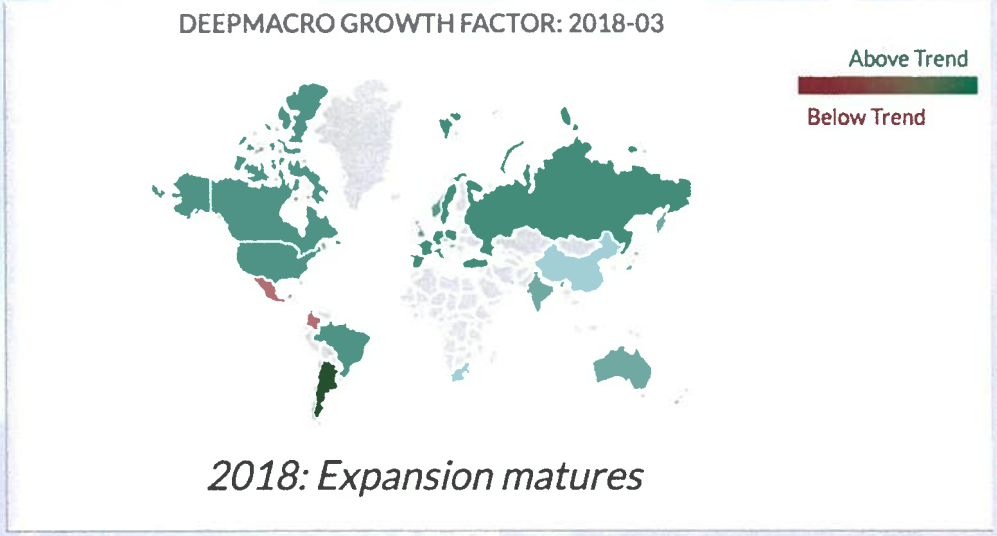
DeepMacro

BIG DATA
MACHINE LEARNING
GLOBAL INVESTING



2018: Expansion matures

Feb 2020

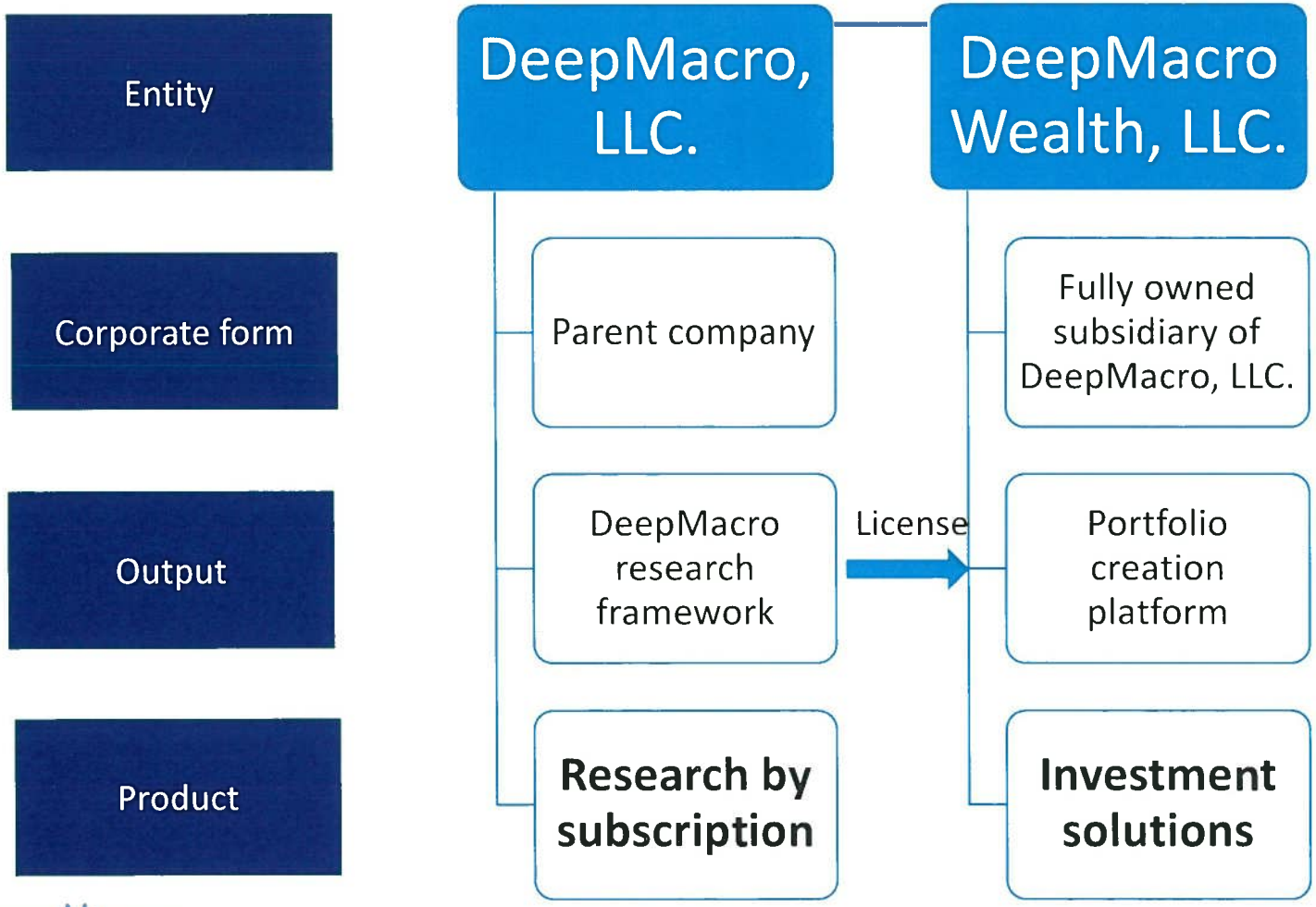
OUTLINE OF PRESENTATION

- WHAT IS DEEPMACRO:
  - BIG DATA FOR GLOBAL INVESTING
  - HOW IT STARTED
  - FOUNDING TEAM
- THREE COMPONENTS OF DEEPMACRO:
  - BIG DATA AND MACHINE LEARNING
  - GLOBAL MACRO FRAMEWORK
  - INVESTMENT SOLUTIONS

COMPANY INTRO

WHAT IS DEEPMACRO?

DEEPMACRO: TWO ENTITIES, TWO PRODUCTS



DeepMacro

HOW IT ALL STARTED: I

- In early 2007, I had been a fund manager for 12 years and in financial industry for 14 years.
- Used models of interest rates, equity prices, and volatilities extensively, for `relative value' investment strategies.
- Macro variables were not the focus even though they had impacts generally across all asset classes.
- Existing systematic macro investment strategies in the industry were almost exclusively either discretionary or price/volume based – momentum, reversion, and a mixture of two.
- Difficulties using macro variables:
  - Thousands of time series of official data which are revised regularly.
  - Need Point-In-Time (PIT) macro data to sync with financial market data.
  - The low frequency nature of official data and private enterprise data such as US ADP monthly private employment.
  - The pooled cross-sectional and time-series data of macro variables constitute a sparse matrix.

HOW IT ALL STARTED: II

- Every day, there are scores or up to hundreds of macro data releases around the world.
- Assets prices respond to these data - stock prices, interest rates, exchange rates, commodity prices… (Cryptocurrency prices?)
- I was always wondering whether asset prices responded to these data releases appropriately.
  - Need to quantify persistent relations between asset prices and macro data.
  - Once persistent relations are quantified, many investment opportunities might surface.
  - These opportunities would be very attractive if the deviations are of higher frequency (than the `persistent relations').
- My suspicion was that market did not price macro risks correctly all the time and deviations were of higher frequencies.
  - At least some of the relative investment opportunities must have been driven by the transitory deviations of the levels of asset prices from a relation relative to macro data.
- Jeff Young became Chief Economist of PGAM beginning of 2007. Quantifying persistent relations between asset prices and macro data was his first project.

IMMEDIATE ISSUES

- Unavailability of PIT data, especially outside US.
  - Started collecting PIT data for 33 countries in 2007.
  - St. Louis Fed had some historical PIT US data.
  - ECB provided some historical PIT Euroland data.
  - Using years of experience, Jeff created quasi-PIT data back to 1990.
- Sparseness of pooled cross-sectional and time-series data:

	Retail sales	Housing starts	Exports	IP	PMI	NFP	UE Rate
1/31/2018	NA	NA	NA	NA	56.7	NA	NA
2/28/2018	NA	NA	NA	NA	NA	220	3.9
3/31/2018	3.4	9.3	NA	NA	NA	NA	NA
4/30/2018	NA	NA	-3.9	3.1	NA	NA	NA
5/31/2018	NA	NA	NA	NA	53.2	330	3.5
6/30/2018	2.5	8.5	NA	NA	NA	NA	NA
7/31/2018	NA	NA	NA	NA	NA	NA	NA
8/31/2018	NA	NA	2.1	4.3	NA	280	3.4

  - Fill in the blanks using time-series techniques such as Kalman filter.
- High correlations among macro data and the need to reduce dimension:
  - Factor analysis to extract important common components.
- The combination of the last two is Dynamic Factor Model (DFM), a la Stock and Watson (2002).

ALMOST TEN YEARS ON IN 2016

- Computing power had grown more than 30 times per unit cost.
- Unit computing cost by usage declined even more due to the availability of cloud computing.
- Many more online companies and governments collecting higher frequency data than official data releases.
- PIT data cumulated, computer programs that processed them, and the derived data there-in were injected into a start-up, DeepMacro.com.
- All these are then enhanced by
  - Unstructured Big Data with data frequencies much higher than official statistics.
  - Analytical tools based on Machine Learning/Artificial Intelligence.
- Above all, enhanced by human capital with deep domain knowledge in macroeconomics and Internet of Things/software technology.
  - Deep domain knowledge in global macroeconomics is crucial as a decade of PIT data are still a small sample in all scheme of things.
  - Many Big Data are unstructured and thus need to be analyzed to extract relevant information in forms of structured data.

Straightforward Inclusion of Big Data Once in Structured Form

- Once in structured PIT data form, one Big Data source is just a new column added to the matrix on page 8, with higher frequencies (in all likelihood).
- The machinery of Dynamic Factor Model applies:
  - Kalman filter fills up the sparse matrix;
  - Factor Analysis extracts macroeconomics factors such as growth and inflation.

DEEPMACRO'S LEADERSHIP

"FIN"

"TECH"

Jeffrey Young

Chief Executive Officer

Systematic macro frameworks and FX portfolios, global economics research, econometrics

- Macro Analysis, Caxton
- Director of Research, Woodbine
- Chief Economist, Platinum Grove Asset Management (PGAM)
- Head of FX Research, Citigroup
- Princeton University

James Cowie

Chief Data Scientist & CTO

Internet measurement, unstructured data acquisition and processing, natural language processing, machine learning

- Founder and CTO, Renesys
- Chief Scientist, Dyn Research
- Yale University

Chi-Fu Huang

Chairman of the Board

- Co-founder and Chief Investment Officer, PGAM
- Partner and Co-Head of Japan Office, Long-Term Capital Management
- Head of Fixed Income Derivatives Research, Goldman Sachs
- JC Penney Professor of Management, Sloan School of Management, MIT

Eric Rosenfeld

Board Member

- Founding Partner, Quantitative Alternatives
- President, Paloma Partners Management Co
- Co-founder, JWM Partners
- Co-founder, Long Term Capital Management
- Head of Government Trading and Member of Executive Committee, Salomon Brothers
- Assistant Professor of Finance, Harvard Business School

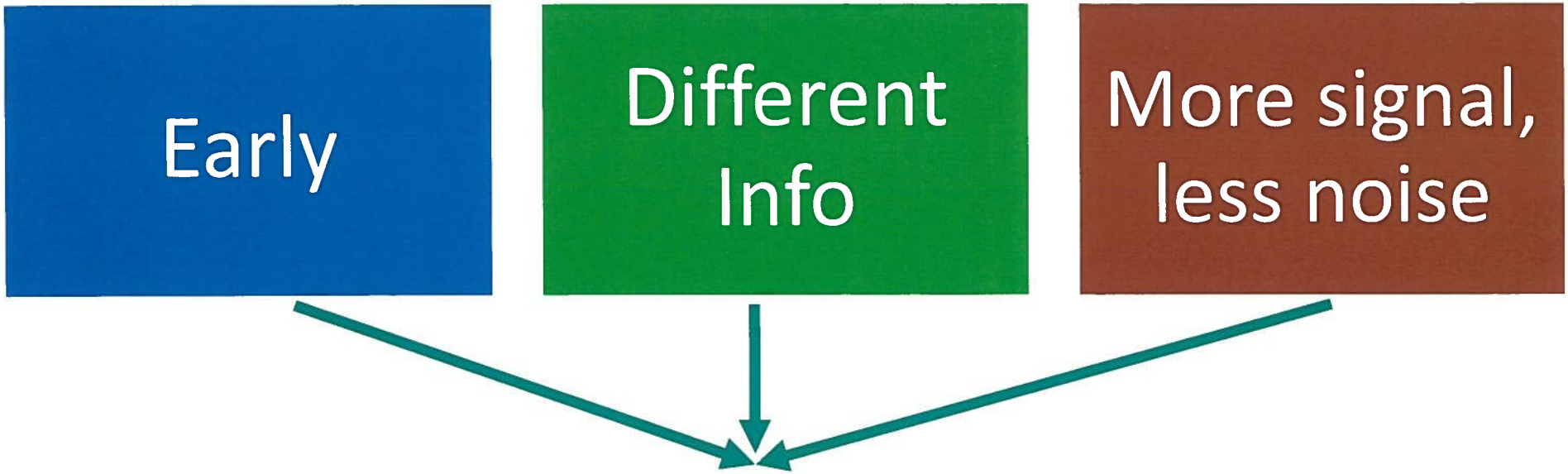
THREE COMPONENTS of DEEPMACRO

I. BIG DATA

II. GLOBAL MACRO FRAMEWORK

III. INVESTMENT PORTFOLIOS

WHY BIG DATA?



THE PROBLEMS

"How do you choose *which* data?"

"It's expensive."

"It doesn't work".

THE SOLUTION: "GOOD" BIG DATA

"*Good*" big data

Many types of big data

Big data *plus* official data

"GOOD" BIG DATA

Statistical criteria	Long enough history	Timely	Seasonally adjustable	Stationary
Economic criteria	Explains the economy	Many countries	Different from official data	Complements other big data sources

EXAMPLES

POLLUTION AND PRODUCTION IN CHINA

SOURCE
Air pollution sensor readings (from a satellite)

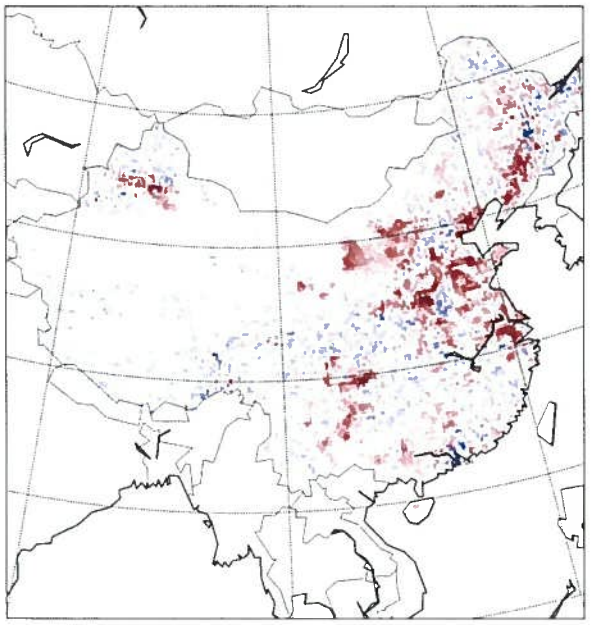
TECHNIQUE
Sensor data analysis

APPLICATION
China and other countries' industrial cycle

- Air pollution correlates with industrial activity
- In China, specific areas of the country (in red) generate pollutants that correlate with national industrial output
- 1.3 million readings per day, 2-3 days lag, 10+ years of history
- View on industry 2-6 weeks before official data
- Objective (government does not touch these data)

Association of Air Pollution With Industrial Production by 20km Blocks

Oct 2004-May 2017 (Red=Strongest Association)



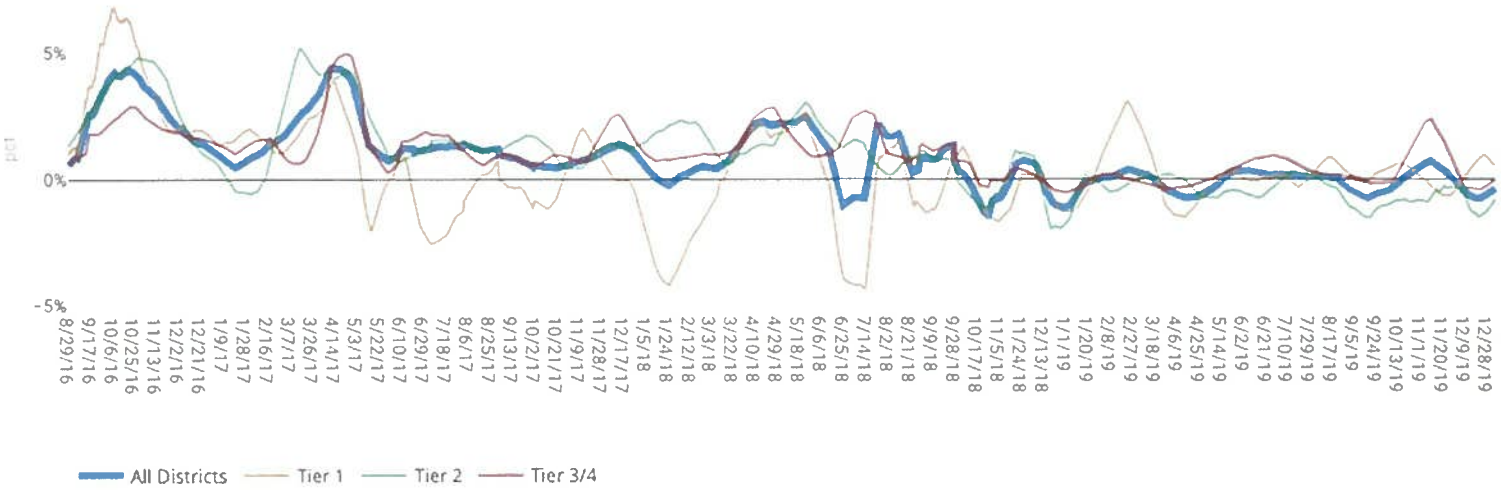
REAL ESTATE IN CHINA

SOURCE
Real estate developer websites

TECHNIQUE
Web scraping (asking prices, etc., 20,000 new projects, daily, no lag)

APPLICATION
China business cycle and capital flows

CHINA REAL ESTATE ASKING PRICES, AVERAGE OF 1131 DISTRICTS
(29 Aug 2016 – 4 Jan 2020, %MoM Changes, 30 Day MVA)



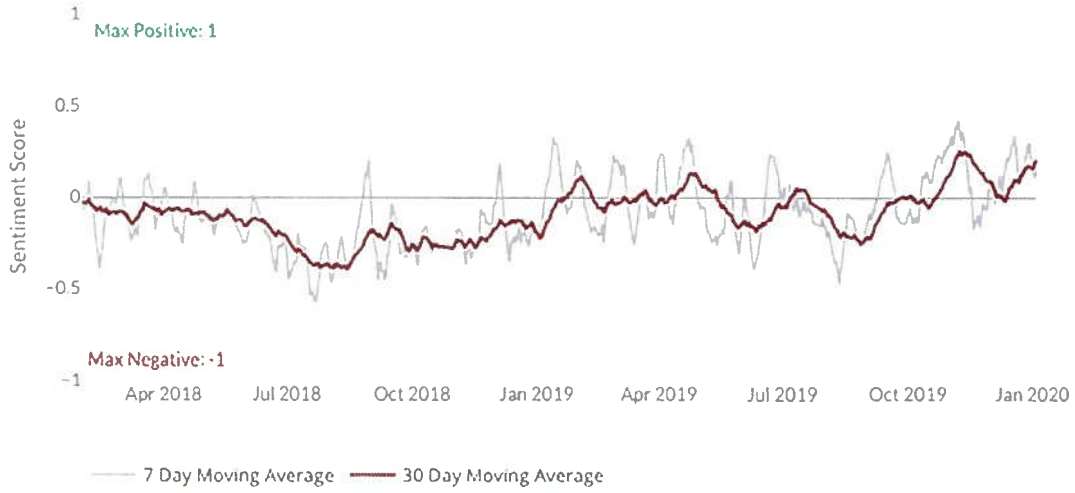
SOCIAL MEDIA: RMB SENTIMENT AND CAPITAL FLOWS

SOURCE
Social media ("Weibo", the Chinese version of Twitter)

TECHNIQUE
Natural language processing

APPLICATION
Capital flows in and out of China

RMB SENTIMENT INDEX
31 Jan 2018 – 3 Jan Nov 2020 (Max Positive Sentiment = 1.00)



US LABOR DATA

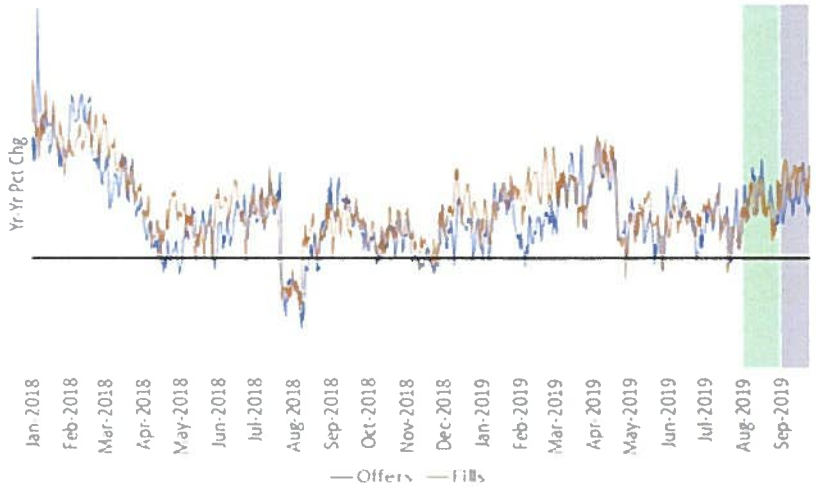
SOURCE
HR websites of 30,000 US companies

TECHNIQUE
Web scraping (count new job openings and fills)

APPLICATION
Trading strategy

US NEW OPENINGS, ESTIMATED FROM HR WEBSITES

1 Jan 2018 – 25 Sep 2019, Yr-Yr Pct Chg of 20 Day Moving Average, Green = Aug, Grey = Sep)



Sources: DeepMacro, LLC. and LinkUp/SmartMarketData.

WIKIPEDIA SEARCHES AND EDITS

SOURCE
Web traffic Wikipedia page views

TECHNIQUE
Time series analysis

APPLICATION
Used as an input into the growth/inflation factor for 14 countries including major economies like US, Europe, UK and China

- Crowd web searching behavior correlates with economic activity.
- Data is available next-day in all cases and gets updated every day. 10+ years of history.
- Cover 12 languages, 14 countries and 10+ financial/economics topics

Wikipedia Search Terms
Jun 2008 – Oct 2019 (Larger = Stronger Association with DeepMacro Factor)

THE THREE PARTS OF DEEPMACRO

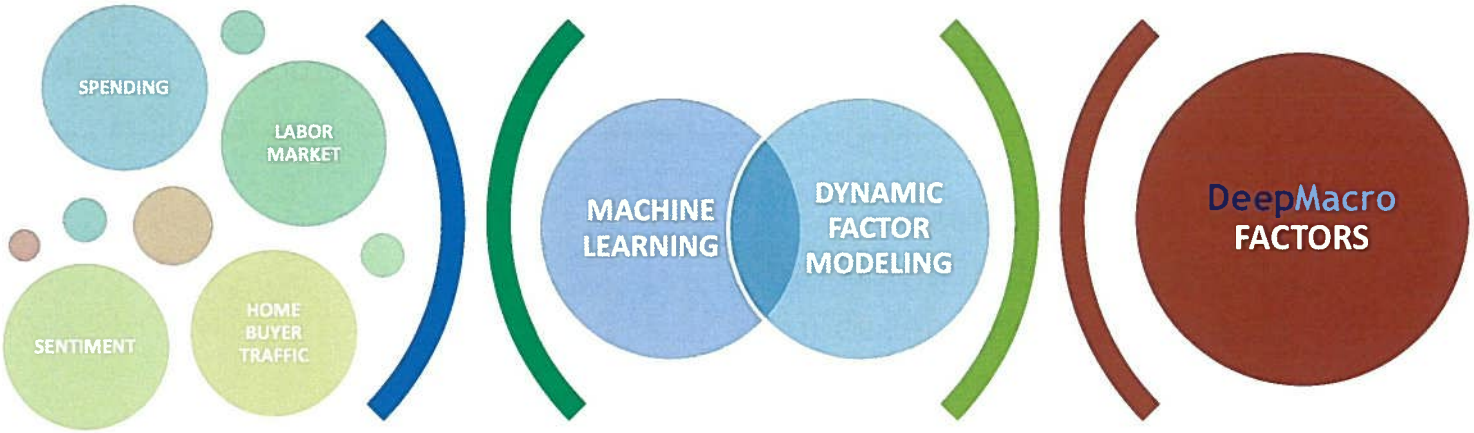
I. BIG DATA

II. GLOBAL MACRO FRAMEWORK

III. INVESTMENT SOLUTIONS

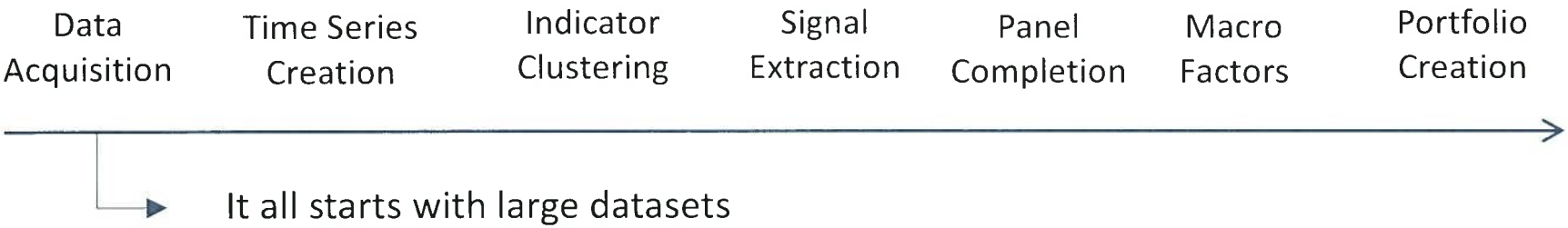
DEEPMACRO FACTORS

- Our growth and inflation "factors" extract the common trend of data on economic activity and prices.
- The level of activity and the rate of change influence how different asset classes perform through the cycle.



DATA SERIES ("OFFICIAL" AND UNSTRUCTURED) → **STATE-OF-THE-ART ECONOMETRIC METHODS** → **OBJECTIVE INDICATOR OF ECONOMIC GROWTH**

Use of Machine Learning



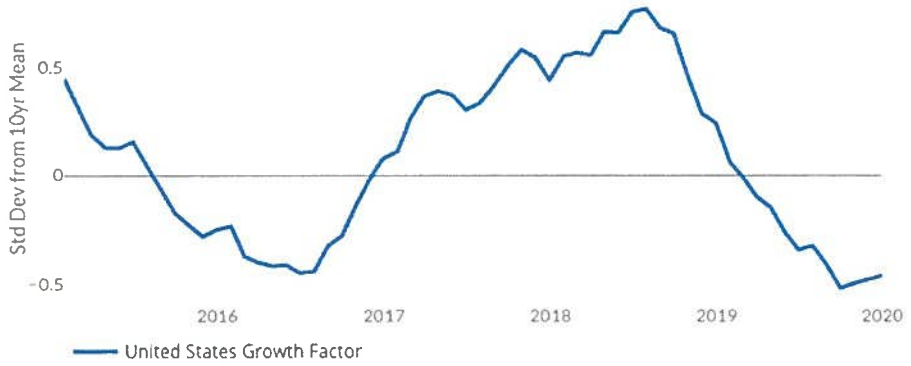
It all starts with large datasets

- Structured and unstructured
- Scraped from Internet sources
- Downloaded from public repositories
- Retrieved from social media

Primary role of ML: cleaning, reduction, primary signal extraction.

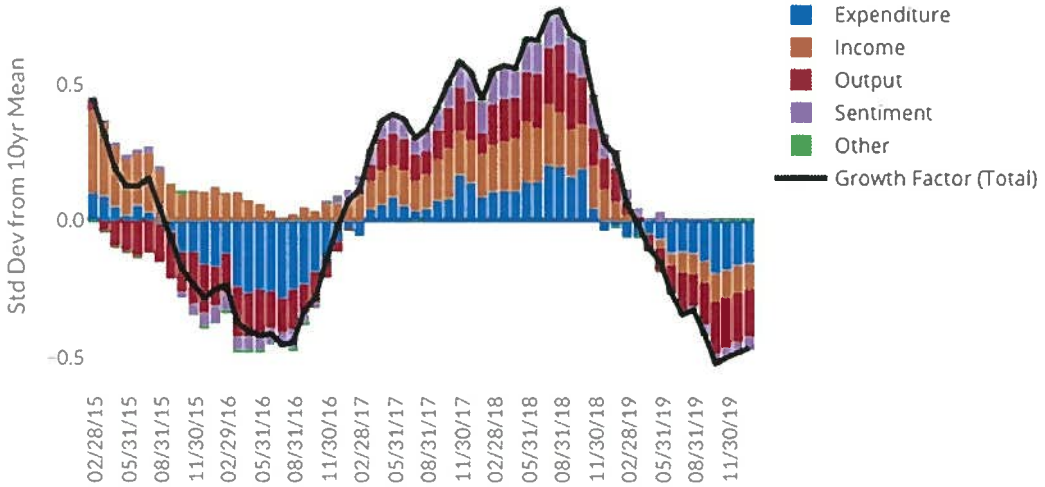
SINGLE COUNTRY FACTOR

- OUT OF MANY INDICATORS, ONE INDICATOR
- The factor is a *single* time series that shows the common trend of a *large number* of data series (hundreds, or thousands).
- Based on *dynamic factor modeling*
  - Automatically selects and weights each series according to its importance.
  - Variables and their weights change as the structure of the economic changes.
  - Incorporates "Big Data"
- Factor shows activity relative to its long-term mean, to facilitate cross-country comparisons.



US: DEEPMACRO GROWTH FACTOR, Feb 2015 – Jan 2020

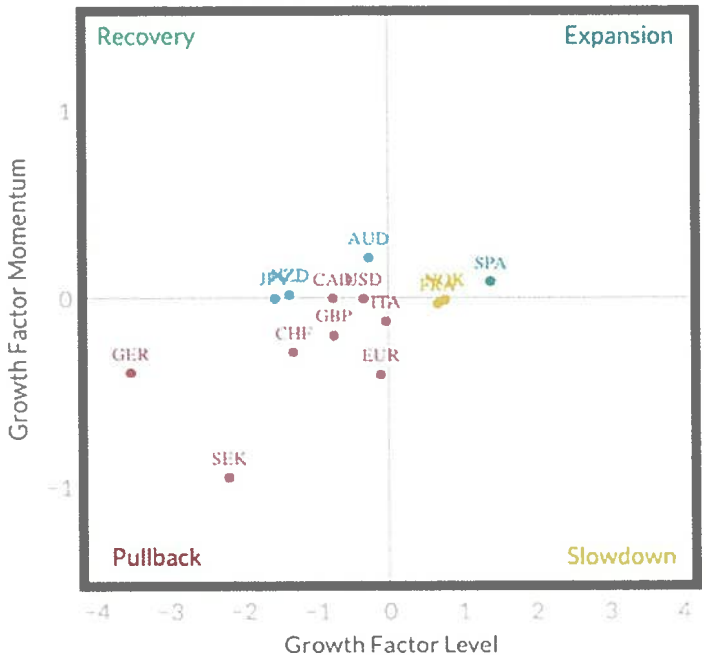
(Std Dev from 10yr Mean)

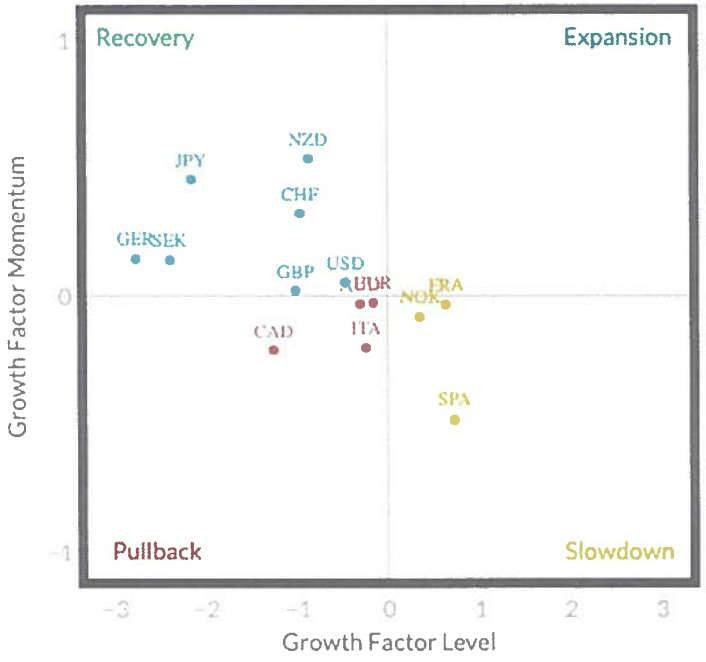


FACTOR-BASED GLOBAL MACRO FRAMEWORK

- Look at all countries together: what is the global growth (or inflation) trend? How will global markets move?

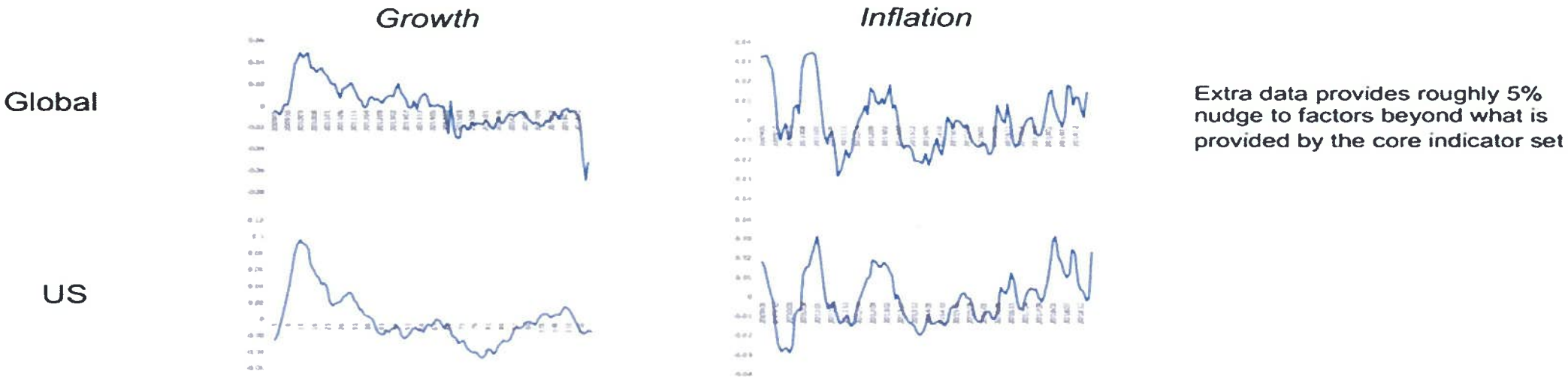
G10: GROWTH FACTOR, LEVEL (X AXIS) VS CHANGE (Y AXIS), 3M AGO (5 OCT 2019, LEFT) VS. CURRENT (5 JAN 2020, RIGHT) (Std Dev vs 10yr Mean)





FACTORS (WITH-WITHOUT) ALT DATA

DeepMacro Growth and Inflation Factors, Global and US, With – Without "Big Data", May 2009 – Apr 2019 (Std Dev from 10yr Mean)



Extra data provides roughly 5% nudge to factors beyond what is provided by the core indicator set

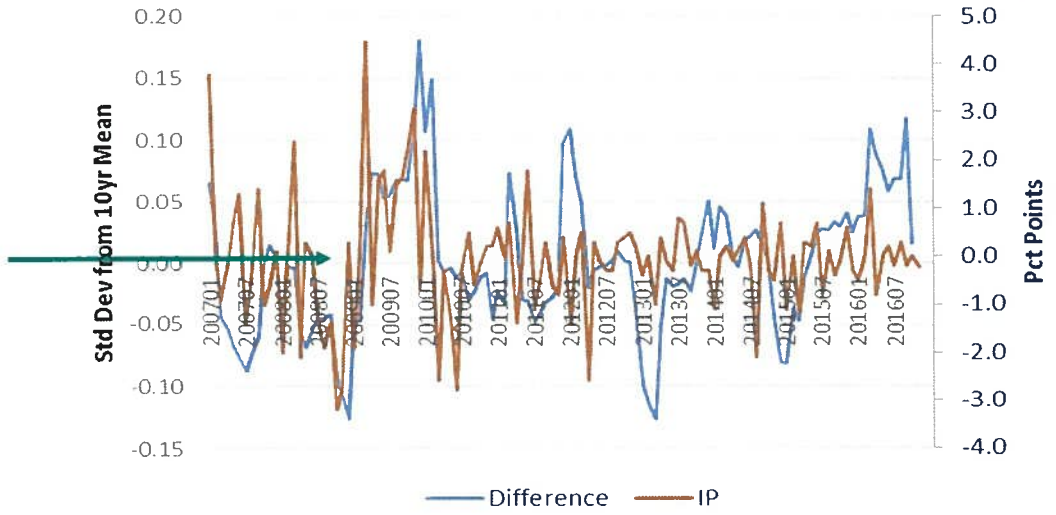
ENHANCED BY "BIG DATA"

- Big Data improves predictive power of the China growth factor
- Daily updates, versus long lags for official data

Good performance during crisis, "V-shaped recovery", and aftermath

CHINA: DIFFERENCE IN GROWTH FACTOR WITH AND WITHOUT "BIG DATA" VS. CHANGES IN INDUSTRIAL PRODUCTION

(Dec 2006 - Nov 2016, Std Dev from 10yr Mean and MoM Diff in %YoY Changes)



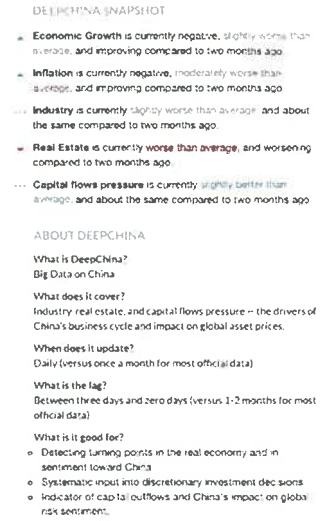
DeepMacro

CORE: DEEPCHINA

INSTANT VIEW OF MAIN DRIVERS OF CHINESE GROWTH

- Automated, daily China-related "big data"
- Direct market implications

DEEPCHINA: 10 NOV 2019 - 5 JAN 2020 (LAST TWO MONTHS IN ONE WEEK INCREMENTS, STD DEV FROM 10YR MEAN OR AS INDICATED)



DEEPCHINA SNAPSHOT

- **Economic Growth** is currently negative, slightly worse than average, and improving compared to two months ago.
- **Inflation** is currently negative, moderately worse than average, and improving compared to two months ago.
- **Industry** is currently slightly worse than average, and about the same compared to two months ago.
- **Real Estate** is currently worse than average, and worsening compared to two months ago.
- **Capital flows pressure** is currently slightly better than average, and about the same compared to two months ago.

ABOUT DEEPCHINA

What is DeepChina?
Big Data on China

What does it cover?
Industry, real estate, and capital flows pressure -- the drivers of China's business cycle and impact on global asset prices.

When does it update?
Daily (versus once a month for most official data)

What is the lag?
Between three days and zero days (versus 1-2 months for most official data)

What is it good for?
- Detecting turning points in the real economy and in sentiment toward China
- Systematic input into discretionary investment decisions
- Indicator of capital outflows and China's impact on global risk sentiment.

	10 NOV	17 NOV	24 NOV	01 DEC	08 DEC	15 DEC	22 DEC	29 DEC	05 JAN
ECONOMIC GROWTH									
Growth Factor: (Level)	-1.74	-1.77	-1.65	-1.64	-1.52	-1.55	-1.52	-1.45	-1.21
Growth Factor: (Momentum)	0.13	0.10	0.22	0.26	0.31	0.29	0.31	0.33	0.47
Growth Factor State	Recovery	Recovery	Recovery	Recovery	Recovery	Recovery	Recovery	Recovery	Recovery
INFLATION									
Inflation Factor (Level)	0.34	-0.34	0.34	0.41	0.41	0.37	0.37	0.35	0.35
Inflation Factor (Momentum)	0.28	0.28	0.28	0.11	0.11	0.07	0.07	0.09	0.09
Inflation Factor State	Disinflation	Disinflation	Disinflation	Disinflation	Disinflation	Disinflation	Disinflation	Reflation	Reflation
INDUSTRY									
Industrial production (Yr-Yr Pct Chg)	6.2%	6.2%	6.2%	5.9%*	5.8%*	5.9%*	5.9%*	5.9%*	5.9%*
Purchasing managers' index (NBS, Level)	50.2	50.2	50.2	50.2	50.2	50.2	50.2	50.2	51.1*
REAL ESTATE									
Real estate sentiment **	-0.48	-0.53	-0.51	-0.52	-0.53	-0.51	-0.48	-0.41	-0.35*
Asking prices (All districts, Mo Mo Chg)	0.2%	0.2%	0.2%	0.1%	0.4%	0.7%	0.8%	0.6%	0.4%
CAPITAL FLOWS PRESSURE**									
RMB sentiment (general)	0.25	0.20	0.13	0.09	0.01	0.06	0.11	0.17	0.20*
RMB sentiment (vs. Bitcoin)	0.17	0.16	0.14	0.32	0.35	0.36	0.33	0.24	0.21*

**Negative = capital outflows pressure, positive = capital inflows pressure

*Indicates that the value is only up to date as of 2020-01-04.

The metrics above are split into deciles based on three years of historical data. The metrics that fall into the top 50% are shaded in gradients of green, to indicate metrics that are generally considered positive, and the metrics that fall into the bottom 50% are shaded in gradients of red to indicate metrics that are generally considered negative.

OUR THREE COMPONENTS

I. BIG DATA

II. GLOBAL MACRO FRAMEWORK

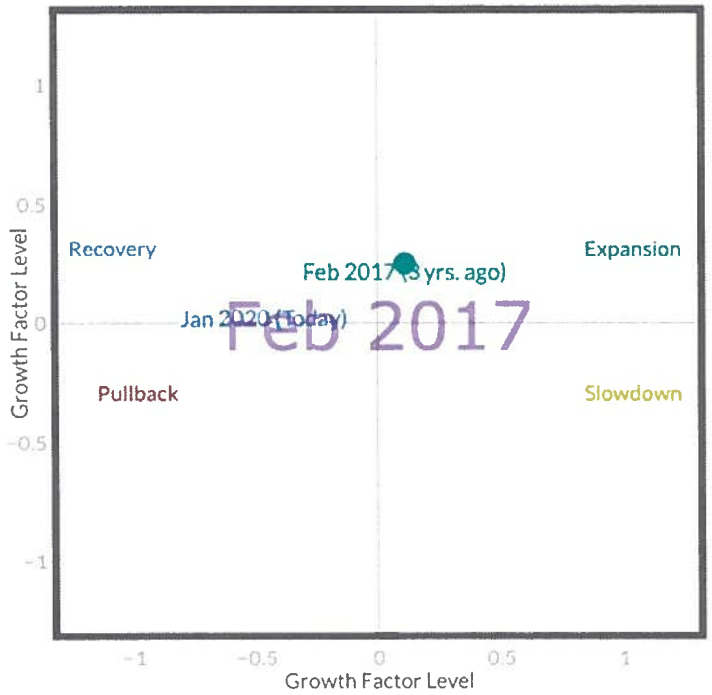
III. INVESTMENT SOLUTIONS

QUESTIONS AI CAN ANSWER

WHERE ARE WE IN THE ECONOMIC CYCLE?

USD: Growth Factor, Feb 2017 - Jan 2020

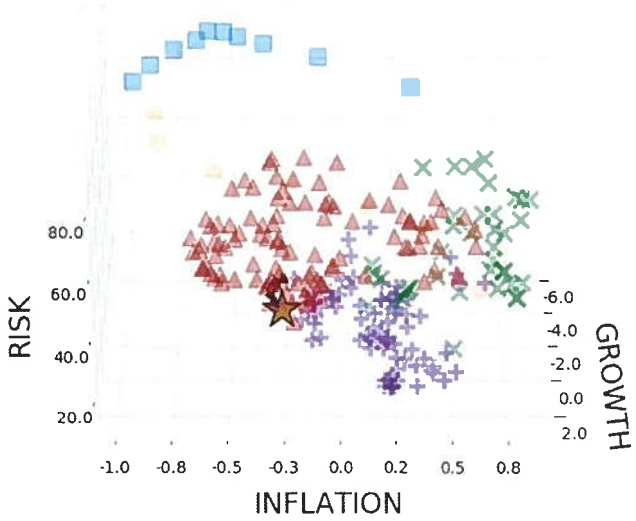
(Std Dev From 10yr Mean Factor Level (x axis) vs. Factor Three-Month Change (y axis)
State changes over the Past 3 Years



WHAT IS THE MARKET "REGIME"?

- "Is it a good environment for equity, or for fixed income"? Let machine learning answer this question.
- (Markers of the same color are in the same "regime" of growth, inflation, and risk).

DEEPMACRO REGIMES, DEC 2003 - JAN 2019 (LARGE STAR REPRESENTS THE MOST RECENT POINT)



Note: The color represents the "regime" that DeepMacro algorithms judge the global economy to be closest to in the month. The large star shows the readings based on data as of 23 Dec 2019, for use in the January portfolio. Arrows show the evolution of the readings over the prior five months.

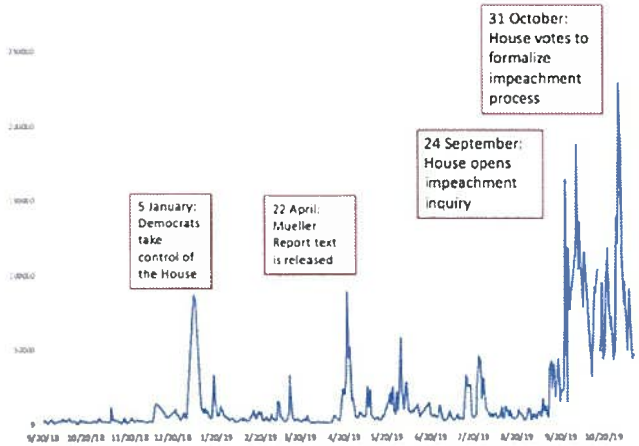
WILL TRUMP GET REMOVED?

SOURCE
Social media

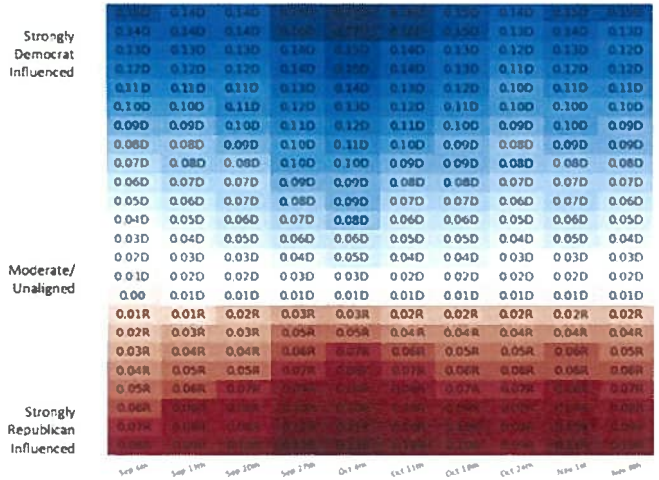
TECHNIQUE
Natural language processing

APPLICATION
Are risks to the market base case worth hedging?

Daily Mentions of the Term 'Impeach' in Tweets Referencing @realDonaldTrump, 20 Sep 2018 – 10 Nov 2019 (Number of Tweets)



Weekly Evolution of Political Party Alignment across 25 Sub-panels of Politically Engaged Twitter Users, from Strongly Democrat-aligned (Blue, D) to Strongly Republican-aligned (Red, R), 6 Sep 2019 – 8 Nov 2019

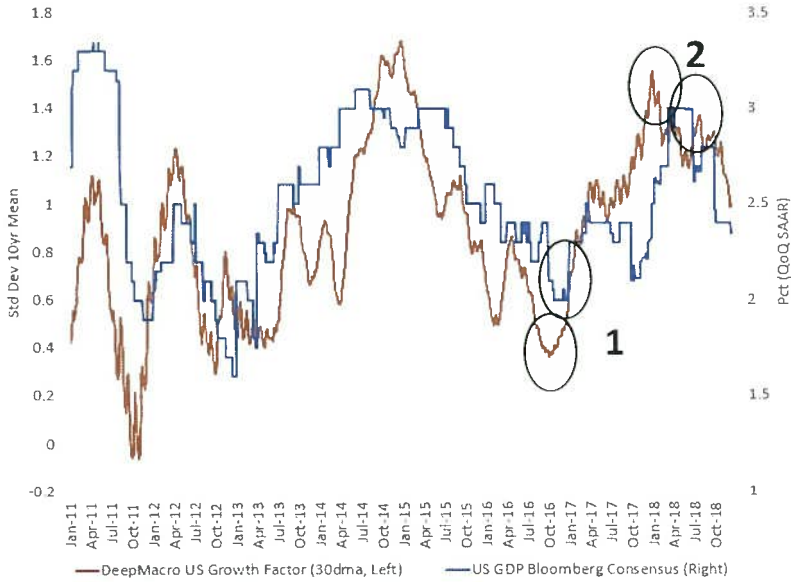


DeepMacro

THE BOTTOM LINE

BENEFIT 1: LEAD CONSENSUS

- Each day, we compare the DeepMacro growth factor with the Bloomberg GDP consensus forecast 1 quarter ahead, calculated on the same day. (For example, the last date on the chart is Dec 18 2018 for our factor and the Dec 18 2018 Bloomberg consensus estimate of 1Q 2019 growth.)
- Our factor tends to pick up on turning points before the consensus. In the US, correlation between these two series is highest when DeepMacro leads by about 30 days.



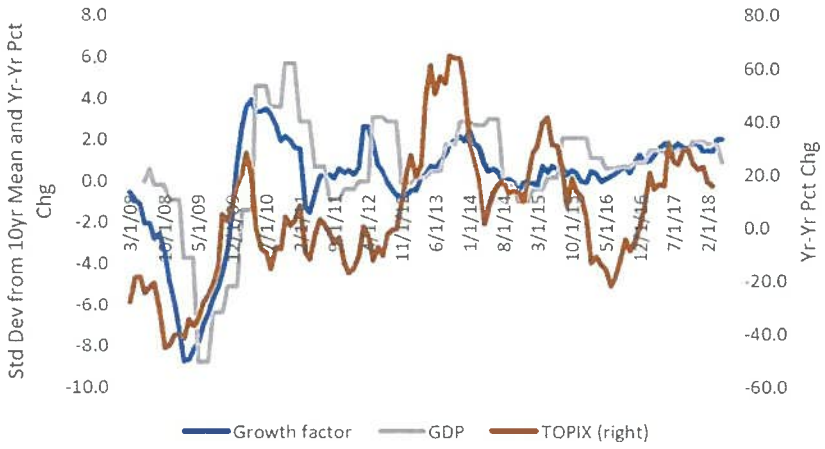
1. DM picked up a turn higher in growth in the fall of 2016. The market caught up in January 2017.
2. DM started to detect signs of slowing US momentum at the beginning of January, 2018 well before the consensus plateau in the spring of 2018.

BENEFIT 2: CORRELATE WITH MARKETS

- The factors are not used to forecast GDP or CPI (although they do it well, pls ask for details).
- The factors focus on extracting macro information that markets will price
  - Factors earn risk premium over time
- The DeepMacro factors have higher correlations with markets than GDP does
  - DeepMacro growth factor correlation with TOPIX (0.57) is higher than GDP correlation with TOPIX (<0.28, including release lags).

JAPAN: DEEPMACRO GROWTH FACTOR, GDP, AND TOPIX, MAR 2008 – MAY 2018

(Std Dev from 10yr Mean and Yr-Yr Pct Chg)



DeepMacro

THE DEEPMACRO SUITE OF INVESTMENT SOLUTIONS

RATES	CURRENCIES	ASSET ALLOCATION	PORTABLE ALPHA
SHORT-TERM RATES-1	FX-1	GTAA-1	GTAA-1 PLUS FX-1

DeepMacro SHORT-TERM RATES-1 (STR-1)

- Intuition: Central banks respond to growth and inflation – Taylor's Rule
- Forecast market expectations of monetary policy in the medium term (2yr swap rates) using DeepMacro growth and inflation factors
- Forecasts based on combinations of machine learning models to capture nonlinearities – Sentiment expressed in CB statements/speeches using Natural Language Processing

STR-1 EXAMPLE (AS OF 3 JAN 2020)

	2yr Swap	2yr Rate 3m Forward		Forecast -	Recommended
Country	*CURRENT*	*FORECAST*	*MARKET*	Market	Action
Switzerland	-0.631	-0.679	-0.621	-0.058	RECEIVE
Japan	0.015	-0.002	0.013	-0.015	NEUTRAL*
United States	1.614	1.543	1.546	-0.003	NEUTRAL*
Canada	1.914	1.931	1.893	0.038	NEUTRAL*
Euro Area	-0.314	-0.255	-0.302	0.047	PAY
New Zealand	1.224	1.279	1.228	0.051	PAY
Australia	0.790	0.922	0.791	0.131	PAY
UK	0.776	0.895	0.761	0.134	PAY
Norway	1.940	2.054	1.833	0.221	PAY
Sweden	0.216	0.495	0.227	0.268	PAY

STR-1: PERFORMANCE

- STR-1 has high hit rates, across years, recommendation direction (receive/pay), and countries.

STR-1 "HIT RATE" BY YEAR, 1 JAN 2014 - 16 OCT 2019 (PCT OF DAYS RECOMMENDATION WAS IN THE MONEY AT EXPIRY THREE MONTHS LATER)

BACKTESTING SUMMARY BY DATE *(DATES)*	TOTAL HIT RATE
Since Inception *(1 Jan 2014 - 16 Oct 2019)*	71.9%
2019	36.0%
2018	79.5%
2017	65.5%
2016	68.3%
2015	79.7%
2014	94.8%
All Receivers *(1 Jan 2014 - 16 Oct 2019)*	72.5%
All Payers *(1 Jan 2014 - 16 Oct 2019)*	49.5%

STR-1 "HIT RATE" BY COUNTRY, 1 JAN 2014 - 16 OCT 2019 (PCT OF DAYS RECOMMENDATION WAS IN THE MONEY AT EXPIRY THREE MONTHS LATER)

BACKTESTING SUMMARY - BY COUNTRY	
Australia *(Since Inception)*	49.8%
Canada *(Since Inception)*	54.5%
Switzerland *(Since Inception)*	72.0%
Euro Area *(Since Inception)*	75.4%
UK *(Since Inception)*	55.4%
Japan *(Since Inception)*	59.9%
Norway *(Since Inception)*	65.4%
New Zealand *(Since Inception)*	60.9%
Sweden *(Since Inception)*	77.3%
United States *(Since Inception)*	64.7%

DeepMacro FX-1

- Developed under Myron Scholes(Nobel Prize laureate in Economic Sciences 1998) and Chi-Fu Huang (CEO & CIO of Platinum Grove).
- FX-1 was traded live in the market and it has benefitted from the many years of practical experience of the people who developed it.
- DeepMacro's "Big Data" is now entering into the FX-1 process, to form views before official data are released.

FX-1 PORTFOLIO AS OF 30 DEC 2019 (PCT WEIGHT AGAINST USD, GREEN=LONG, RED=SHORT)

CURRENT PORTFOLIO	AUD	EUR	GBP	NZD	CAD	CHF	JPY	NOK	SEK	USD
FINAL WEIGHT	+8.4%	-7.2%	+7.4%	+2.2%	-14.9%	-30.0%	-11.4%	+8.3%	+10.1%	+27.1%
Growth factor	+10.5%	-7.8%	+7.2%	+9.4%	-20.0%	+15.0%	-23.7%	+3.1%	+3.3%	+2.9%
Carry	0.0%	0.0%	0.0%	0.0%	0.0%	-50.0%	0.0%	0.0%	0.0%	+50.0%
Valuation	+7.4%	-7.1%	+8.3%	-7.1%	-14.9%	-19.1%	-2.1%	+14.9%	+19.1%	+0.6%
Global risk index	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Portfolio construction	-9.6%	+7.7%	-8.1%	-0.1%	+19.9%	+24.1%	+14.4%	-9.6%	-12.3%	-26.4%

Net USD Weight: +27.1%

DeepMacro FX-1 (Continued)

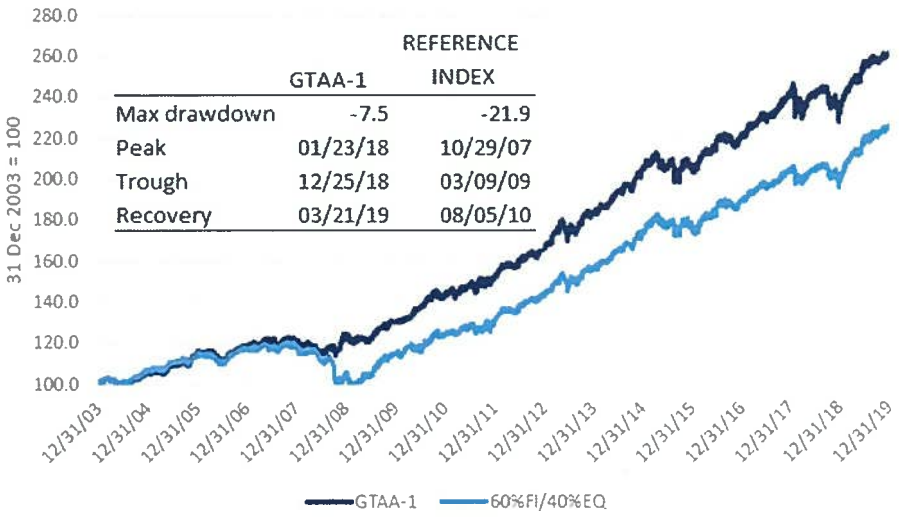
- DeepMacro's FX-1 portfolio outperforms carry and momentum indexes over most horizons.

DEEPMACRO FX-1 PERFORMANCE VS. CARRY AND MOMENTUM INDEXES, JAN 2005 - DEC 2019 (ANNUALIZED PCT AND RATIO)

	DeepMacro FX-1			Barclays Optimized Currency Carry			Deutsche Bank FX Momentum		
	Return	Volatility	Sharpe Ratio	Return	Volatility	Sharpe Ratio	Return	Volatility	Sharpe Ratio
2005	15.8%	10.1%	1.57	14.4%	4.5%	3.17	-1.7%	6.9%	-0.25
2006	32.1%	8.3%	3.88	15.7%	5.4%	2.91	-0.1%	4.7%	-0.03
2007	17.2%	14.7%	1.17	4.8%	5.6%	0.85	-1.7%	11.4%	-0.15
2008	36.3%	17.1%	2.12	-15.5%	6.2%	-2.51	21.3%	13.3%	1.60
2009	16.0%	7.9%	2.04	6.0%	3.9%	1.55	-14.3%	10.3%	-1.38
2010	-3.8%	6.0%	-0.63	3.6%	4.4%	0.82	3.7%	5.7%	0.65
2011	6.1%	13.4%	0.46	-1.0%	4.4%	-0.23	-9.3%	8.2%	-1.13
2012	1.7%	3.7%	0.47	2.2%	5.3%	0.42	-1.6%	8.0%	-0.20
2013	-6.7%	8.0%	-0.84	-9.2%	6.3%	-1.45	3.8%	7.1%	0.54
2014	-2.5%	5.7%	-0.43	0.5%	3.8%	0.14	3.0%	5.9%	0.51
2015	22.3%	17.4%	1.28	-1.9%	6.8%	-0.28	3.2%	6.1%	0.52
2016	-0.5%	6.4%	-0.07	0.4%	4.8%	0.09	-1.5%	6.6%	-0.23
2017	6.6%	8.6%	0.77	-2.0%	4.2%	-0.47	-1.9%	6.2%	-0.30
2018	15.7%	10.3%	1.53	2.6%	5.1%	0.52	-6.3%	6.6%	-0.96
2019	0.9%	6.9%	0.13	2.2%	6.3%	0.34	-2.9%	5.9%	-0.50
1 Yr	0.9%	6.9%	0.13	2.2%	6.3%	0.34	-2.9%	5.9%	-0.50
3 Yr	7.6%	8.8%	0.86	0.9%	5.3%	0.18	-3.7%	6.3%	-0.60
5 Yr	8.6%	11.0%	0.79	0.3%	5.5%	0.05	-1.9%	6.3%	-0.31
10 Yr	3.6%	9.8%	0.37	-0.3%	5.3%	-0.06	-1.1%	6.8%	-0.16
Since Inception	9.8%	11.0%	0.89	1.2%	5.6%	0.22	-0.7%	8.2%	-0.09

GTAA-1 PORTFOLIO PERFORMANCE

CUMULATIVE PERFORMANCE (JAN 2004 - DEC 2019, 12/31/03 = 100)



	GTAA-1	REFERENCE INDEX
Max drawdown	-7.5	-21.9
Peak	01/23/18	10/29/07
Trough	12/25/18	03/09/09
Recovery	03/21/19	08/05/10

GTAA-1 PORTFOLIO RISK-RETURN PROFILES (JAN 2004 - DEC 2019)

	Return (Pct)	Std Dev (Pct)	Sharpe Ratio
2004	6.25	3.47	1.80
2005	7.97	4.39	1.82
2006	3.40	3.60	0.94
2007	2.40	3.36	0.71
2008	2.60	6.17	0.42
2009	4.41	5.38	0.82
2010	10.27	3.15	3.26
2011	6.40	3.65	1.75
2012	9.12	2.39	3.81
2013	10.44	5.12	2.04
2014	11.17	2.92	3.83
2015	1.12	6.61	0.17
2016	6.87	3.24	2.12
2017	8.95	2.75	3.26
2018	-3.16	5.71	-0.55
2019	11.86	4.46	2.66
Since Inception*	**6.18**	**4.47**	**1.38**
Reference Index**	**5.21**	**5.06**	**1.03**

Notes: Backtest results for 5% target vol in US, EUR area, UK, Japan and Canada. For fixed income, 10-yr government futures were used. 10-yr Bund futures used fur EUR area fixed income. Returns are gross of fees and expenses.

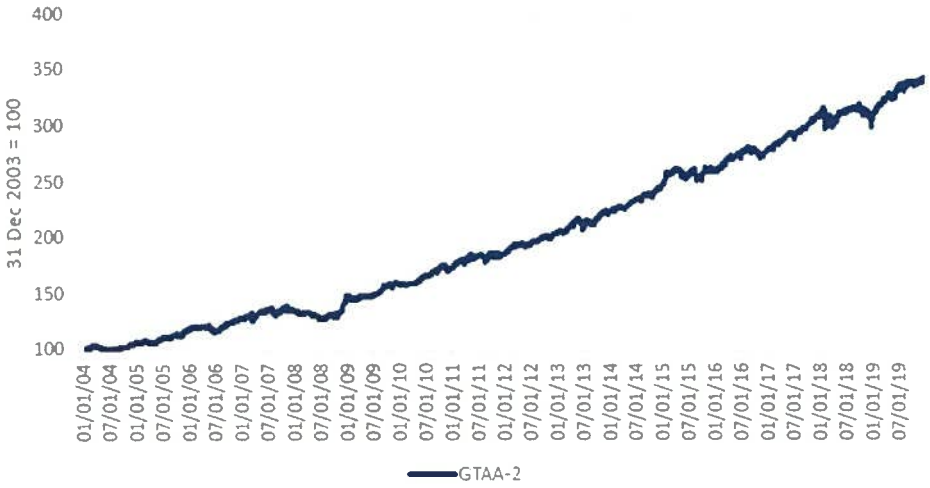
** Inception Date 12/30/03*

*** 60% Fixed Income 40% Equity G5 Index*

GTAA-1 + FX-1 (GTAA-2): GAIN ALPHA

- Combining equity and fixed income asset allocation with an FX overlay can get a very attractive reward-risk profile (2.8 pct points of alpha).
- FX-1 can go short currencies, which offsets returns in the long-only GTAA strategy during risk-off periods.

GTAA-2 INDEX, 1 JAN 2004 - 31 DEC 2019 (31 DEC 2003 = 100)



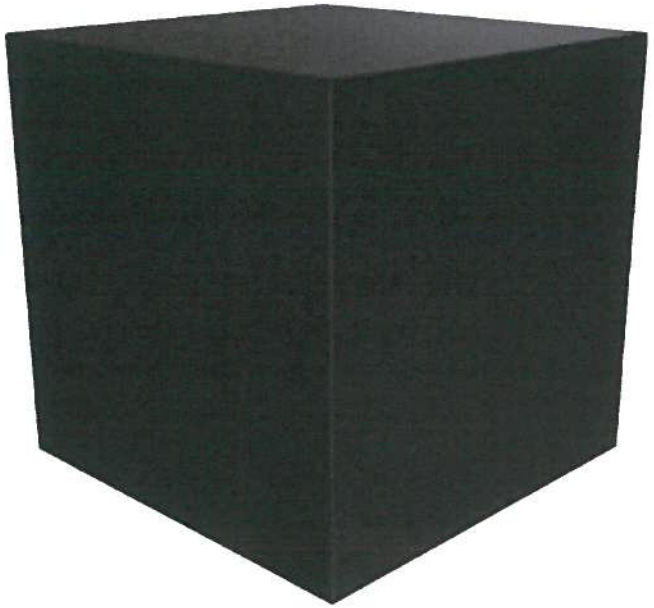
RISK-RETURN PROFILES, GTAA-2 INDEX VS REFERENCE INDEXES, JAN 2004 - 31 DEC 2019 (PCT OR RATIO)

DeepMacro GTAA-2 Strategy	YTD	1 Yr	3 Yr	5 Yr	10 Yr	Since Inception
Annualized Return	11.24	11.24	6.90	6.58	7.93	7.97
Annualized Vol	4.10	4.10	4.30	4.72	4.21	4.84
Sharpe ratio	2.74	2.74	1.61	1.39	1.88	1.65
Max drawdown						-9.05
60% Fixed Income / 40% Equity Reference						
Annualized Return	12.80	12.80	5.86	5.28	6.99	5.21
Annualized Vol	4.00	4.00	4.08	4.34	4.30	5.06
Sharpe ratio	3.20	3.20	1.44	1.22	1.62	1.03
Max drawdown						-21.91
Market Capitalization-Weighted Reference						
Annualized Return	14.51	10.61	7.49	6.29	7.97	5.17
Annualized Vol	6.43	8.03	6.11	6.37	6.27	7.77
Sharpe ratio	2.26	1.32	1.23	0.99	1.27	0.66
Max drawdown						-39.06

Notes: Backtest results for 5% target vol in US, EUR area, UK, Japan and Canada. For fixed income, 10-yr government futures were used. 10-yr Bund futures used fur EUR area fixed income. Based on daily backtest results with of 5% target volatility GTAA portfolio plus 20% FX-1 overlay. Returns are gross of fees and expenses.

WHAT AI DOES NOT *HAVE* TO BE

BLACK BOX



IT'S WHAT YOU KNOW ALREADY

Everything here is in the language you *already understand*.

You read, talk, and think about it *every day*.

Economic growth. Inflation. Risk. Politics. *Markets*.

It is not a *"black box"*.

IMPORTANT NOTES

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