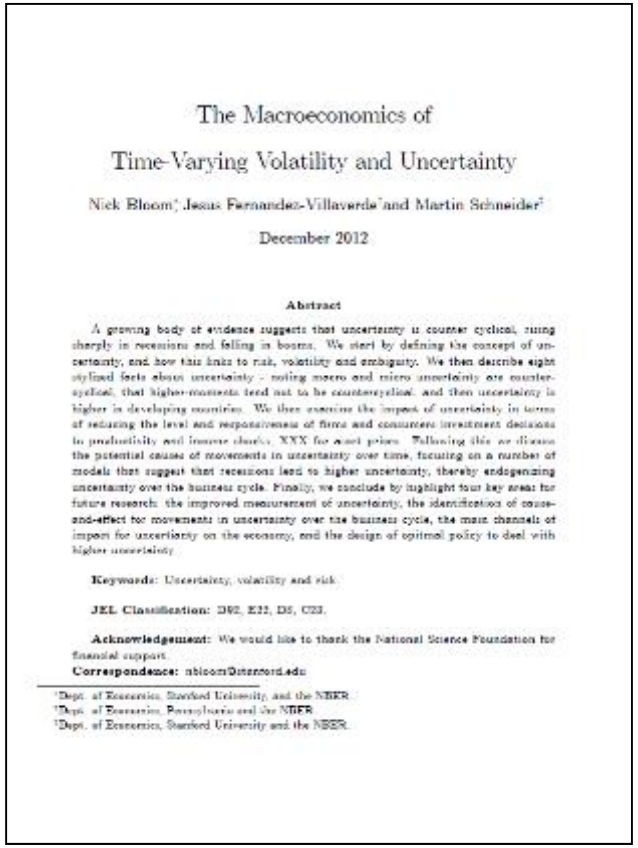

The Macroeconomics of

Time-Varying Volatility and Uncertainty

Nick Bloom*, Jesus Fernandez-Villaverde† and Martin Schneider‡

December 2012

Abstract

A growing body of evidence suggests that uncertainty is counter cyclical, rising sharply in recessions and falling in booms. We start by defining the concept of uncertainty, and how this links to risk, volatility and ambiguity. We then describe eight stylized facts about uncertainty - noting macro and micro uncertainty are counter-cyclical, that higher-moments tend not to be countercyclical, and then uncertainty is higher in developing countries. We then examine the impact of uncertainty in terms of reducing the level and responsiveness of firms and consumers investment decisions to productivity and income shocks. XXX for asset prices. Following this we discuss the potential causes of movements in uncertainty over time, focusing on a number of models that suggest that recessions lead to higher uncertainty, thereby endogenizing uncertainty over the business cycle. Finally, we conclude by highlight four key areas for future research: the improved measurement of uncertainty, the identification of cause-and-effect for movements in uncertainty over the business cycle, the main channels of impact for uncertainty on the economy, and the design of optimal policy to deal with higher uncertainty.

Keywords: Uncertainty, volatility and risk

JEL Classification: D92, E22, D8, C23.

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…plus of course the fantastic forthcoming book