



**SOCIETY OF
ACTUARIES®**

SOA Predictive Analytics Seminar – Taiwan

31 Aug. 2018 | Taipei, Taiwan

Session 1

**The predictive nature of Business Cycles and
Financial Cycles, understanding the
implications for a prudent investment
framework**

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The predictive nature of Business Cycles and Financial Cycles, understanding the implications for a prudent investment framework

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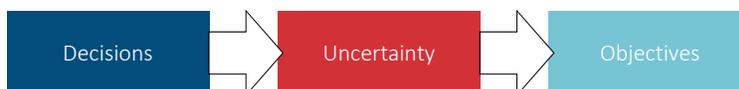
"To expect the unexpected shows a thoroughly modern intellect. " --
Oscar Wilde

Introduction / Context



The Essence of Our Problem

A more realistic assessment of what *might* (rather than what *will*) happen in the future contributes to people and organizations becoming more successful in achieving their objectives



A Better Understanding

of *how* economies and financial markets move up and down

contributes to better *decisions*

and more likely achievement of *objectives*.

Common Prediction Strategies

- Fundamental Analysis
- Technical Analysis
- Machine Learning - Over the last 5 to 10 years markets have heavily focused on Machine Learning applications next to the above two strategies, partially driven by increase in computer power

Predictive Analytics for Investors

- Predictive Analytics / Machine Learning has been used for many years within the investment industry
- Different machine learning algorithms used for different time horizons!
- Also different applications as to what the investor is trying to achieve – Goal Specification is very important!!

Papers on ML for Stock Prediction

- “How 140 Characters can be related to the Stock Market Movements: Sentiment Analysis of Twitter”
- “Analyzing predictive performance of linear models on high-frequency currency exchange rates”
- “Support vector machine with adaptive parameters in financial time series forecasting” - 2003
- “An application of an artificial neural network investment system to predict takeover targets” - 1999
- “Financial market predictions with Factorization Machines: Trading the opening hour based on overnight social media data” - 2017
- **“An improved support vector regression modeling for Taiwan Stock Exchange market weighted index forecasting” - 2005**
- “Comparison of support-vector machines and back propagation neural networks in forecasting the six major Asian stock markets” - 2006

Financial Market Participants Goals

- There is a Universe of Investors with varying goals and hence varying investment time horizons
 - Micro-Seconds – High Frequency Traders
 - Minutes to Hours – Day traders / Hedge Funds
 - Days to Weeks – Hedge Funds
 - Years – Pension Funds / Life Insurance Companies / SWF's

- For Institutional Investors with a longer investment horizon forecasting future returns is driven by understanding the dynamics of business cycles and financial cycles

Failures & Near Misses in Insurance - EIOPA

- EIOPA 2018 Report: “Failures and Near Misses in Insurance”

	Life	Non-life
<i>Top 5 primary causes of failures and near misses for EU life and non-life undertakings</i>		
1	Management & staff competence risk	Technical provisions - evaluation risk
2	Investment / Asset-liability management risk	Internal Governance & control risk
3	Market risk	Management & staff competence risk
4	Technical provisions - evaluation risk	Underwriting risk
5	Economic cycle / condition risk	Accounting risk

- “However, inappropriate investment decisions leading to investment losses or mismatch problems may explain the preponderance of the investment/ALM risk as the uppermost primary cause of failure for EU life undertakings”
- “this may be indicative of a higher degree of correlation of life insurers with the business cycle.”

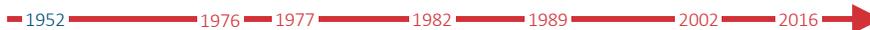
Portfolio Optimization with Predictive Analytics – A walk down memory lane



Advances in Modern Portfolio Theory

1952: Markowitz

Cornerstone of Modern Portfolio Theory based on the notion that investing in multiple assets is less risky than in a single investment



- Harry Markowitz
- Portfolio selection
- MPT



Advances in Modern Portfolio Theory

1976: Ross

Expected returns and (co)variances vary with characteristics, also called factors. The market factor is not the only such factor.

Some well-established “factors”:

- **Momentum:** trend in prices during the last 12 months.
- **Low Volatility / Betting-Against-Beta (BAB):** exposure to market risk (CAPM)
- **Value:** price relative to fundamentals.
- **Carry:** return if prices do not change.



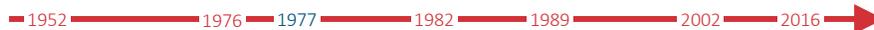
- Stephen A. Ross
- Arbitrage Pricing Theory (APT)
- Statistical testing framework for factors



Advances in Modern Portfolio Theory

1977: Lucas (building on e.g. seminal work of Burns and Mitchell 1946)

“a type of fluctuations found in the aggregate economic activity of nations that organize their work mainly in business enterprises”



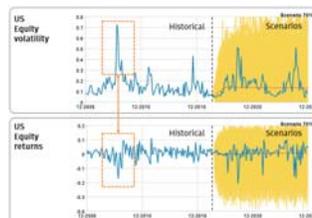
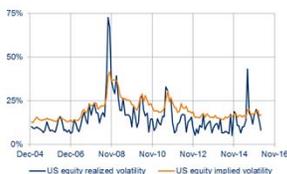
- Robert E. Lucas
- Understanding Business Cycles
- *“Though there is absolutely no theoretical reason to anticipate it, one is led by the facts to conclude that, with respect to the qualitative behavior of co-movements among series, business cycles are all alike.”*



Advances in Modern Portfolio Theory

1982: Engle

Engle awarded 2003 Nobel Memorial Prize in Economic Sciences "for methods of analyzing economic time series with time-varying volatility (ARCH)".

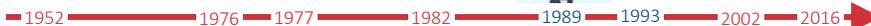
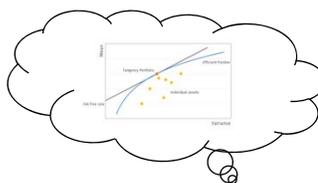


- Robert F. Engle
- Variance of time series is volatile
- Variance is correlated

Advances in Modern Portfolio Theory

1989: Michaud

Markowitz optimization is not robust and sensitive to input:
 "The fundamental problem is that the level of mathematical sophistication of the optimization algorithm is far greater than the level of information in the input forecasts."

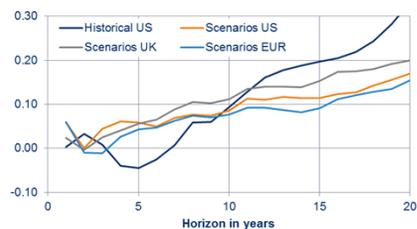


- | | |
|--|---|
| <ul style="list-style-type: none"> ▪ Michaud ▪ Is 'optimized' optimal? ▪ Resampling | <ul style="list-style-type: none"> ▪ Chopra ▪ Near optimal portfolio ▪ Totally different asset allocations |
|--|---|

Advances in Modern Portfolio Theory

2002: Campbell & Viceira

Investors should take the investment horizon into consideration when making portfolio decisions



Correlations
Equity - CPI
(historical 1900-2010)



- Campbell & Viceira
- Long-term vs short-term
- 2016: Chaudhuri & Lo

Overview of Stylized Facts

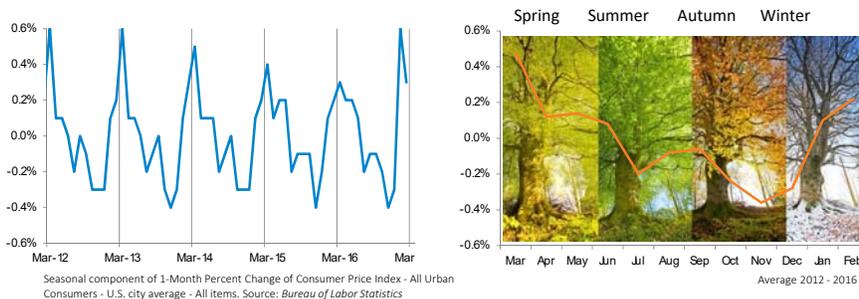
- Looking back at these advances over the last 60+ years, to summarize investors would like to incorporate the following stylized facts in realistic forward-looking scenarios (predictions):

Term structure of risk and return	Risk and return vary with the investment horizon, e.g. equity - inflation correlation higher on longer horizons
Business cycles	Medium term fluctuations inherent to economies and markets, e.g. equities leading on real economy, prices lagging
Time varying volatility	E.g. low volatility in years preceding the financial crisis
Tail risk	Correlations increase in times of crisis (less diversification)
Non-normal distributions	Skewed and fat-tailed distributions

- One idea for achieving this challenge is through a “Bi-Orthogonal Frequency Decomposition Approach”..

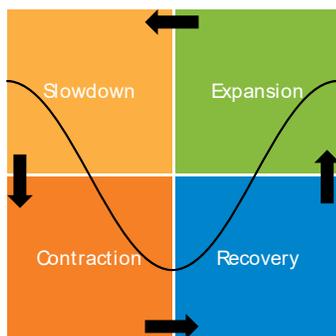
Short Term Cycles

Seasonality



Medium Term Cycles

Business cycles



"...a type of fluctuations found in the aggregate economic activity of nations that organize their work mainly in business enterprises: a cycle consists of expansions occurring at about the same time in many economic activities, followed by similarly general recessions, contractions, and revivals which merge into the expansion phase of the next cycle; this sequence of changes is recurrent but not periodic; in duration business cycles vary from more than 1 year to 10 or 12 years..."

Burns and Mitchell (1946)

- Behavioral as well as structural drivers
- KITCHIN "inventory" cycle: Average length of **3 to 5** years, named after Kitchin (1923).
- JUGLAR "investment" cycle: Average length of **7 to 11** years, named after Juglar (1862).

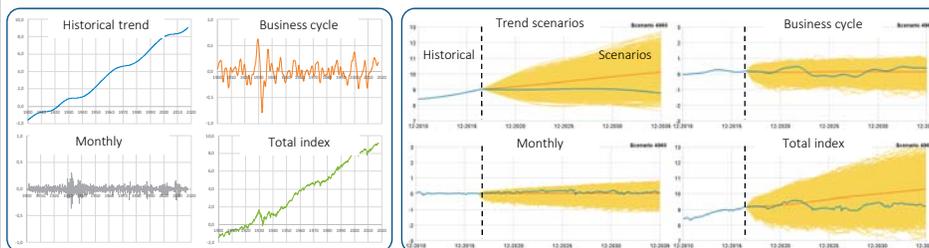
Long Term Cycles

- KONDRATIEFF “innovation” cycle: named after Kondratieff (1926) but first reported by Van Gelderen (1913) and made famous by Schumpeter (1939). Length of some **45 to 60** years. Driven by a product life cycle at large, identified with basic innovations or “technological styles”.

	<i>Trough – Peak – Trough</i>	<i>Basic Innovation</i>
1	1780 – 1810 – 1850	Steam transport
2	1850 – 1875 – 1890	Steel and electricity
3	1890 – 1915 – 1950	Cars and assembly lines
4	1950 – 1973 – 1990	Microelectronics and biotechnology
5	1990 – ? – ?	ICT ?

Bi-Orthogonal Frequency Decomposition Approach

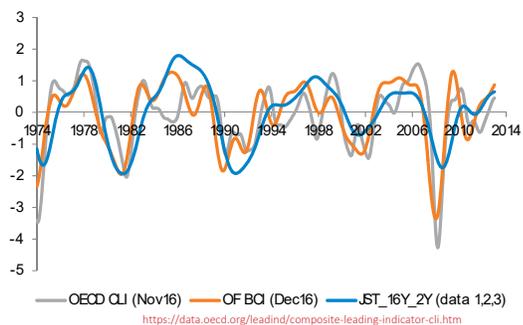
Steehouwer (2016): Bringing all stylized facts together



- Better understanding and capturing of long-, medium and short-term risk and return

Business cycle estimates

Similar, but also sensitive to input data and methodology

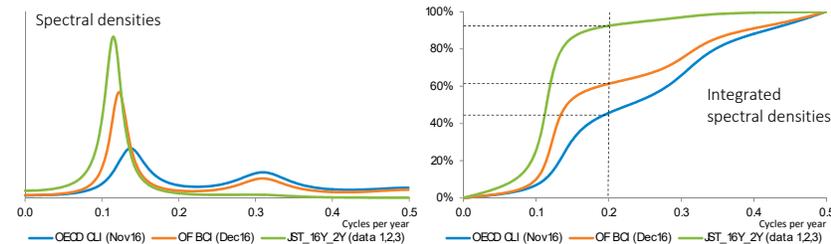


<https://data.oecd.org/leading/composite-leading-indicator-cli.htm>

- JST input data
 - 347 series
 - 1974 – 2013 (Bretton Woods)
 - Levels and annual log returns
- Filter: 16Y-2Y
- Reference series
 - OECD Composite Leading Indicator (OECD CLI)
 - Ortec Finance Business Cycle Indicator (OF BCI)

Business cycle dynamics

Dominant average cycle length 8 years



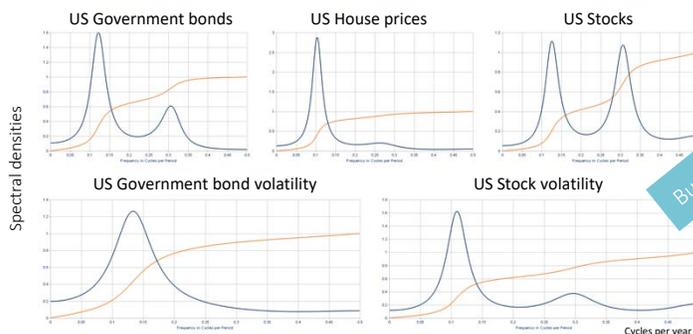
	Peak freq.	Period (years)
OECD CLI	0.14	7.2
OF BCI	0.12	8.1
JST_16Y_2Y (data 1,2,3)	0.12	8.6
Average	0.13	8.0

	Coh. OECD CLI	Lead OECD CLI
OF BCI	97%	0.5
JST_16Y_2Y (data 1,2,3)	95%	-0.2

More financial market data in OF BCI?

More macro data in JST?

Related to asset class risk and return? Yes!



	Coherence	Lead (years)	Correlation <u>ST_16Y_2Y</u>
US gov. bonds	88%	2.5	9%
US house prices	96%	0.5	63%
US stocks	72%	0.3	37%
-US bond volatility	89%	1.1	41%
-US stock volatility	92%	0.9	15%

At cycle peak frequency

- Similar spectral shape as cycle estimate
- High coherence

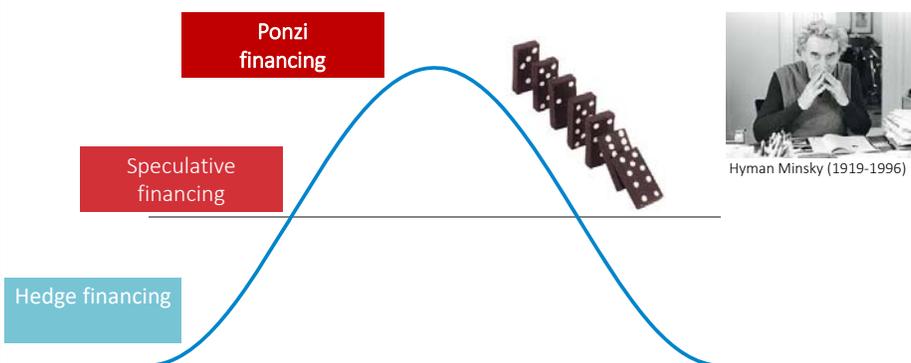
The financial cycle

The broad concept of the financial cycle encapsulates joint fluctuations in a wide set of financial variables. Financial cycles are characterized by financial booms and busts that can lead to serious financial and macroeconomic strains. Drehmann et al. (2012) find an average length of 16 to 20 years and dominant information to be contained in credit to GDP ratios and real house prices.

- Much more debated than business cycles, both in terms of existence as such, measurement methodology and policy implications
 - **Stylized facts:** under construction
 - **Central banks:** generally accepted and important for macro prudential policy (counter cyclical buffer in Basel and Solvency), debate about definitions, measurement and so forth
 - **Macroeconomists:** financial sector not an important factor in their models
 - **Investors:** not a central theme → but shouldn't it be??

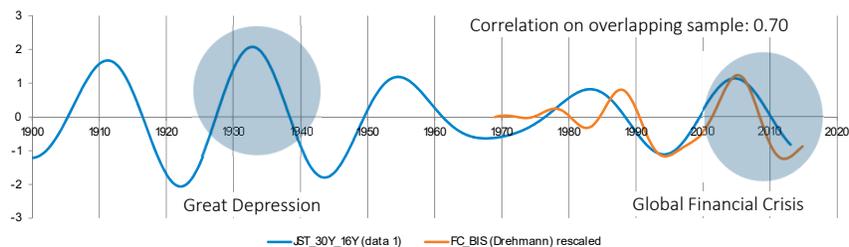
The financial instability hypothesis

Minsky, H. (1982), "Can 'it' happen again", Essays on Instability and Finance



Financial cycle: estimate and dynamics

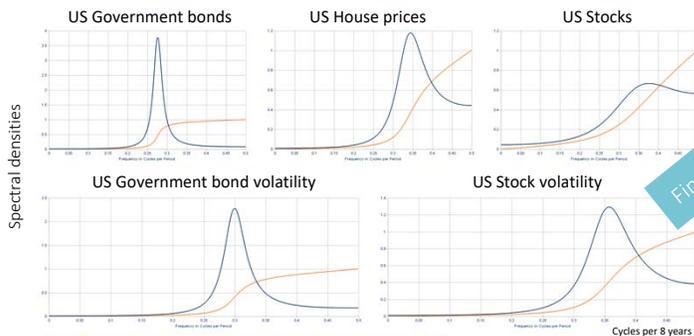
Average cycle length around 25 years



Peak to peak (years)	1911	22	22	29	22	Avg: 24
Peak		1933	1955	1983	2005	
Trough	1922		1944	1968	1994	
Trough to trough (years)		21	24	27		Avg: 25



Related to asset class risk and return? Yes!



	Coherence	Load (years)	Correlation JST_30Y_16Y (data 1)
US gov. bonds	79%	-3.2	33%
US house prices	98%	2.8	71%
US stocks	90%	1.6	37%
US bond volatility	81%	-1.4	34%
US stock volatility	99%	1.0	94%

At cycle peak frequency

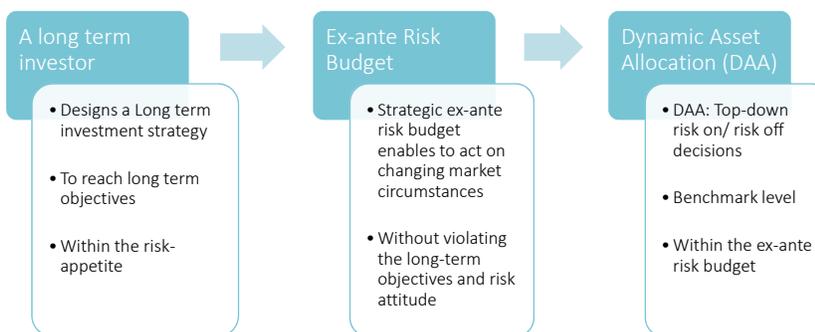
- Spectral peak around 25 years as in cycle estimate
- High coherence



Dynamic Asset Allocation based on Predictive Analytics



Dynamic Asset Allocation (DAA)



DAA back-test: case description

To reach objectives within risk appetite Risk Budget

Asset allocation (100% hedged to EUR)	Risk Budget		
	SAA	Min	Max
Fixed Income	50.0%	40.0%	60.0%
FI Government Bonds (dur 07)	30.0%	20.0%	40.0%
FI Govt Bond US (dur 06)	15.0%	10.0%	20.0%
FI Govt Bond EUR GER (dur 08)	15.0%	10.0%	20.0%
FI Corporate Bonds (dur 05)	20.0%	15.0%	25.0%
Corporate Credits IG EU (dur 05)	10.0%	5.0%	15.0%
Corporate Credits HY US (dur 05)	10.0%	5.0%	15.0%
Equity	35.0%	25.0%	45.0%
EQ EUR	17.5%	12.5%	22.5%
EQ US	10.5%	5.0%	15.0%
EQ Emerging	7.0%	5.0%	10.0%
Real Estate	10.0%		
Direct Real Estate EUR	10.0%		
Alternatives	5.0%		
Private Equity BO USD	5.0%		

- Sample 1999 – 2017
- End of year DAA decisions based on 1-year optimizations within the risk budget
- Based on Internal Developed Scenarioset (OFS) - back-tested to provide forecasts which are 10% better in line with reality than those from simple benchmark models(*)

- Benchmark investment portfolios
- 100% currency hedge
- Quarterly rebalancing
- Base assumptions for investment costs passive mandates

(*) Documented in Boer and Stehouwer (2016)

DAA back-test: results

Dynamic Asset Allocation weights



Figure 1: annual Dynamic Asset Allocation

Relative performance



Figure 2: annual outperformance of DAA versus SAA (net of transaction costs)



DAA back-test: some intuition

2000-2002 → Risk Off →
Good decision

- Positive financial market conditions (business cycle) during 1999, the end of this phase of the economy is within sight in OFS
- For DAA it is recommended to reduce equity exposure
- This downturn became reality (burst tech bubble), together with a decline of interest rates with consequent positive fixed income returns

2003-2005 → Risk On →
Good decision

- OFS expects the business cycle to recover from its downturn
- Consequent indication for DAA: overweight equity at a cost of fixed income
- This is in line with the realized positive market developments

2006-2008 → Risk Off →
Good decision for 2008,
though too early (2006/2007)

- Positive phase of the economy (business cycle) has been going on for some time now and OFS expects an economic downturn
- Recommendation for DAA to tilt fixed income, at a cost of equity
- Although the downturn didn't occur until 2008 and some return was consequently missed in 2006 and 2007, cutting down on risk proved to be a prudent move

2009-2017 → Risk On →
Good decision

- OFS expects markets to recover from the crisis with the consequent indication for DAA to overweight equity at a cost of fixed income
- Accommodating monetary policy continues with resulting positive financial market conditions and further interest rate declines
- Both equity and fixed income perform well during this period, while the DAA tilt to equity still provides additional return



Conclusions

- Estimates of the business cycle and the financial cycle are sensitive to data and methodology. However, not to the extent that this dramatically affects (alleged) stylized facts.
- Medium term asset class risk and return are related to the business cycle. Long term asset class risk and return appear related to the financial cycle as well.
- A Dynamic Asset Allocation (DAA) investment strategy can be used to exploit medium term cyclicalities in risk and return.

A better understanding of the financial cycle and the business cycle
and how they are related to asset class risk and return

For constructing more realistic long- and medium term scenarios for the
future

To support better (SAA and DAA) asset-allocation decisions
and thereby more likely achievement of objectives

