Stock Market Cross-Sectional Skewness and Business Cycle Fluctuations[1]

Thiago Ferreira*

*Federal Reserve Board

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Risk, Volatility and Central Bank's Policies

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[1] The views expressed in this presentation are solely my responsibility and should not be interpreted as reflecting the views of the Federal Reserve System or of any other person associated with the Federal Reserve System.

Business Cycles (BCs): Theory and Cross-Section Behavior

Fluctuations in economic uncertainty and business cycles (Bloom (2014))

Idio risk of of HH's and nfin firms is important determinant of BCs.

- Several channels: wait-and-see effects from capital adjustment frictions (Bloom et al. (2012)); financial frictions (Arellano et al. (2012), Christiano et al. (2014), Gilchrist et al. (2014), and Chugh (2016)); search frictions in the labor market (Schaal (2017)); agency problems in the management of the firm (Panousi and Papanikolaou (2012)); granular effects (Gabaix (2011)); and network effects (Acemoglu et al. (2012)).

Cross-sectional behavior of HHs and nonfin firms follow BCs

- Dispersion (Bloom 2014) and high-order moments of the cross-sectional distribution of many economic variables seem to co-move with BCs, such as nonfinancial firm sales, profit, and employment (Bloom et al. (2016)); household income (Guvenen et al. (2014)); price changes (Luo and Vallenas (2017)); and general stock returns (Kelly and Jiang (2014))

Theories X Data $\Rightarrow$ surviving theories (e.g. Ilut et al (2017))

Business Cycles (BCs): Theory and Cross-Section Behavior

How about financial firms?

Most models have focused representative financial sector

- Gertler and Kiyotaki (2015), Gerter and Karadi (2011), Brunnermeier and Sannikov (2014), Christiano and Ikeda (2016), and Ferrante (2018)

Few models analyze macro implications of heterogeneous financial sector

- Boissay et al (2016) on the effects from moral hazard and asymmetric information in the interbank market, and Martinez-Miera and Repullo (2017) on the effects from search for yield
- little on whether the cross-sectional cyclical behavior of financial firms predicted by theory is consistent with the data (exception Coimbra and Rey (2017))

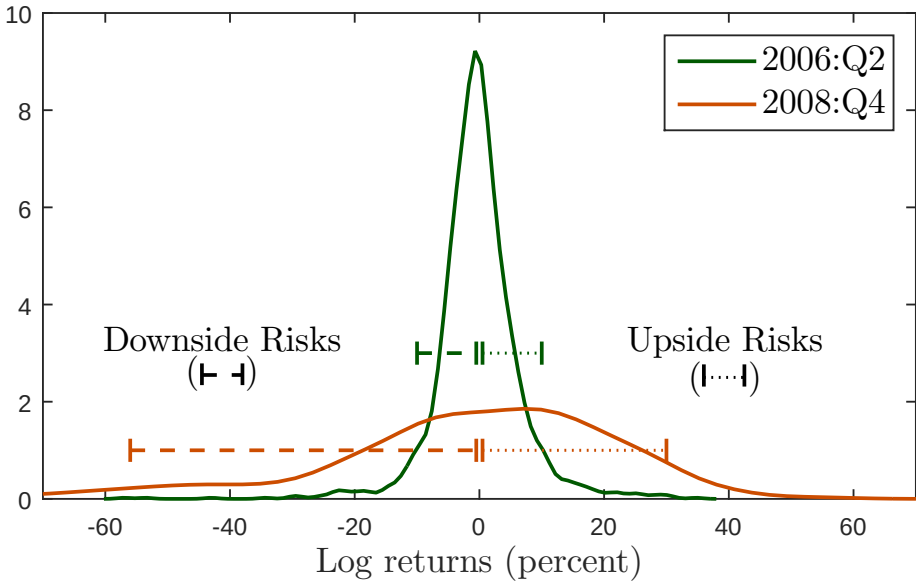
Empirical evidence is also limited

- studies on cross-sectional equity volatility focusing on issues related to systemic risk (Giglio et al (2016))

Does cross-sectional behavior of financial firms fluctuate over BCs? Yes!

Does it help us better understand BCs? Yes!

Cross-Sectional Distribution of Stock Returns of Financial Firms



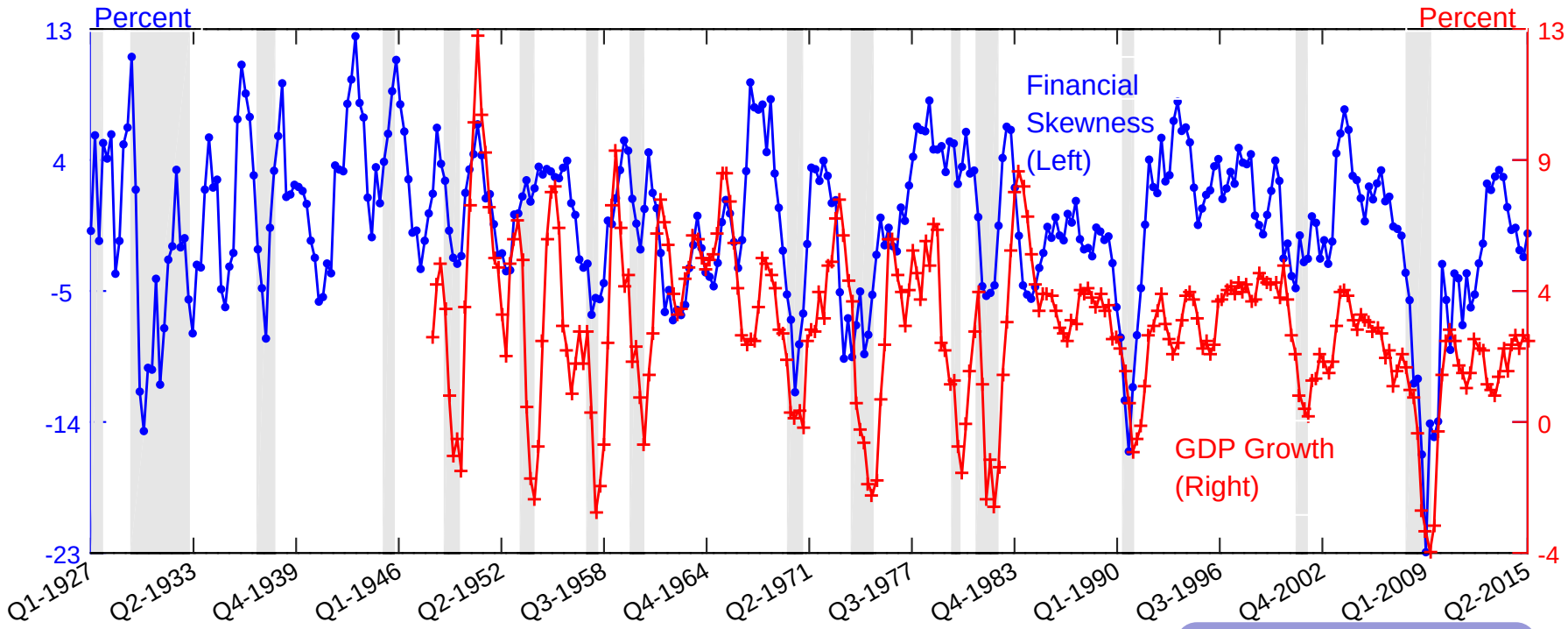
(a) Probability Density Function

2006:Q2	2008Q4
0%	-27%

(b) Financial Skewness

$$\text{financial skewness}_t = \underbrace{\left(ln\_r_t^{95th} - ln\_r_t^{50th}\right)}_{\text{upside tail risks}} - \underbrace{\left(ln\_r_t^{50th} - ln\_r_t^{5th}\right)}_{\text{downside tail risks}}.$$

Financial Skewness Tracks Business Cycles



Financial vs Nonfinancial

Correlations

Logit

Financial Skewness...

1) . . . is a powerful predictor of economic and credit activity

2) . . . is largely exogenous, with its shocks leading to sizable macro effects via a financial frictions mechanism

3) . . . measures cross-sectional risk on fundamentals faced by financial firms and their borrowers

1) Financial skewness:

powerful predictor of economic and credit activity

Financial Skewness Predicts Economic Activity, In-Sample

Dependent Variable: Mean 4Q Ahead GDP Growth

Sample: 1973Q1 - 2015Q2

	Regressions Specifications											
Variable	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Mean^{+}		1.19***									0.73*	
Dispersion^{+}			-0.15*								1.07**	
Skewness^{+}				1.20***							1.60**	1.00***
Left Kurtosis^{+}					0.71**						0.26	
Right Kurtosis^{+}						0.46**					-1.06***	
Uncertainty							-0.46**					0.24
Real Fed Funds								-0.44				0.18
Term Spread									0.92***			1.03***
GZ Spread										-0.55**		-0.49
R^2	0.08	0.29	0.11	0.28	0.17	0.11	0.19	0.12	0.28	0.23	0.40	0.54

$^{+}$Moments of the cross-section distribution of returns are for returns from financial firms

All regressors are standardized, so we can compare the magnitude of their coefficients. For each regressor, I include its current and one-period lagged value, with reported coefficients being the sum of current and lagged effect. Coefficients measure the effect in GDP-growth (in percentage) of a sustained increase of 1 std in the regressor.

Financial Skewness Predicts Economic Activity, In-Sample

1) is one of the variables that single-handedly most explain future GDP growth
   - Comparing R^2's and columns (2)-(10)

2) has predictive power robust to the inclusion of many other variables.
   - Such as other moments, financial uncertainty, GZ spread: columns (11)-(12)
   - In all regressions, financial skewness is stat-sig and has intuitive effects.

3) is specially informative about the cycle
   - In regressions (11)-(12) for un/weighted measures: one of largest coefficients
   - 1 std $\downarrow$ in financial skewness: $\downarrow$ of 1%-1.6% in mean GDP growth over next 4Q's

4) is powerful predictor of many other variables: not shown
   (Consumption, Investment, Hours, U-rate)

Financial Skewness Predicts $GDP_{t+h|t-1}$, Out-of-Sample

$GDP_{t+h|t-1}$: mean GDP growth h quarters ahead
Sample : 1973Q1 - [1986Q1...2015Q2]

For each variable X_t, forecasts are:

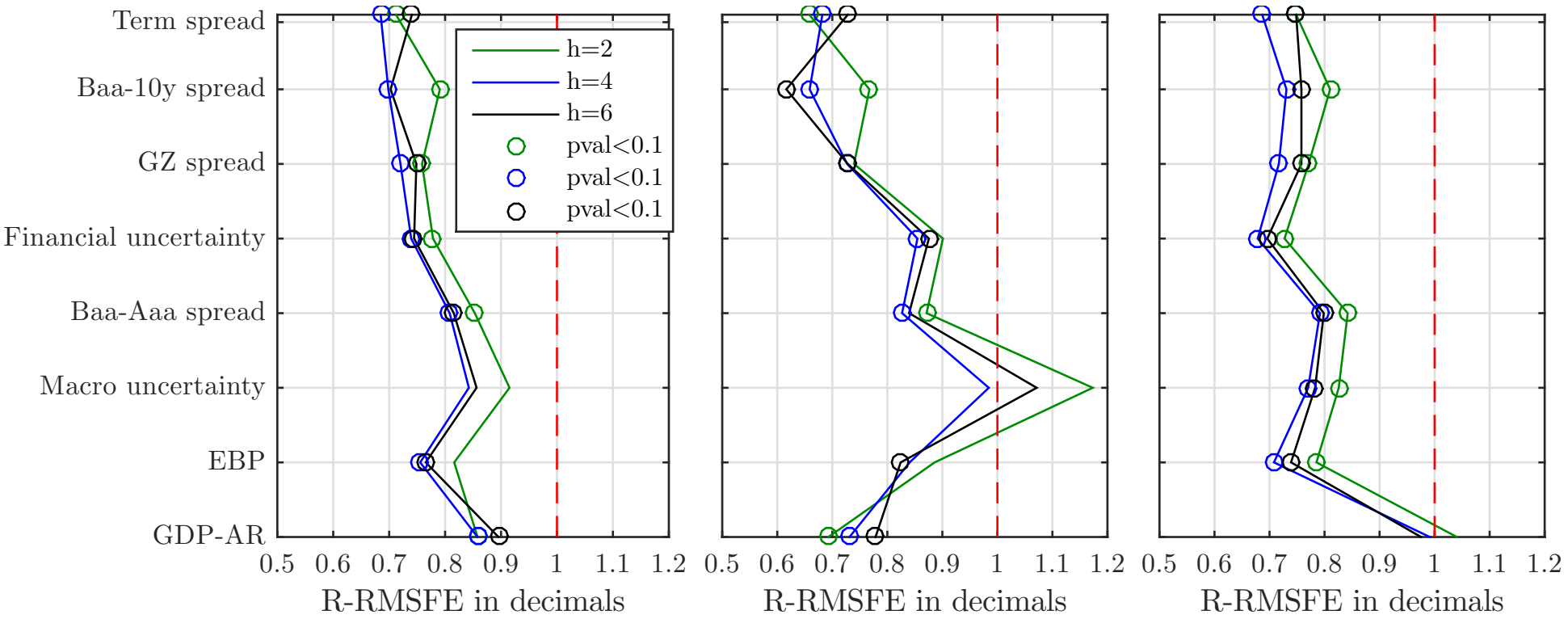
$$GDP_{t+h|t-1} = \alpha + \sum_{i=1}^{p} \rho_i GDP_{t-i|t-i-1} + \sum_{j=0}^{q} \theta_j X_{t-j} + u_{t+h}.$$

Performance of financial skewness relative to variable Z_t is:

$$\text{R-RMSFE of Variable } Z_t = \frac{\text{RMSFE of Financial Skewness}}{\text{RMSFE of Variable } Z_t} \text{ (in decimals)}$$

Financial Skewness Predicts $GDP_{t+h|t-1}$, Out-of-Sample

$$\text{R-RMSFE} = \frac{\text{RMSE of Financial Skewness}}{\text{RMSE of Other Variable}} \text{ (in decimals)}$$



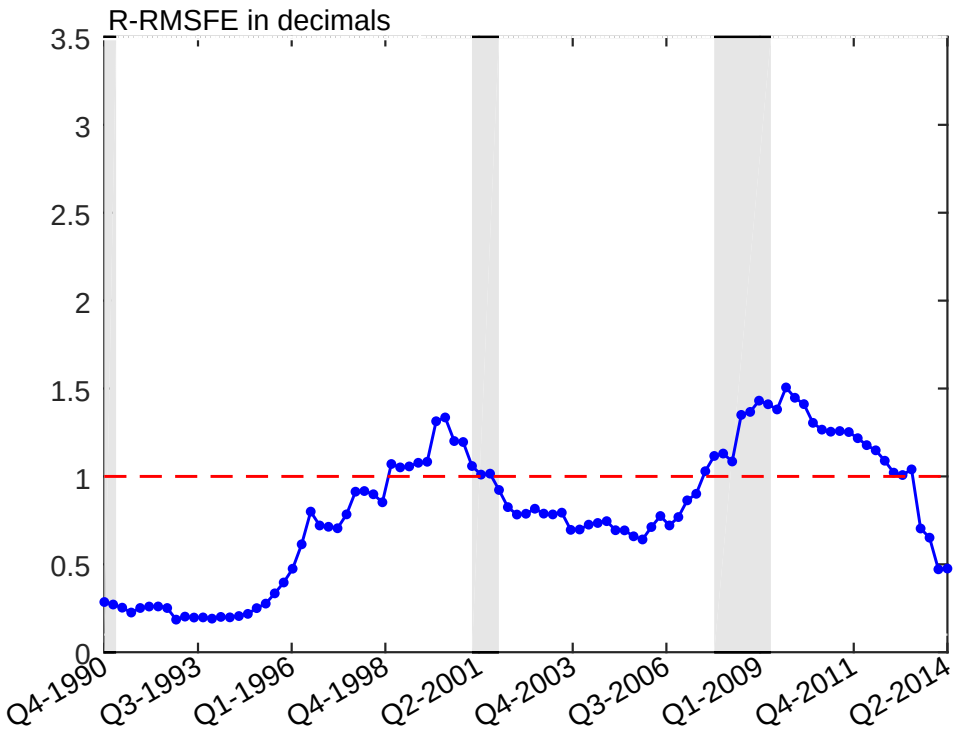
(c) Full Sample (d) Recessions (e) Expansions

Financial Skewness Predicts $GDP_{t+h|t-1}$, Out-of-Sample

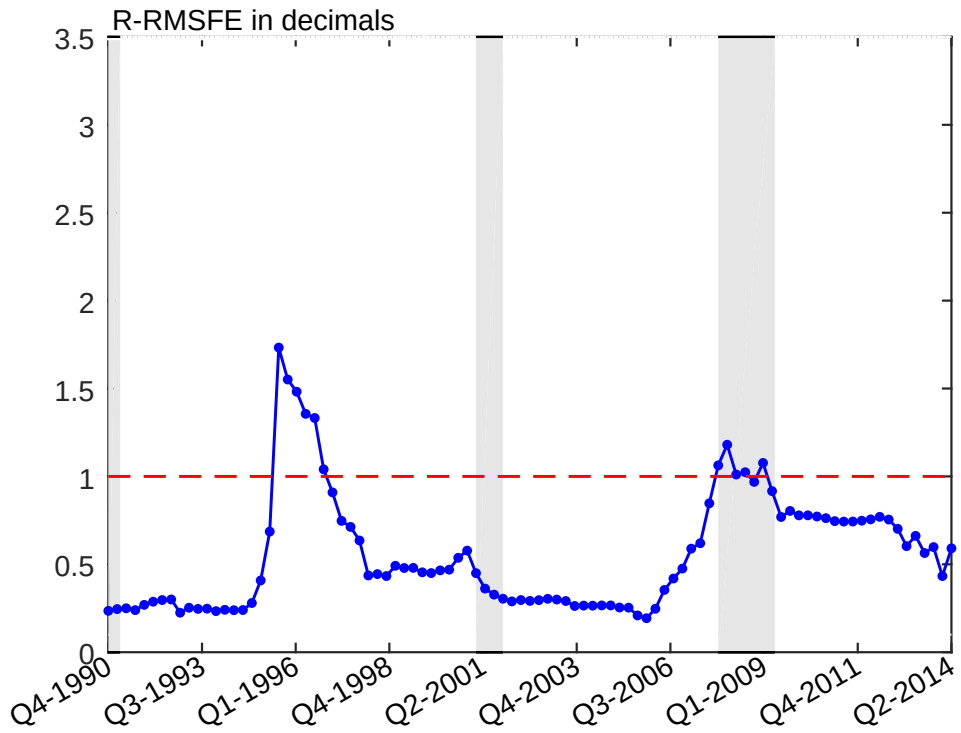
Financial skewness most often predicts GDP growth relatively well

- Lowest RMSE, with most results stat. significant
- Differences economically significant: up to 38% of improvement
- Also, better than other distribution measures

Rolling RMSE Ratios: financial skewness predicts well most of the time



(f) Macro Uncertainty

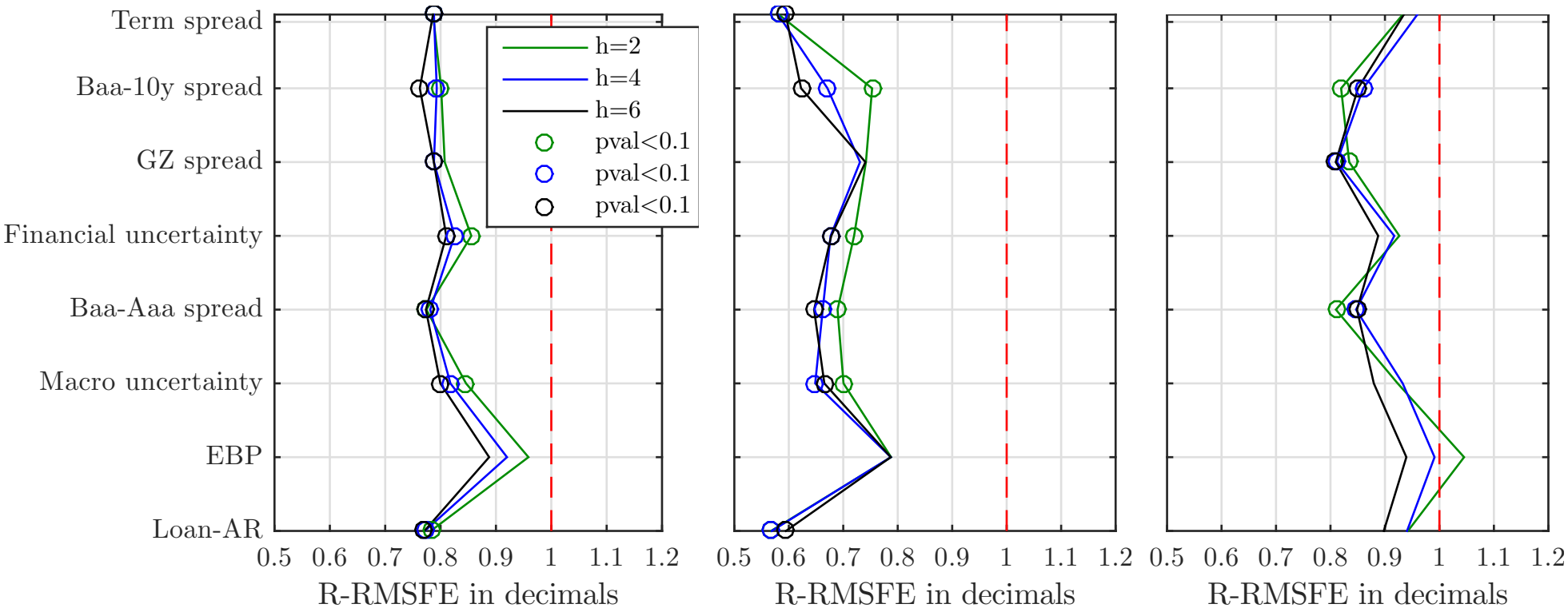


(g) GZ-Spread

Other Rolling RMSE ratios tell similar story.

Financial Skewness Predicts Loans$_{t+h|t-1}$, Out-of-Sample

$$\text{R-RMSFE} = \frac{\text{RMSE of Financial Skewness}}{\text{RMSE of Other Variable}} \text{ (in decimals)}$$



(h) Full Sample (i) Recessions (j) Expansions

Financial Skewness Predicts Loans$_{t+h|t-1}$, Out-of-Sample

Financial skewness most often predicts loan growth relatively well

- Lowest RMSE with most results stat. significant
- Differences economically significant: up to 42% of improvement

Financial skewness predicts other credit variables, but it does particularly well for loan growth

2) Financial skewness (using BVAR & DSGE):

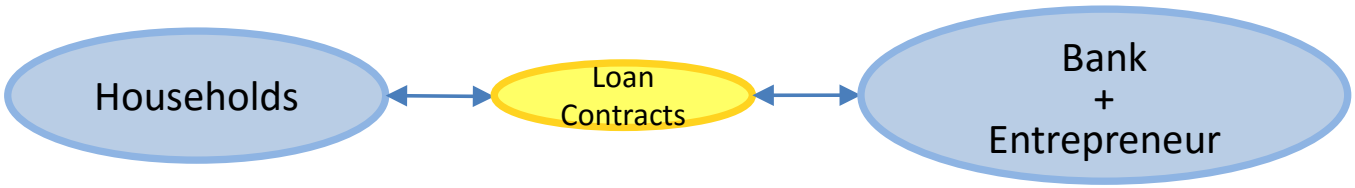
largely exogenous, with its shocks leading to sizable macro effects via a financial frictions mechanism

NK-DSGE with financial accelerator channel

Similar to Christiano et al (2014) in its bells and whistles

Why this model?
- cross-section shocks generates business cycles
- endogenous cross-section distribution
- compare widely used DSGE model against BVAR

Re-interpretation of the model:



cross-section skewed risk shocks (un-modeled events) $\Rightarrow$
- productivity of borrowing firms' projects
- lending capacity of financial firms

Distribution of Returns and the Financial Accelerator

Define *gross realized equity return* of entrepreneur i at period t:

$$X_t^i = \begin{cases} \frac{\omega_t^i R_t^c Q_{t-1} \overline{K}_t^i - Z_t^i B_t^i}{N_t^i}, & \text{if } \omega_t^i R_t^c Q_{t-1} \overline{K}_t^i \geq Z_t^i B_t^i \\ 0, & \text{otherwise} \end{cases} = \begin{cases} \left[\omega_t^i - \overline{\omega}_t\right] R_t^c L_t, & \text{if } \omega_t^i \geq \overline{\omega}_t \\ 0, & \text{otherwise.} \end{cases}$$

- *endogenous distribution of* X_t^i: $\overline{\omega}_t$, R_t^c and L_t are *endogenous variables*
- ω_t^i follows a mixture of two log-normal distributions
  - $\mathbb{E}(\omega_t^i) = 1$, $\text{Std}(\omega_t^i) = sd_t$ and m_t^1 proxies skewness

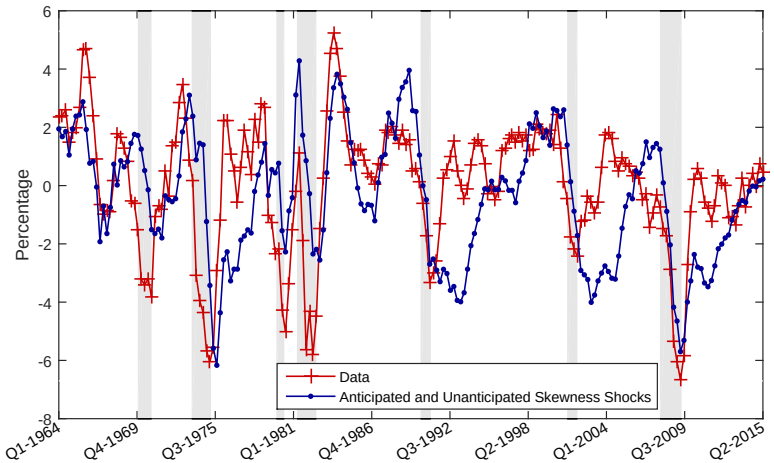
For instance, cross-section skewness of the model is: $(\widetilde{x}_t^{95} - \widetilde{x}_t^{50}) - (\widetilde{x}_t^{50} - \widetilde{x}_t^{5})$, where $\widetilde{x}_t^v = \log(\widetilde{\omega}_t^v - \overline{\omega}_t)$ and $\widetilde{\omega}_t^v$ is the v^{th} percentile of cdf $F_t(\cdot|\omega_t > \overline{\omega}_t)$.

NK-DSGE with financial accelerator channel: 1964-2015

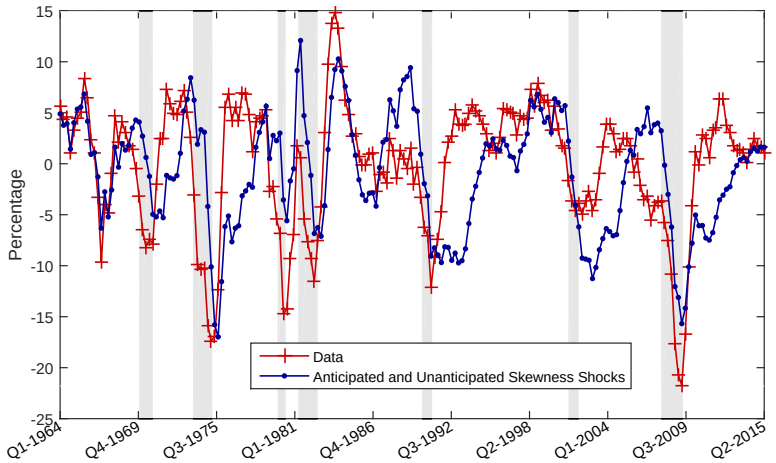
1st Step: 1964-2006, Taylor Rule;
2nd Step: 2002-2015, Taylor Rule with news; re-estimate shocks autocorr and std;

Observable variables	Shocks
GDP	permanent TFP-growth
Consumption	inter-temporal discount
Investment	capital adjustment cost (IS-shock)
Hours worked	transitory TFP
Real wage	price-markup
Fed Funds rate	monetary policy
OIS 1Y-ahead (2002-2015)	news on monetary policy
PCE core inflation	inflation trend/target
Relative price of Investment	investment price
Real credit	government/NX residual
Equity ($Mean_t^{nfin}$)	equity and meas-error
Baa - US_10y	
$Disp_t^{nfin}$ and $Skew_t^{fin}$	sd_t and m_t^1 news about them up to 4Q in advance

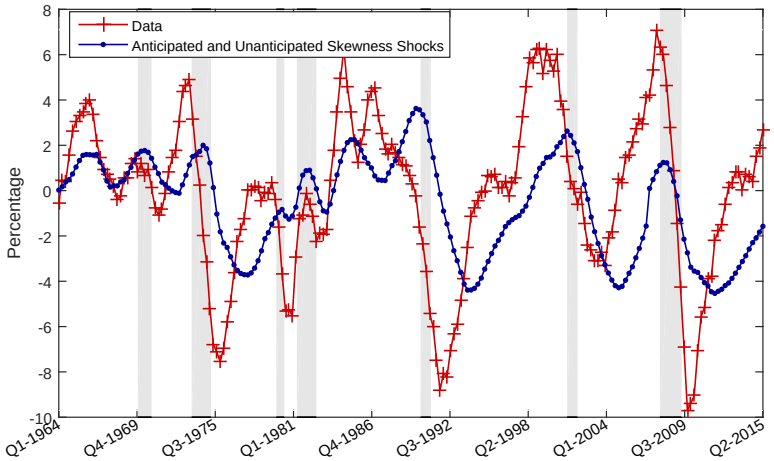
Primacy of Skewness Shocks: Hist + Var Decomp's



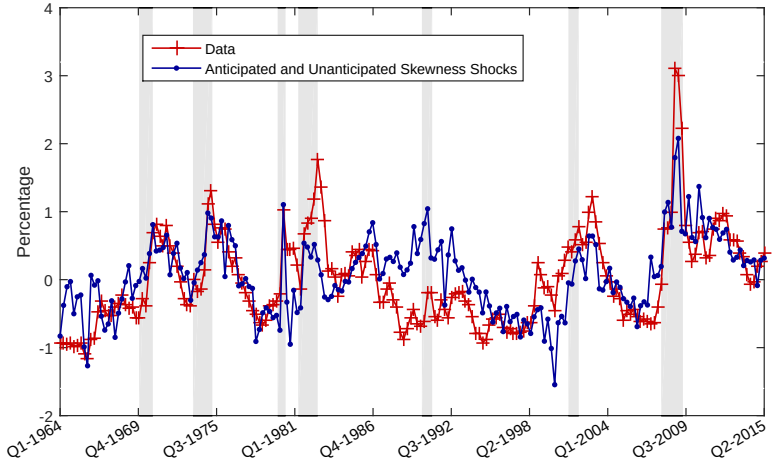
(k) GDP (7 | 41 %)



(l) Investment (9 | 51%)



(m) Credit (6 | 35%)



(n) Baa spread (16 | 50%)

Skewness shocks

FinSkew largely exo

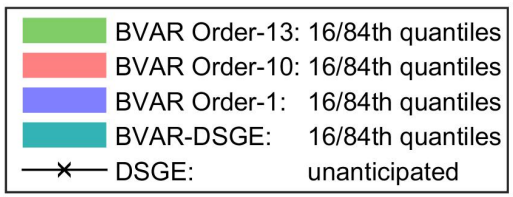
- FEVD: majority of FinSkew

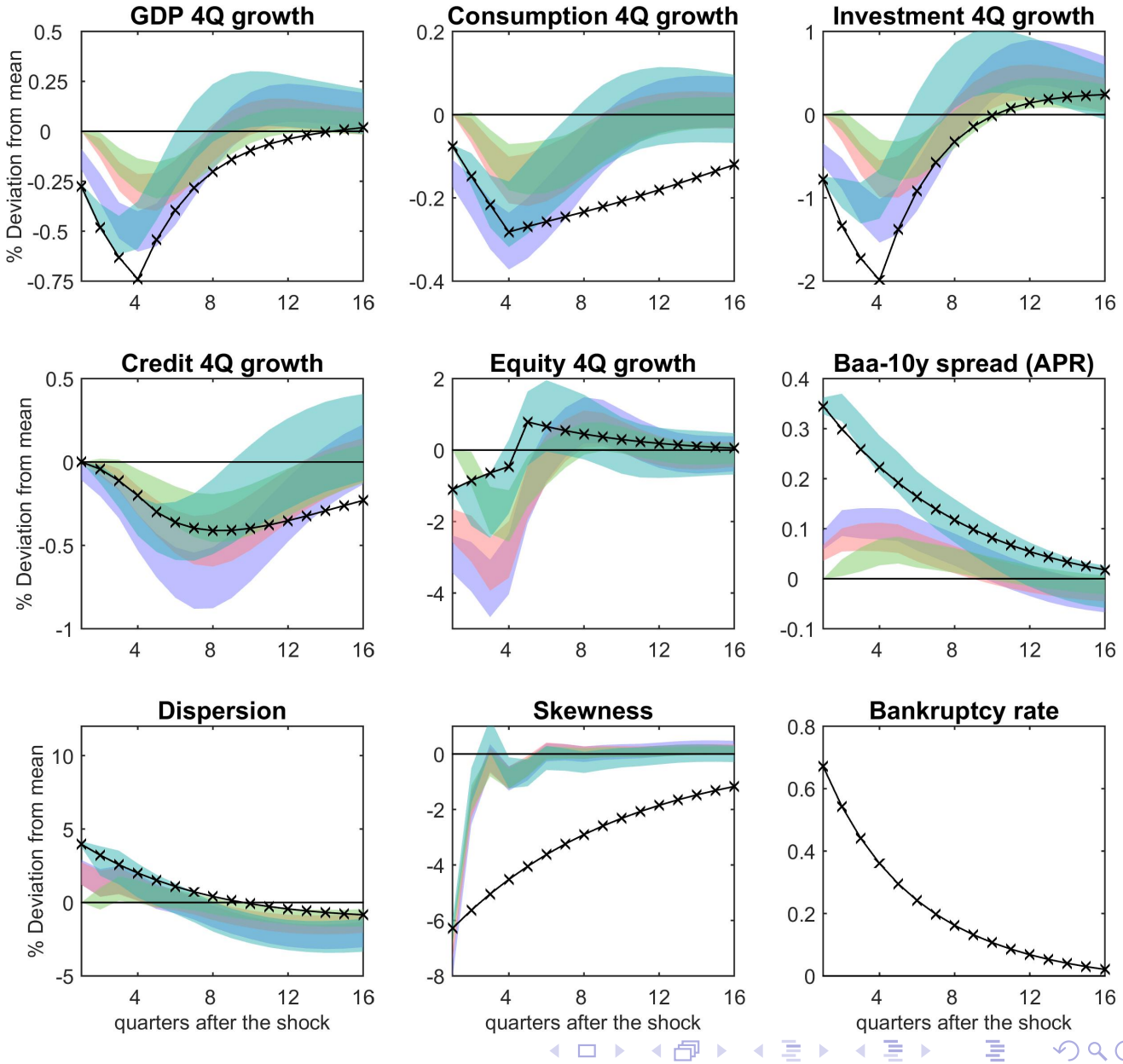
Macro effects:

- IRF: GDP falls 0.3-0.75%

Fin-friction transmission:

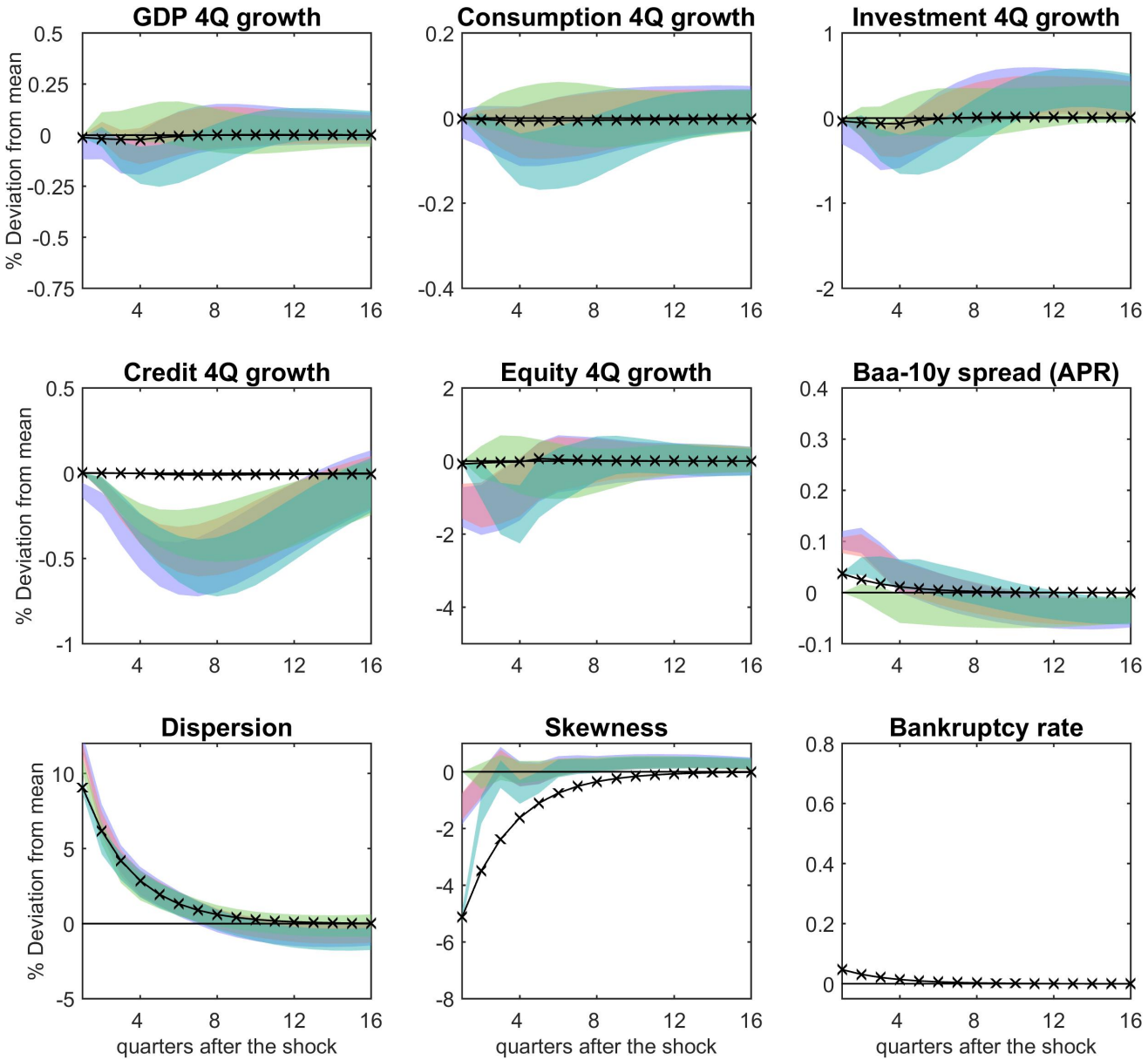
- IRFs: general picture
- ↑ Baa-10y ⇒ Larger IRFs
- DSGE IRFs ≈ BVAR IRFs





Dispersion shocks

- FEVD of GDP = 0-3%
- IRF ≈ 0



3) Financial skewness

measures cross-sectional risk on fundamentals faced by financial firms and their borrowers

1st Interpretation: Risks Faced by Credit Demand

Cross-Sectional Risks on Investment Projects of Borrowers

Financial firms' stocks antecipate BCs because:

- lending relationships makes them well interconnected
- asset diversification purges nonfinancial idio risk $\perp$ to aggregate outcomes

Results corroborating this interpretation:

- financial skewness correlated with measures of credit demand's health
- financial skewness predicts loan growth better than debt growth
- financial skewness predicts GDP better than nfin CS moments
- CS distributions of stock returns of financial firms are less dispersed and thinner-tailed relative to nonfin ones

2nd Interpretation: Risks Faced by Credit Supply

Cross-Sectional Risks on Lending Capacity of Financial Sector

Financial firms' stocks antecipate BCs because:

- adverse shocks push financial firms against capital and liquidity constraints
- these shocks then tilt financial firm's risks to the downside
- then, causing less lending and less GDP growth

Results corroborating this interpretation:

- financial skewness correlated with measures of distress faced by financial firms
- financial skewness predicts loan growth better than debt growth

Financial sector holds smaller cross-section risks

Table: Times Series Averages of Distribution Measures (in Percent)

	Sample 1947-2015		
	financial	nonfinancial	difference
	(1)	(2)	(3) = (1) - (2)
Mean	2.9	3.4	-0.5
Dispersion	35.8	58.8	-23.0***
Skewness	-1.1	-2.0	0.9**
Left kurtosis	-7.9	-12.1	4.3***
Right kurtosis	7.0	11.0	-4.0***

Financial { Mean: stat the same; Dispersion: smaller; Skewness: somewhat higher; Left tail: thinner; Right tail: thinner } than Nonfinancial

Financial skewness correlates with...

- credit demand conditions: ROA, LSSF
- distress faced by financial firms: AFCI, EBP, UC, RA, term-spread
- **but not** with current & lagged macro conditions: $\widehat{\text{GDP}}_{t|t-1}$, $\text{GDP}_{t-1|t-5}$
  - thus, evidence against reverse causality

		Variable						
		AFCI	EBP	UC	RA	Term Spread	$\widehat{\text{GDP}}_{t\|t-1}$	$\text{GDP}_{t-1\|t-5}$
ROA	3.2***	2.7***	3.1***	3.0***	2.9***	3.8***	3.0***	4.2***
LSSF	-3.4***	-2.1*	-2.7**	-2.1**	-2.6***	-2.9***	-3.2***	-3.4***
Variable		-1.9	-1.0	-2.1**	-1.6*	1.2	0.4	-1.4
R^2	0.36	0.38	0.37	0.39	0.38	0.37	0.36	0.37

Summarizing: Financial Skewness...

1) . . . is a powerful predictor of economic and credit activity

2) . . . is largely exogenous, with its shocks leading to sizable macro effects via a financial frictions mechanism

3) . . . measures cross-sectional risk on fundamentals faced by financial firms and their borrowers

Going forward:

This paper points to an agenda for business cycle theories

- not only financial firms play an active role
- but the cross-sectional distribution of their equity is strongly cyclical
- and is an important veil for signaling macroeconomic fundamentals.

Cross-Section Skewness: Financial X Nonfinancial

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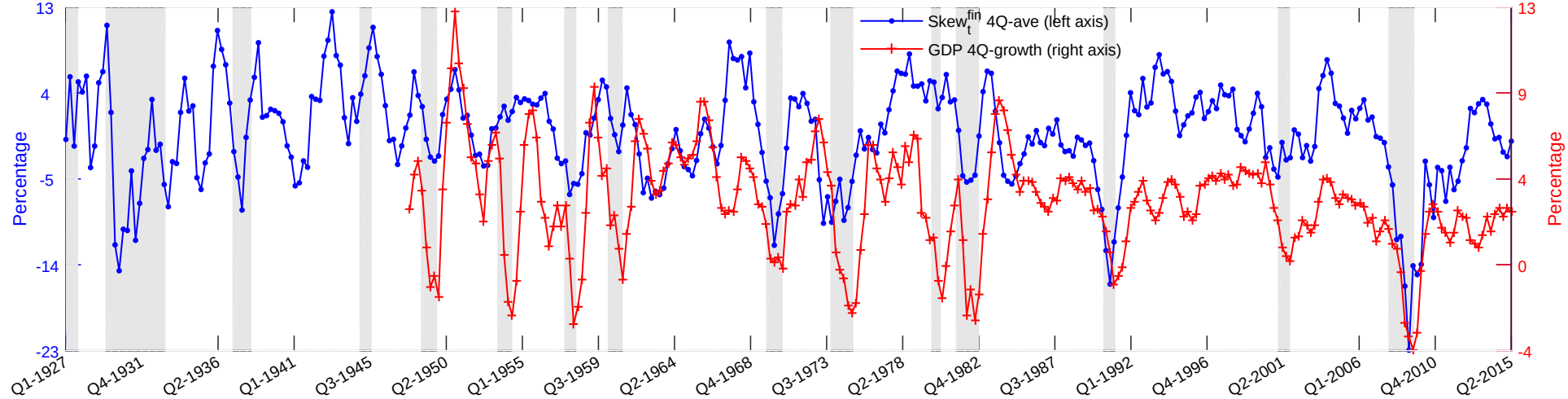

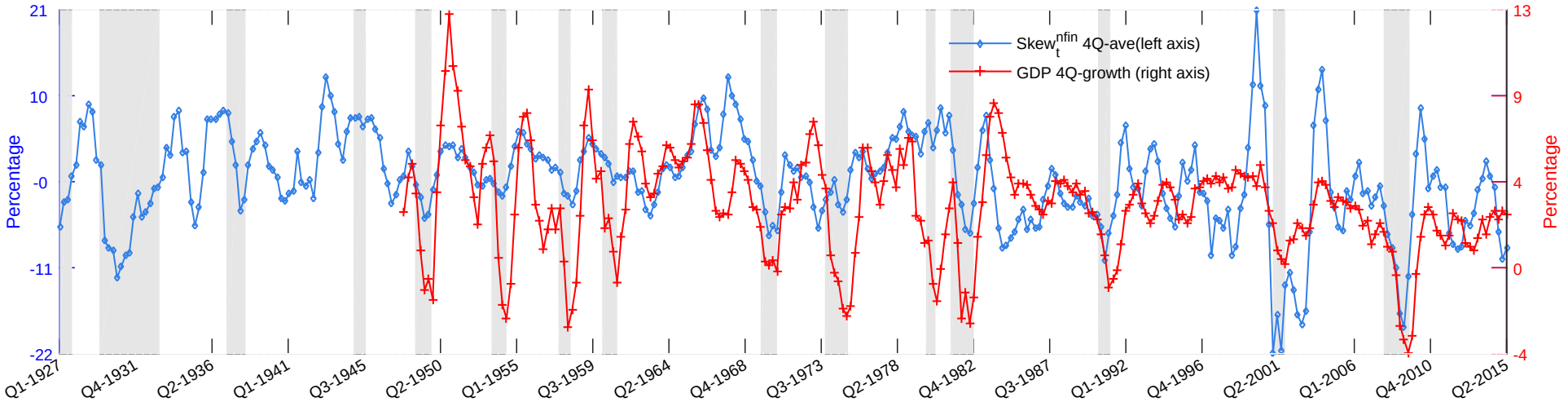

Correlations

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Sample	Financial Skewness	Nonfinancial Skewness
1926-2015	0.34	0.31
1985-2015	0.58	0.48

(a) Correlations with Expansion Indicator

Sample	Financial Skewness	Nonfinancial Skewness
1947-2015	0.40	0.36
1985-2015	0.69	0.41

(b) Correlations with GDP 4Q-growth

1926-2015: Financial Skewness Tracks Business Cycles

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Logit Regression

Dependent Variable: NBER Expansion Indicator

Variables	Regressions with Unweighted Distribution Measures (1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Constant	-1.26***	-1.55***	-1.11***	-1.36***	-1.24***	-1.35***	-1.22***	-1.73***	-1.77***
Expansion Lag	4.12	4.55	3.93	4.38	4.11	4.23	4.04	5.02	5.05
Mean^{+}		1.17***						1.33***	1.23**
Dispersion^{+}			-0.34					-0.44	-0.68
Skewness^{+}				1.17***				1.71**	1.68**
Left Kurtosis^{+}					0.43			-0.92*	-0.98*
Right Kurtosis^{+}						0.20		-0.69	-0.64
Baa-Aaa							-0.24**		0.23
Pseudo R^2	0.53	0.58	0.54	0.57	0.54	0.53	0.55	0.62	0.63

$^{+}$Moments of the cross-section distribution of returns are for returns from financial firms

All regressors are standardized, so we can compare the magnitude of their coefficients. For each regressor, I include its current and one-period lagged value, with reported coefficients being the sum of current and lagged effect.

1926-2015: Financial Skewness Tracks Business Cycles

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Financial Skewness:

1) is one of the variables that single-handedly most explain NBER-indicator.
   - Comparing R^2's of columns (2)-(7)

2) has explanatory power robust to the inclusion of many other variables.
   - Such as other moments and credit spreads in columns (8)-(10).
   - In all regressions, financial skewness is stat-sig and has intuitive effects.

3) is specially informative about the cycle
   - In regressions (9)-(10) for un/weighted measures: one of largest coefficients
   - 2 std decrease in financial skewness: 52% prob of recession

Financial Skewness Predicts $GDP_{t+h|t-1}$, Out-of-Sample

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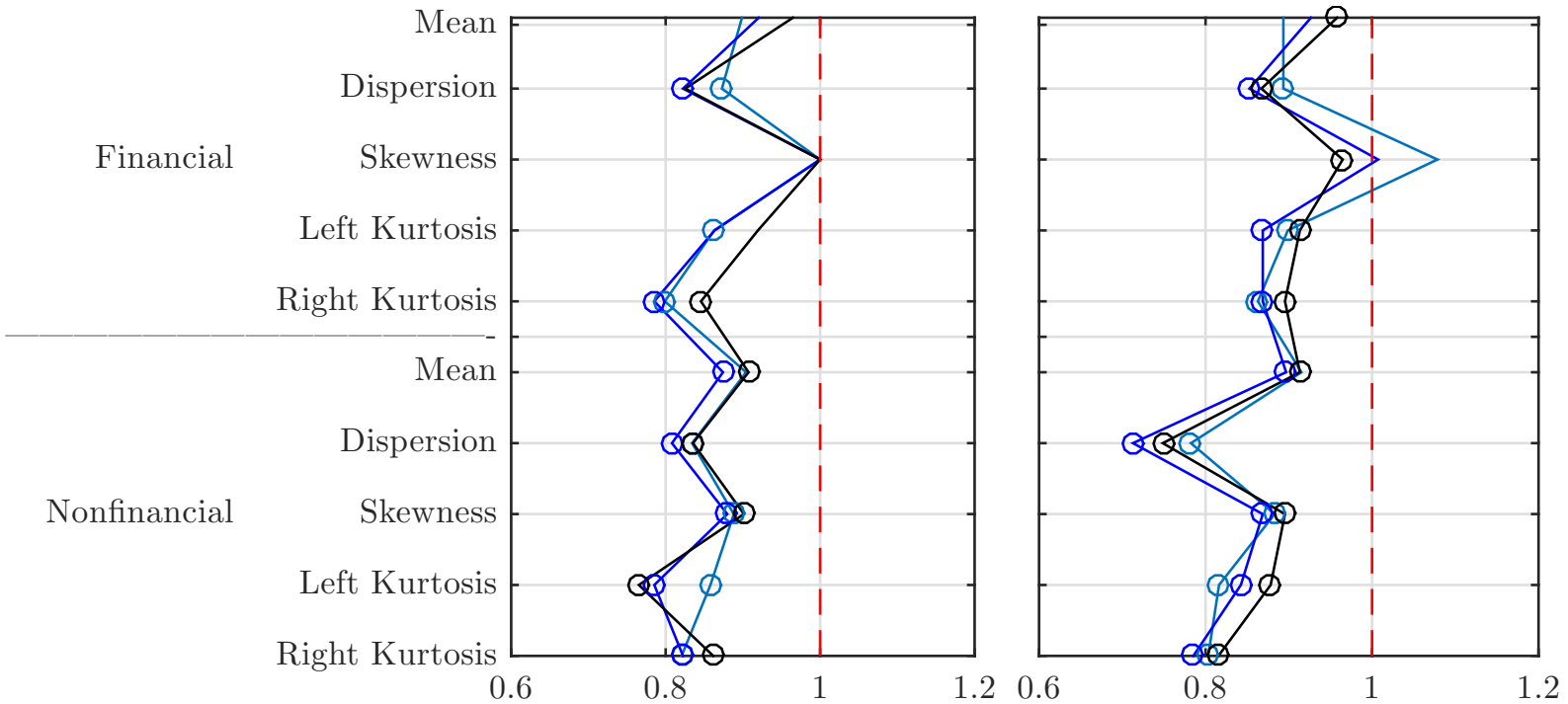
Sample: 1973Q1 - [1986Q1...2015Q2]

RMSE of Financial Skewness Relative to other Variables (in decimals)



(o) Nonweighted Measures (p) Weighted Measures

What explain Financial skewness? Part II

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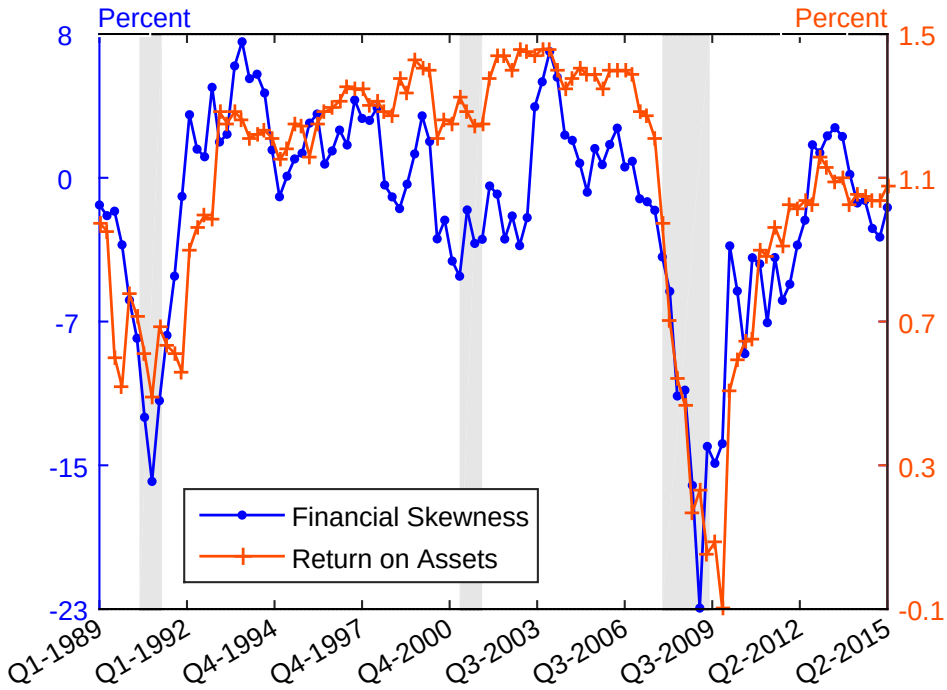
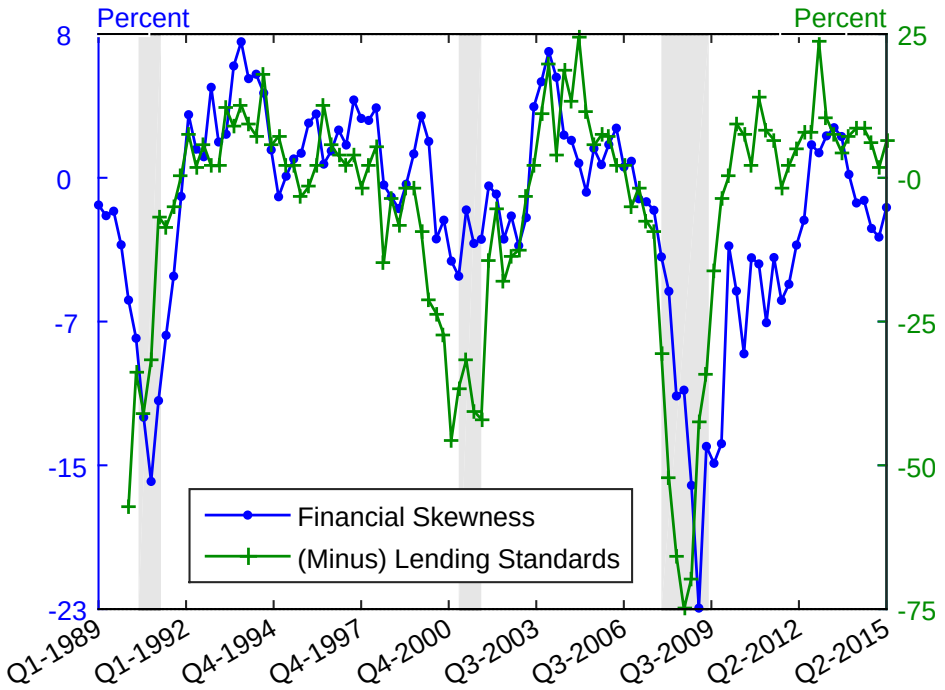


(q) Return on Assets



(r) Lending Standards