

# Surprise and Uncertainty Indexes: Real-time Aggregation of Real-Activity Macro Surprises

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Federal Reserve Board

The Causes and Macroeconomic Consequences of Uncertainty  
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# This Paper – A Summary

I construct:

- a SURPRISE index: real-time, real activity index that summarizes (aggregates) recent economic data surprises and measures deviation from consensus expectations  
INTERPRETATION: A positive (negative) reading of the surprise index suggests that economic releases have on balance been higher (lower) than consensus, meaning that agents were more pessimistic (optimistic) about the economy
- an UNCERTAINTY index: real-time, real activity index that measures economic uncertainty  
INTERPRETATION: A greater (smaller) reading of the uncertainty index suggests that agents have on balance been more (less) uncertain about the state of the real economy

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## More about the indexes

- REAL TIME indexes: I use information as it becomes available
- REAL ACTIVITY indexes: I only use real activity variables (GDP, IP, Retail sales, employment/unemployment, survey measures)
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# Data

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- announcement data
- survey/expectation data

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# Data - details

Country	Series Name	Description	Frequency	Publication Lag(days)	Transformation for factor	Source	Bloomberg Mnemonic
<b>United States</b>	GDP	Real GDP, level	Q	29	log diff	BEA	GDP CQOQ
	IP	Index, level	M	16	log diff	FRB	IP CHNG
	Employment	Level	M	5	log diff	BLS	NFP TCH
	Retail Sales	Level	M	13	log diff	ISM	RSTAMOM
	ISM Manufacturing	Index	M	2	diff	ISM	NAPMPMI
	Personal Income	level	M	29	log diff	BEA	PITLCHNG
<b>Euro Area</b>	GDP	Real GDP, level	Q	48	log diff	EUROSTAT	EUGNEMUQ
	IP	Index, level	M	46	log diff	EUROSTAT	EUITEMUM
	Unemployment rate	Level, percent	M	32	log diff	EUROSTAT	UMRTEMU
	Retail Sales	Level	M	41	log diff	EUROSTAT	RSSAEMUM
	PMI Composite (Flash)	Index	M	-9	diff	Markit	ECPMICOU
	<b>United Kingdom</b>	GDP	Real GDP, level	Q	24	log diff	UK ONS
IP		Index, level	M	38	log diff	UK ONS	UKIPIMOM
Unemployment rate		Level, percent	M	15	log diff	UK ONS	UKUER
Retail Sales		Level	M	20	log diff	UK ONS	UKRVAMOM
PMI Manufacturing		Index	M	2	diff	Markit	PMITMUK
<b>Canada</b>	GDP	Real GDP, level	Q	61	log diff	STCA	CGE9ANN
	IP (monthly GDP)	Index, level	M	60	log diff	STCA	CAIPMOM
	Employment	Level	M	7	log diff	STCA	CANLNETJ
	Retail Sales	Level	M	52	log diff	STCA	CARSCHNG
	Ivey PMI	Index	M	6	diff	PMAC	IVEY
<b>Japan</b>	GDP	Real GDP, level	Q	46	log diff	ESRI	JGDPAGDP
	IP	Index, level	M	28	log diff	METI	JNIPMOM
	Unemployment rate	Level, percent	M	28	log diff	MIC	JNUE
	Retail Sales	Level	M	27	log diff	METI	JNRETMOM
	Tankan Survey	Index	Q	-4	diff	BoJ	JNTSMFG

# News Surprises

- News surprise ( $s_t$ ) = announcement ( $y_t$ ) - forecast ( $y_t^f$ )
- Market participants react to the NEWS component of scheduled macroeconomic announcements
- Are Bloomberg forecasts efficient?
- Mincer–Zarnowitz test:  $s_t = \alpha + \beta y_t^f + u_t$

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# Mincer–Zarnowitz test

Country	Series Name	$\alpha$	$\beta$	F	pvalue
<b>United States</b>	GDP	-0.02	-0.04	0.71	<b>0.50</b>
	IP	-0.12 ***	0.27 ***	6.62	0.00
	Employment	-12.94 **	-0.06 *	4.00	0.02
	Retail Sales	-0.02	0.08	0.52	<b>0.59</b>
	ISM	1.40	-0.02	1.25	<b>0.29</b>
	Personal Income	0.05	-0.01	1.10	<b>0.34</b>
<b>Euro area</b>	GDP	-0.01	0.11 **	2.76	0.08
	IP	-0.06	-0.16 ***	4.49	0.01
	Unemployment	0.04	0.00	0.21	<b>0.81</b>
	Retail Sales	-0.12 **	-0.26 *	4.65	0.01
	PMI	1.27	-0.03	0.41	<b>0.66</b>
	<b>United Kingdom</b>	GDP	-0.15 ***	0.27 ***	6.13
IP		-0.23 ***	-0.02	7.32	0.00
Unemployment		0.04	-0.01 **	3.12	0.05
Retail Sales		0.20 ***	-0.04	3.56	0.03
PMI		2.89	-0.05	1.16	<b>0.32</b>
<b>Canada</b>		GDP	0.05	-0.01	0.11
	IP	-0.07 ***	0.06	6.56	0.00
	Employment	5.70	0.12	2.52	0.09
	Retail Sales	-0.06	0.26 **	2.66	0.07
	Ivey Survey	15.95 ***	-0.27 ***	4.06	0.02
	<b>Japan</b>	GDP	0.12	-0.01	1.79
IP		-0.44 ***	0.06	10.41	0.00
Unemployment		0.29 **	-0.07**	4.44	0.01
Retail Sales		0.13	0.25 ***	3.80	0.03
Tankan		0.17	0.01	0.22	<b>0.80</b>

\* 10 percent significance, \*\* 5 percent significance, and \*\*\* 1 percent significance

# Why do we use Bloomberg forecasts?

Markets react to those forecasts!

$$d\log(FX_t) = \alpha + \beta * s_t^i + \varepsilon_t$$

	Euro/\$		GBP/\$		CAD/\$		JPY/\$	
	Beta	R2	Beta	R2	Beta	R2	Beta	R2
<b>US</b>								
IP	0.058	0.007	0.022	0.001	0.046**	0.005	-0.053	0.005
Employment	0.258***	0.091	0.186***	0.094	-0.058	0.008	0.377***	0.210
Retail sales	0.033	0.003	0.091*	0.026	-0.097**	0.024	0.215***	0.117
Personal income	0.013	0.000	-0.019	0.001	0.036	0.003	-0.057	0.010
PMI	0.021	0.001	0.010	0.000	-0.029	0.002	0.091**	0.022
GDP	0.139*	0.043	-0.106*	0.030	0.054*	0.006	0.025	0.002
<b>Foreign</b>								
IP	-0.107***	0.033	-0.131***	0.066	-0.029	0.002	0.114	0.021
Employment/unemployment	0.133***	0.035	-0.037	0.002	-0.260***	-0.124	0.023	0.002
Retail sales	-0.190***	0.079	-0.131***	0.044	-0.215***	0.094	-0.067**	0.001
PMI/Ivey/Tankan	0.014	0.000	-0.250***	0.092	-0.120***	0.025	-0.099*	0.029
GDP	-0.107	0.034	-0.394***	0.295	-0.108	0.035	0.049	0.013

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# The Model - Underlying Factor Model

- The monthly variables:

$$y_t^M = \mu^M + Z^M x_t + \varepsilon_t^M \quad (1)$$

$$\varepsilon_t^M = \alpha \varepsilon_{t-1}^M + e_t^M \quad (2)$$

with  $e_t^M \sim i.i.d.N(0, \Sigma_e^M)$

- The quarterly variables:

$$y_t^Q = \mu^Q + Z^Q x_t + \varepsilon_t^Q \quad (3)$$

$$\varepsilon_t^Q = \rho \varepsilon_{t-1}^Q + e_t^Q \quad (4)$$

with  $e_t^Q \sim i.i.d.N(0, \Sigma_e^Q)$

- Unobserved factor is a VAR process of order  $p$ :

$$x_{t+1} = \Lambda x_t + \eta_t, \quad (5)$$

$$\eta_t \sim i.i.d.N(0, \sigma_\eta). \quad (6)$$

# The Model - State Space

$$y_t = \mu + Z\alpha_t \quad (7)$$

$$\alpha_t = T\alpha_{t-1} + u_t, \quad u_t \sim i.i.d.N(0, \Sigma) \quad (8)$$

where

$$y_t = (y_t^M, y_t^Q)'$$

$$\alpha_t = (x_t, x_{t-1}, x_{t-2}, x_{t-3}, x_{t-4}, \varepsilon_t^M, \varepsilon_t^Q, \varepsilon_{t-1}^Q, \varepsilon_{t-2}^Q, \varepsilon_{t-3}^Q, \varepsilon_{t-4}^Q)'$$

# The Model - Weights

- As shown in Koopman and Harvey (2003)

$$\alpha_{t|t} = \sum_{j=1}^t w_j (\alpha_{t|t}) y_j. \quad (9)$$

where  $y_t$  can contain vectors of monthly or quarterly series  
 $(y_t^M, y_t^Q)$

- WEIGHTS  $w_j$ 
  - interpretation: represent the importance of the corresponding (past and present) macro variable releases in determining the common factor = underlying state of the economy
  - implicitly display a time decay feature with more recent data exhibiting higher importance in determining the factor
  - do not depend on time  $t$ , but depend on the forecast horizon and the real-time release pattern of the data

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# The Model - Surprise Index ( $\mathcal{SI}$ )

Given

$$x_{t|t} = \sum_{j=1}^t w_j y_j \quad (10)$$

we can rewrite the Surprise Index as

$$\mathcal{SI}_t = \sum_{j=1}^t w_j s_j \quad (11)$$

where

$$s_t^i = \frac{y_t^i - E[y_t^i | \mathcal{F}_t]}{\sigma_s} \quad (12)$$

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# The Model - Uncertainty Index ( $UI$ )

Given

$$x_{t|t} = \sum_{j=1}^t w_j y_j \quad (13)$$

we can rewrite the Uncertainty Index as

$$UI_t = \sqrt{\sum_{j=1}^t w_j s_j^2} \quad (14)$$

where

$$s_t^i = \frac{y_t^i - E[y_t^i | \mathcal{F}_t]}{\sigma_s} \quad (15)$$

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# Estimation

The construction of the indexes requires three steps:

- (i) estimation of the state space model
- (ii) determination of the weights  $w_j$
- (iii) construction of the indexes

# Estimation

- 1 Estimate the Business Coincident Index on the full sample (January 1980 to September 30, 2012, except for the Euro area where the sample starts on January 1985)
- 2 For each day on the real-time subsample (May 15, 2003 through September 30, 2012):
  - Run Kalman Filter
  - Compute Weights
  - Compute Surprise and Uncertainty indexes



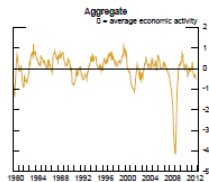
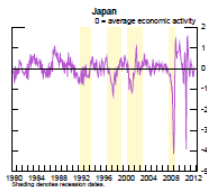
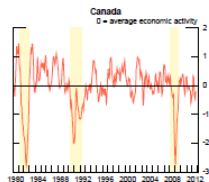
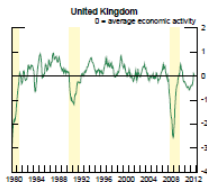
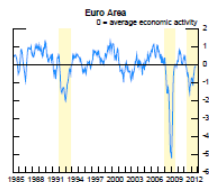
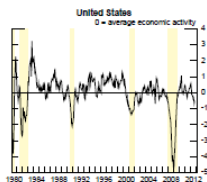
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# Results

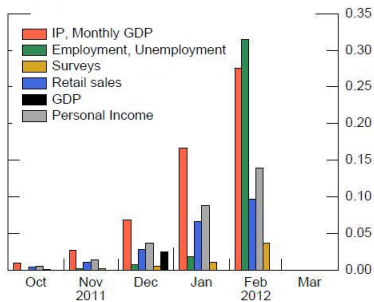
- 1 Business Condition Indexes
- 2 Weights
- 3 Indexes: Surprise and Uncertainty

# Business Conditions

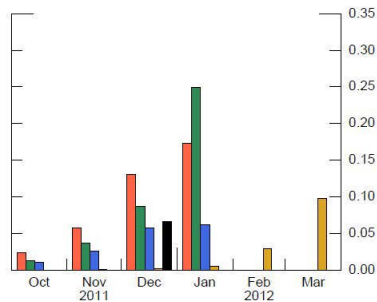


# Weights

## United States



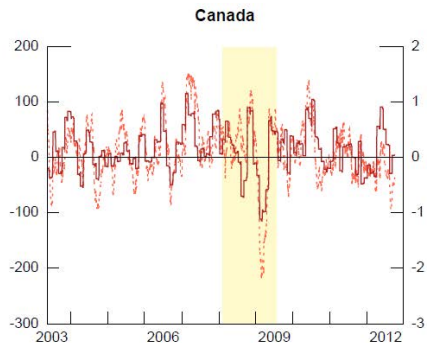
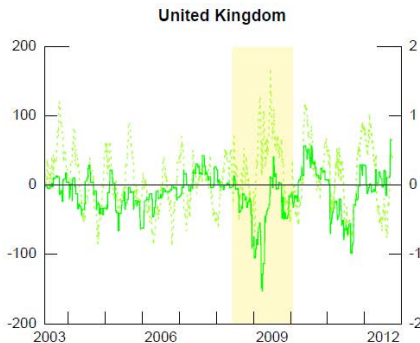
## Euro Area







# Surprise Index: UK and CA



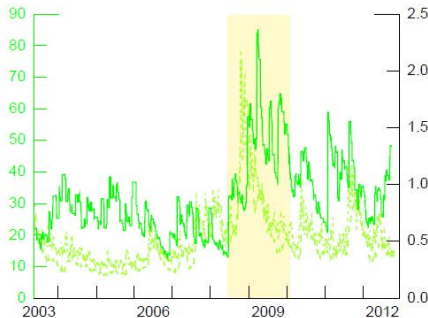




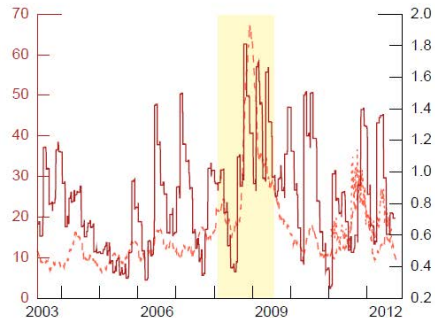


# Uncertainty Index: UK and CA

## United Kingdom



## Canada





# Application 1: Assessing the impact of the Surprise Index on FX returns

$$d\log(FX_t) = \alpha + \beta * d(S_t) + \varepsilon_t$$

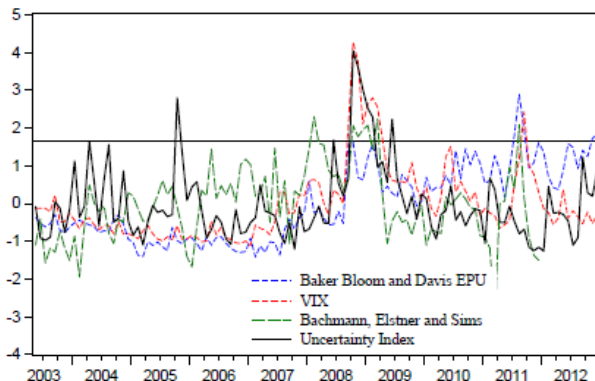
	Euro/\$		GBP/\$		CAD/\$		JPY/\$	
	$\beta$	$R^2$	$\beta$	$R^2$	$\beta$	$R^2$	$\beta$	$R^2$
US surprise index	0.362***	0.022	0.263***	0.014	-0.096	0.002	0.418***	0.031
Foreign surprise index	-0.332***	0.013	-0.140	0.007	-0.691***	0.042	0.128	0.002

\*\* 5 percent significance, \*\*\* 1 percent significance

# Business Cycle

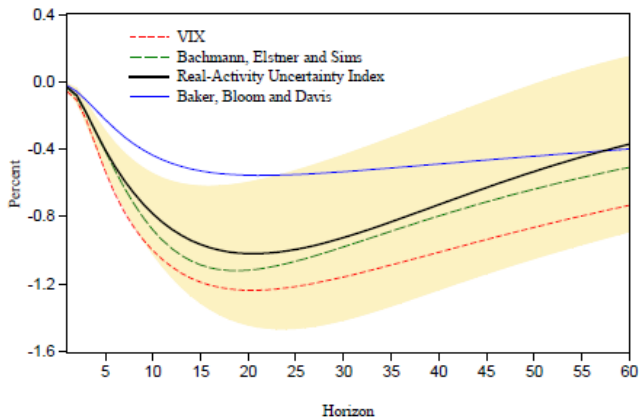
The solid line represent the uncertainty index which is compared against other common proxies for uncertainty, namely the Baker, Bloom and Davis measure, the Bachmann, Elstner and Sims measure, and the VIX.

All series are demeaned and standardized. The horizontal line represents the 1.65 standard deviation limit.



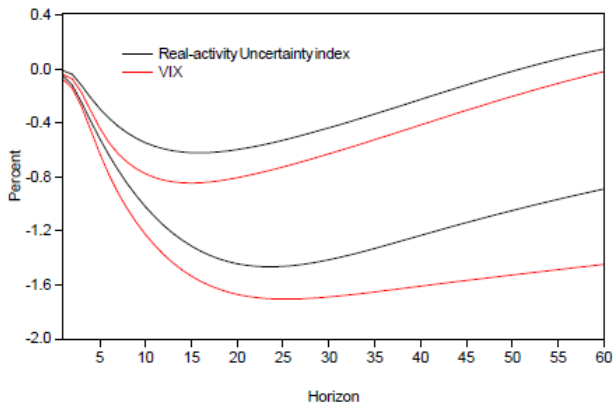
# Business Cycle

Employment response to a 1 standard deviation shock in the different uncertainty proxies. The shaded area represents the  $\pm$  one standard error confidence interval for the uncertainty index.



# Business Cycle

+/- one standard error confidence interval for the real-activity uncertainty shock and the VIX



# Conclusions

I constructed a surprise index and an uncertainty index using only macroeconomic information. Looking into a number of possible extensions:

- construct indexes for nominal variables to gauge optimism/pessimism about inflation stance
- incorporate additional indicators and surprises for each country to construct a summary measure of real and nominal variables
- extend the framework to include U.S. macro surprises into foreign economies to exploit the correlation/causation across business cycles.
- include vintages of data so that the indexes change not only when new information is released but also when past information is revised.
- expand the dataset to construct indexes with a longer history
- experiment with different weight systems



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- incorporate additional indicators and surprises for each country to construct a summary measure of real and nominal variables
- extend the framework to include U.S. macro surprises into foreign economies to exploit the correlation/causation across business cycles.
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