Aggregate Skewness and the Business Cycle

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Motivation: Measuring the balance of risks

> *"The outlook for the UK and global economies remains unusually uncertain. [...] The risks are skewed to the downside."*
>
> *Monetary Policy Report, Bank of England, Aug. 2020 (p.1)*

- Policy institutions analyse macroeconomic risks
  - Often not symmetric around the baseline outlook
  - Skewness is a key concept to communicate beliefs about risks
- The literature has also focused on modelling higher-order moments to better capture asymmetric/downside risk

Contribution and preview results

- New measure of expected aggregate skewness
  - Common factor that drives individual skewness series
  - Robust asymmetry measure and cond. quantile techniques
- Advantages
  - No need to select suitable predictors of skewness (for each variable)
  - Asymmetry not restricted to move in tandem with fin. conditions
- Main results
  - Aggregate skewness is procyclical and mainly reflects the skewness of real variables
  - Revisions in exp. skewness can cause cyclical fluctuations consistent with the *business cycle anatomy* (Angeletos et al., 2020)

A measure of expected aggregate skewness

- Based on large dataset rather than single macroeconomic indicator
- McCracken and Ng (2020) dataset: 211 macro series for the U.S.
- Sample period: 1960:Q1–2019:Q4
- Two-step approach: combination of quantile regression and PCA
  1. Estimate conditional skewness of each variable
  2. Aggregate information into a single skewness factor

A measure of expected aggregate skewness

For each (demeaned) variable, estimate an autoregressive quantile regression (Engle and Manganelli, 2004) for $p = \{0.1, 0.5, 0.9\}$:

$$Q^p(y_{i,t}) = \beta_0^p + \beta_1^p Q^p(y_{i,t-1}) + \beta_2^p y_{i,t-1}\mathbb{I}(y_{i,t-1} > 0) + \beta_3^p y_{i,t-1}\mathbb{I}(y_{i,t-1} < 0)$$

This model is used to construct the expected (Kelley) skewness:

$$\mathbb{E}_t[Skew(y_{i,t+1})] = \frac{\mathbb{E}_t[Q_{i,t+1}^{0.9}] + \mathbb{E}_t[Q_{i,t+1}^{0.1}] - 2\mathbb{E}_t[Q_{i,t+1}^{0.5}]}{\mathbb{E}_t[Q_{i,t+1}^{0.9}] - \mathbb{E}_t[Q_{i,t+1}^{0.1}]}$$

$\Rightarrow$ Expected skewness factor is the first PC of individual skewness series

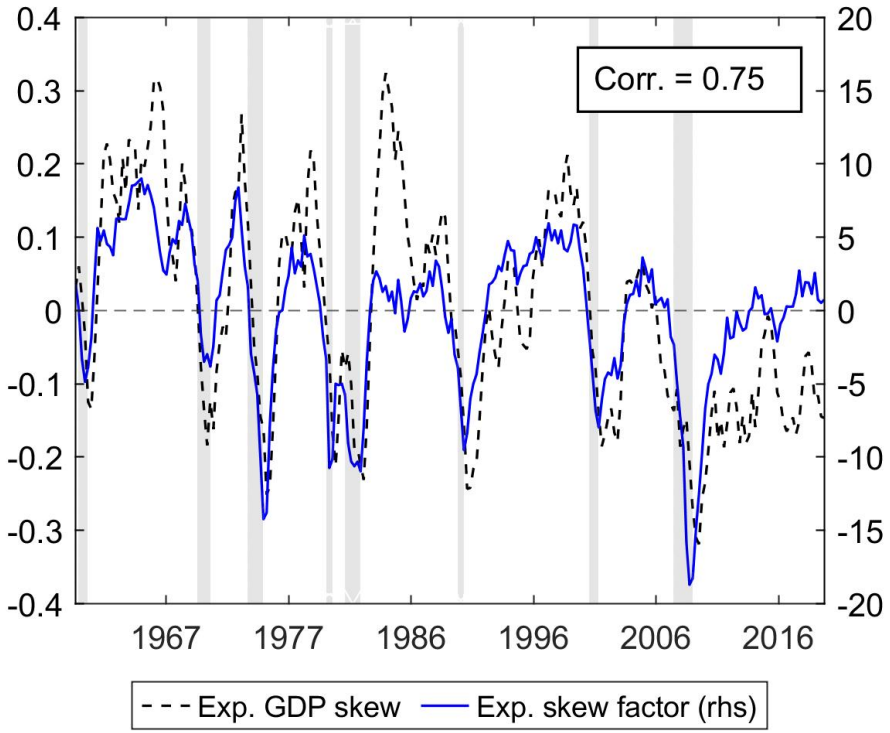
What does our factor of expected skewness measure?

Skewness variation explained by first principal component (in %)

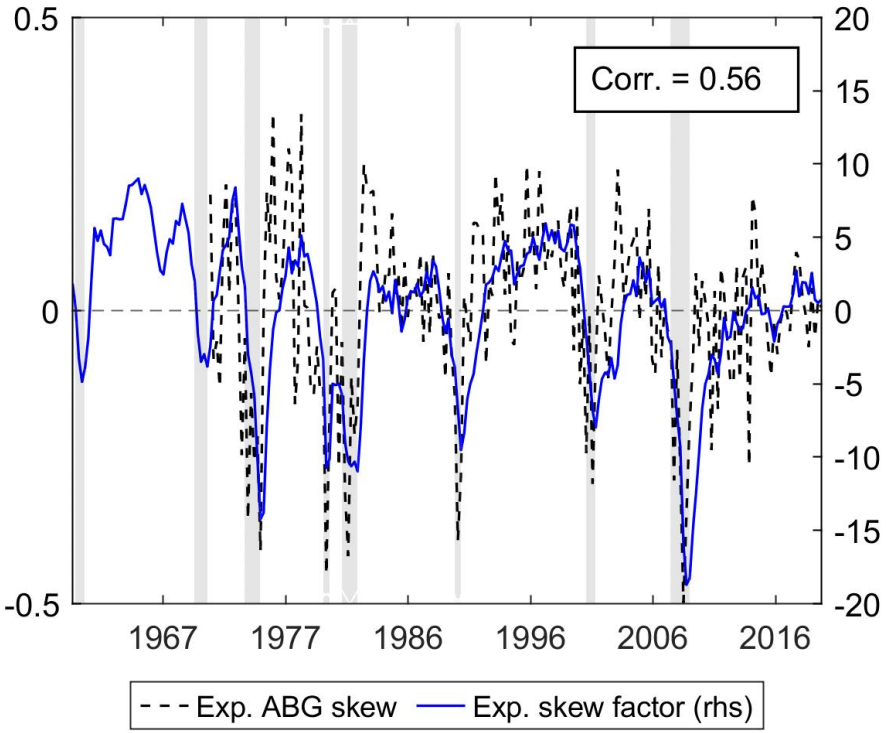
Group	**Variables**	**Mean**	**Median**	**Max.**	**Min.**
National income and product accounts	22	18.3	8.9	55.9	0.1
Employment and unemployment	44	17.9	14.1	66.7	0.0
Inventories, orders, and sales	6	15.5	17.9	26.7	0.3
Non-household balance sheets	11	14.4	12.7	28.1	0.8
Industrial production	15	12.9	9.8	43.9	0.4
Stock markets	5	12.6	8.0	34.2	0.2
Exchange rates	4	12.5	14.5	20.4	0.5
Household balance sheets	9	9.7	8.7	26.8	0.0
Housing	6	9.4	7.5	20.2	0.3
Prices	46	8.9	5.4	52.1	0.0
Interest rates	18	8.5	4.1	50.9	0.0
Earnings and productivity	10	7.2	5.4	19.9	0.0
Money and credit	14	6.2	3.0	21.5	0.2

$\Rightarrow$ The skewness factor tends to explain more of the skewness variation in real variables than, for example, prices

Skewness factor vs. measures of GDP skewness



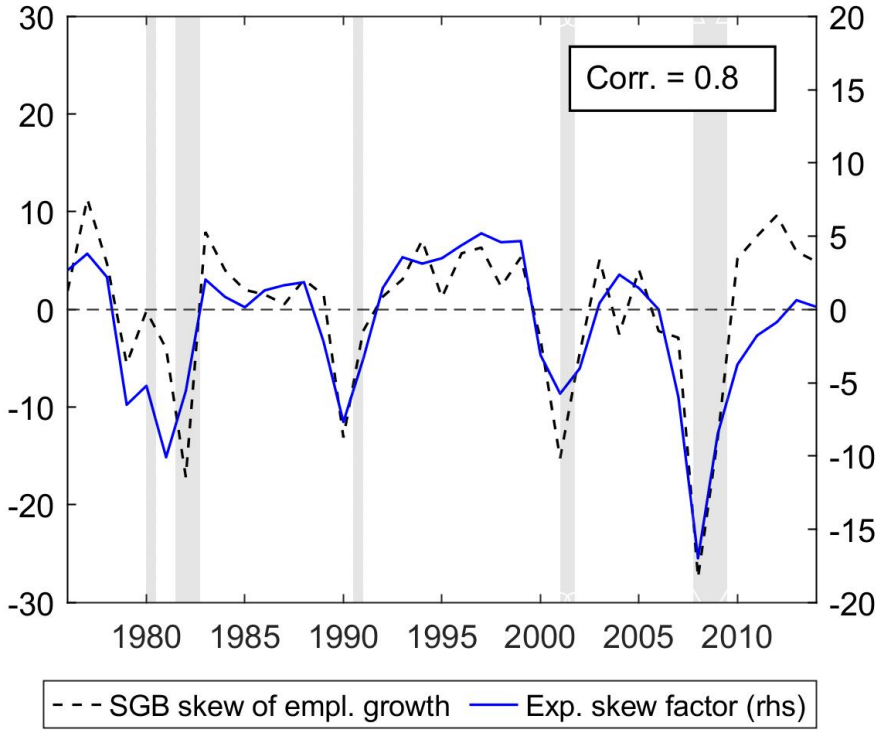
(a) GDP skew (Engle and Manganelli, 2004)



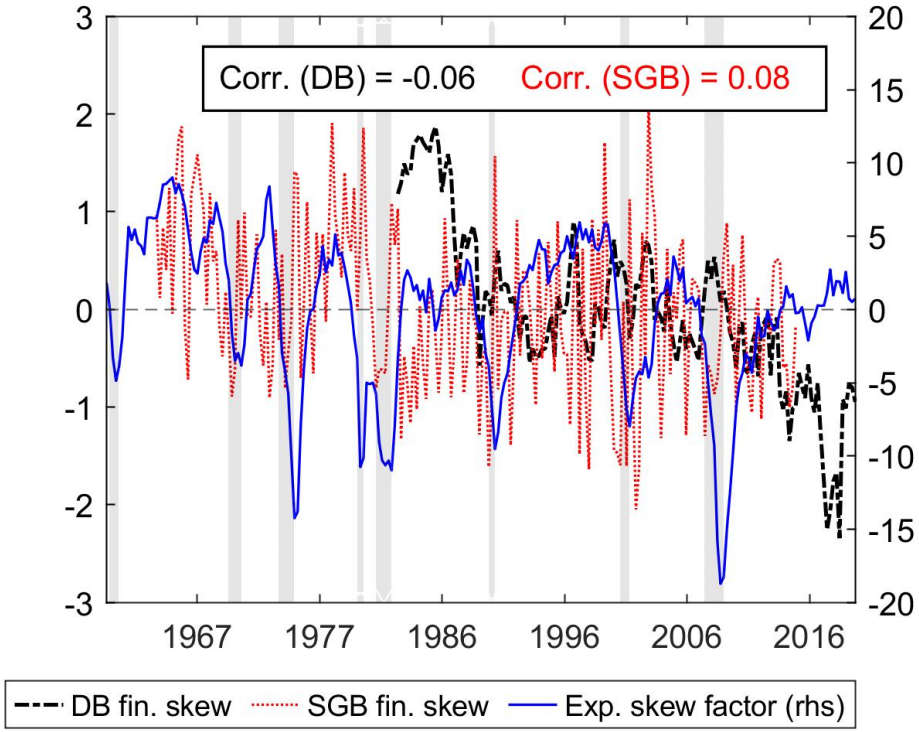
(b) GDP skew (Adrian et al., 2019)

Note: Both individual GDP skewness series are de-meaned.

Skewness factor vs. firm-level and financial skewness



(a) Firm-level skew (Salgado et al., 2019)



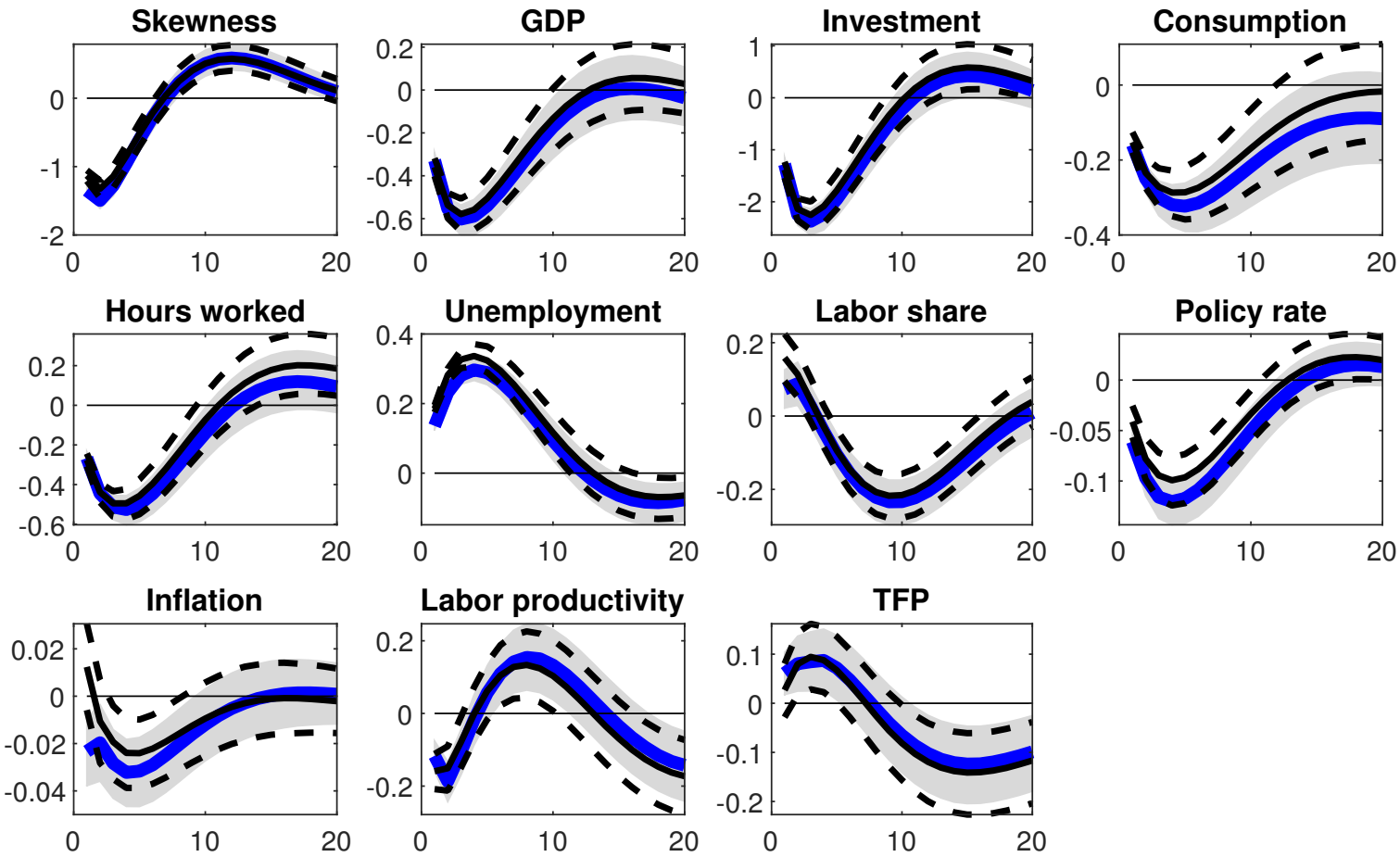
(b) Fin. market skew (Dew-Becker, 2021; Salgado et al., 2019)

Note: The alternative skewness measures are de-meaned.

Macroeconomic effects of skewness shocks

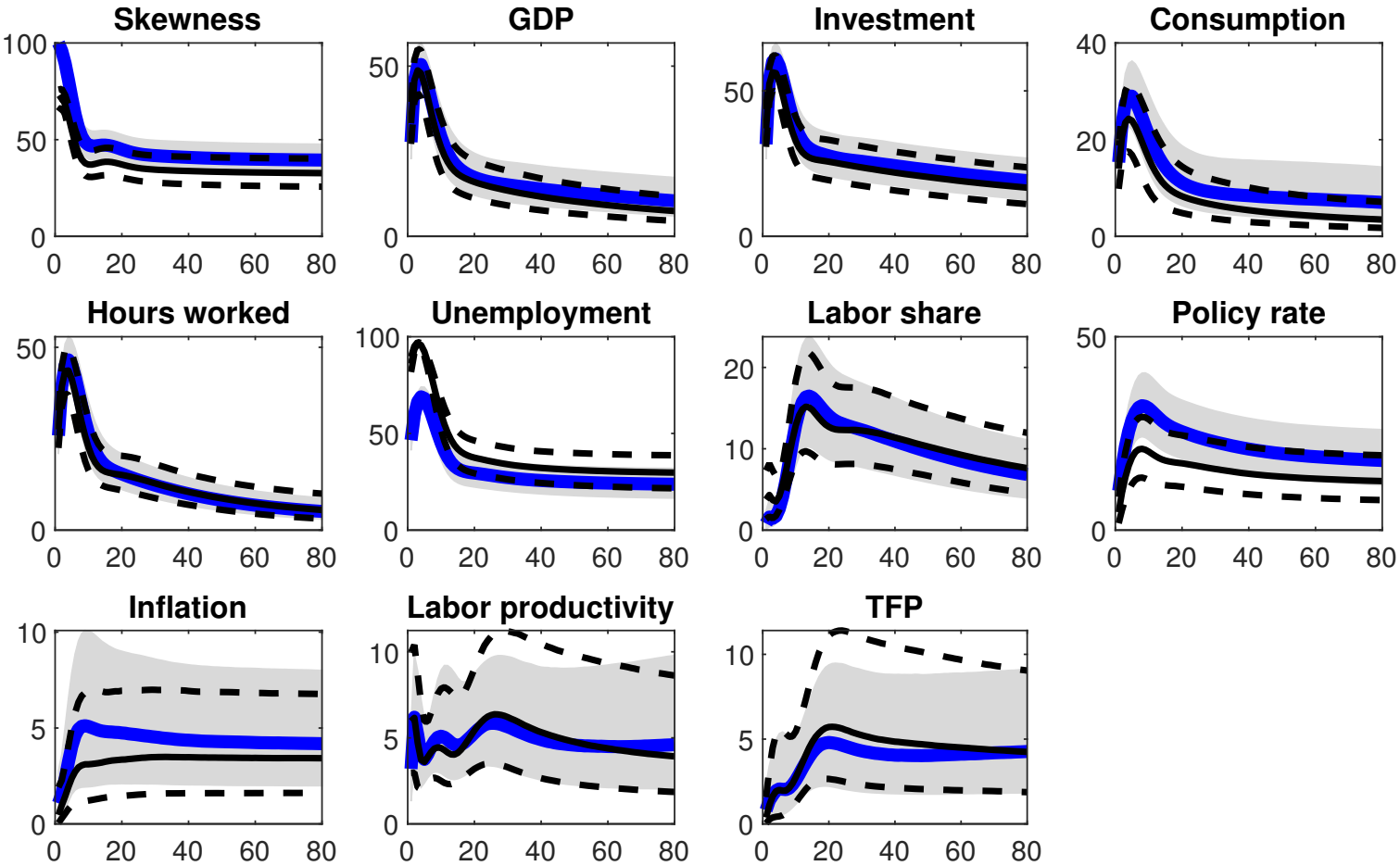
- Extend a standard BVAR with our expected skewness factor
- Cholesky ordering:
  [Exp. skewness; GDP; investment; consumption; hours; unempl.; labor share; policy rate; inflation; labor prod.; TFP]
- This identifies $\mathbb{E}_t[Skew_{t+1}] - \mathbb{E}_{t-1}\left[\mathbb{E}_t[Skew_{t+1}]\right]$
  - Revisions in expected skewness (or risk assessment)
- Link to the *business cycle anatomy* (Angeletos et al., 2020)
  - Empirically identify a single *main business cycle* shock
  - No structural interpretation, but could relate to changing risk perceptions/confidence

IRFs: Skewness shock vs. *main business cycle* shock



Note: The blue lines are the mean responses to a one S.D. shock to expected skewness. The black lines are the responses to a one S.D. shock to unemployment, i.e. the MBC shock of Angeletos et al. (2020).

Forecast error variance contributions



Note: Posterior mean of the forecast error variance contributions for a shock to expected skewness (blue) and the MBC (unemployment) shock (black).

Correlation of revisions in exp. skewness and MBC shock

	Skewness measure			MBC shock
a)	Exp. skewness factor	**Skew. shock** (1960:Q1-2017:Q4)	Median	**0.84**
			95% HDI	0.78 0.89
b)	Exp. GDP skewness	**Skew. shock** (1960:Q1-2017:Q4)	Median	**0.04**
			95% HDI	-0.03 0.11
c)	Exp. GDP skewness (ABG)	**Skew. shock** (1971:Q1-2017:Q4)	Median	**0.57**
			95% HDI	0.48 0.66
d)	S&P500 skewness	**Skew. shock** (1983:Q2-2017:Q4)	Median	**-0.32**
			95% HDI	-0.45 -0.19
e)	Firm-level stock return skewness	**Skew. shock** (1964:Q1-2015:Q1)	Median	**0.14**
			95% HDI	0.02 0.26

- Revisions in the expected skewness factor correlate strongly with the *main business cycle* shock of Angeletos et al. (2020)
- This is not (or much less) the case for alternative measures:
  - GDP skew (based on Adrian et al. (2019) approach)
  - Financial skewness (Dew-Becker, 2021; Salgado et al., 2019)

Correlation of revisions in exp. skewness and MBC shock

	Specification			MBC shock
a)	Exp. skewness factor	**Skew. shock** (1960:Q1-2017:Q4)	Median 95% HDI	**0.84** 0.78 0.89
f)	Orthog. to GARCH volatility	**Skew. shock** (1960:Q1-2017:Q4)	Median 95% HDI	**0.67** 0.56 0.76
g)	Orthog. to macro and fin. unc.	**Skew. shock** (1960:Q3-2017:Q4)	Median 95% HDI	**0.63** 0.52 0.73
h)	Orthog. to geopolitical risk	**Skew. shock** (1960:Q1–2017:Q4)	Median 95% HDI	**0.84** 0.78 0.89
i)	Orthog. to excess bond prem.	**Skew. shock** (1973:Q1-2017:Q4)	Median 95% HDI	**0.73** 0.64 0.81
j)	Orthog. to total factor product.	**Skew. shock** (1960:Q1-2017:Q4)	Median 95% HDI	**0.84** 0.78 0.90
k)	Orthog. to fiscal policy	**Skew. shock** (1960:Q1-2015:Q4)	Median 95% HDI	**0.83** 0.77 0.89
l)	Orthog. to monetary policy	**Skew. shock** (1990:Q1-2016:Q4)	Median 95% HDI	**0.84** 0.77 0.90

Controls: uncertainty (Jurado et al., 2015; Ludvigson et al., 2021), geopolitical risk (Caldara and Iacoviello, 2022), EBP (Gilchrist and Zakrajšek, 2012), TFP (Fernald, 2014), fiscal policy (Ramey and Zubairy, 2018), monetary policy (Jarociński and Karadi, 2020).

Conclusion and implications

- Construct a factor of expected macroeconomic skewness that
  - Is strongly procyclical
  - Mainly reflects variation in the skewness of real variables
  - Correlates with skew. of GDP growth and firm-level empl. growth
- Revisions in expected skewness are consistent with the *business cycle anatomy* (Angeletos et al., 2020)
  - Robust to controlling for volatility/uncertainty
- Highlights importance of higher-order dynamics for theory
  - Business cycle theories need to be able to reproduce variations in aggregate skewness (e.g. changing risk perceptions)

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