

# Economic Scenario Generators: Usage and Trends in General Insurance

GIRO 40 – Edinburgh, October 8-11, 2013



LOIC GRANDCHAMP

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## Agenda

1. Introduction
2. Usage and trends
  1. Assets
  2. Liabilities
  3. Assets & Liabilities

# 1

## Introduction to ESG

## Economic scenario generators – Why?

What are the sources of market and economic risks for P&C insurers?

- » Interest rates
  - Government bonds (incl. inflation-linked bonds)
  - Municipal bonds
  - Mortgage-backed securities
- » Credit
  - Corporate bonds
  - Reinsurance counterparties
- » Currency
- » Price inflators
  - CPI / Wage inflation
  - Specific claims exposures: medical, construction, auto
- » Equity & property markets
- » Correlations / dependencies

ASSETS			
	2012	2013	2014
1. Government bonds	1,234.5	1,234.5	1,234.5
2. Municipal bonds	1,234.5	1,234.5	1,234.5
3. Mortgage-backed securities	1,234.5	1,234.5	1,234.5
4. Corporate bonds	1,234.5	1,234.5	1,234.5
5. Reinsurance counterparties	1,234.5	1,234.5	1,234.5
6. Currency	1,234.5	1,234.5	1,234.5
7. Price inflators	1,234.5	1,234.5	1,234.5
8. Equity & property markets	1,234.5	1,234.5	1,234.5
9. Correlations / dependencies	1,234.5	1,234.5	1,234.5
10. Other	1,234.5	1,234.5	1,234.5
11. Total	1,234.5	1,234.5	1,234.5

LIABILITIES, SURPLUS AND OTHER FUNDING			
	2012	2013	2014
1. Government bonds	1,234.5	1,234.5	1,234.5
2. Municipal bonds	1,234.5	1,234.5	1,234.5
3. Mortgage-backed securities	1,234.5	1,234.5	1,234.5
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## Economic scenario generators – What?

### ESG outputs

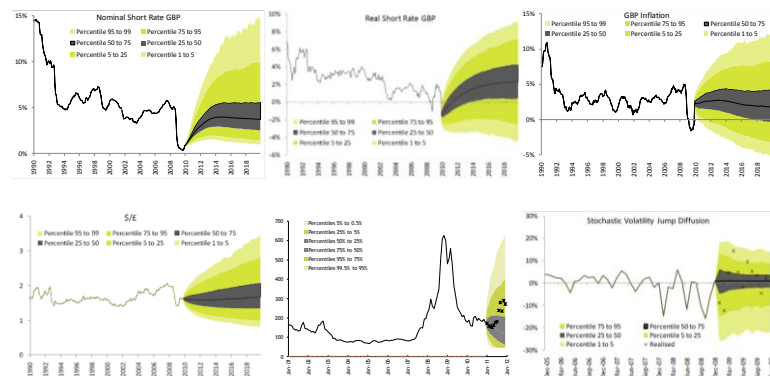
- » An ESG produces forward-looking scenarios for multiple risk drivers
  - ESG provides a distribution of possible values for economic risk factors at future timesteps
  - Output is a time series of variables for each scenario (trial)
  - Economically coherent joint distributions of financial and economic factors attempting to capture the dynamics of financial markets – dependency, tail risk



Trial	Time Step	Interest Rate	FX	...
1	0	0.20%	1.25	...
1	1	0.21%	1.19	...
1	2	0.25%	1.22	...
1	3	0.23%	1.30	...
2	0	0.20%	1.25	...
2	1	0.23%	1.33	...
2	2	0.21%	1.34	...
2	3	0.30%	1.27	...
3	0	0.20%	1.25	...
...	...	...	...	...

## Economic scenario generators – What?

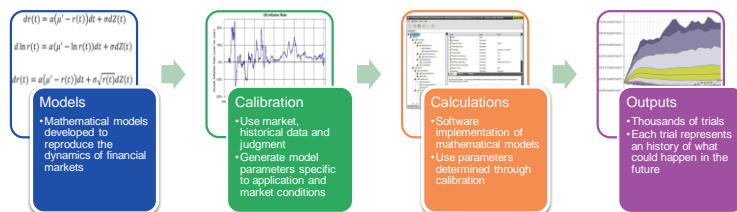
### Sample ESG outputs



## Economic scenario generators – How?

ESG modeling process

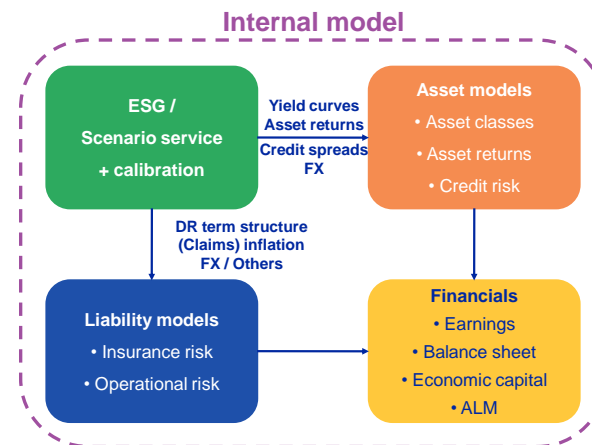
- » Goal: Realistic and justifiable projections of financial and economic variables
- » Roadmap in principle
  - Develop and document stylized facts and beliefs
    - » E.g. interest rates are mean reverting
    - » Credit spreads and equity returns are negatively correlated
  - Structure, calibrate and validate models
  - Validate and review the stylized facts and model regularly



## Economic scenario generators – Where?

Drivers

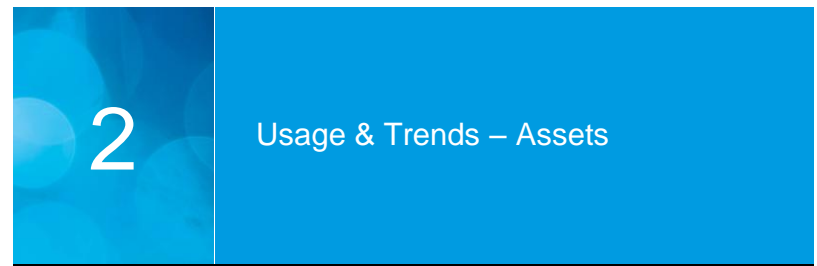
- » Regulators
- » Rating agencies
- » ERM best practice



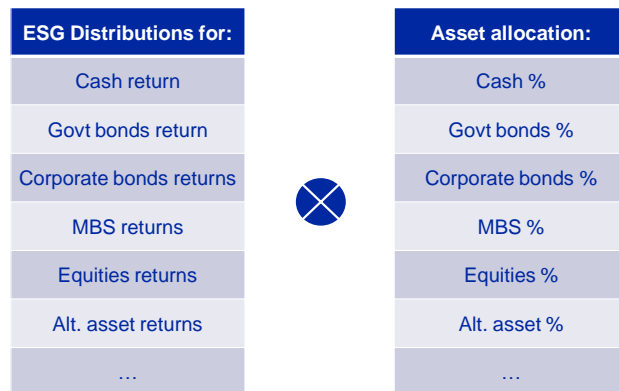
## Economic scenario generators – Where?

ESG and ORSA

- » ORSA to become a worldwide requirement
  - ICP 16
- » ESG called for:
  - Assessment of economic risks on the company risk profile
  - Assessment of market risk
  - Capital adequacy assessment
  - Multi-year modelling for the prospective solvency assessment
  - Assessment of risks in both normal and stressed environments
  - Model validation, stress testing and sensitivity analyses



## A schematic market risk model



## Market risk management

Market risk is important

- » Tends to be underestimated especially since asset management is typically outsourced
- » Investment income is a very significant share of insurers' earnings
- » Low yields / volatile environment



Stretching for yields

- » What happens when interest rates rise?
- » How do I model "new" asset classes?
- » Do I have enough granularity on credit?
- » Liquidity?

## 2.1

### Interest Rates

### 1-year and 10-year US rates



## Investment risk for the P&C insurance industry

Risk scenario #1: Interest rates remain near historical lows

- » Continued pressure on profitability from weak investment income
  - More pain due to slow fixed income portfolio turnover
  - Mitigation
    - » Make up for shortfalls in investment earnings by increasing premium rates and improving underwriting margins
    - » Increase investment risk

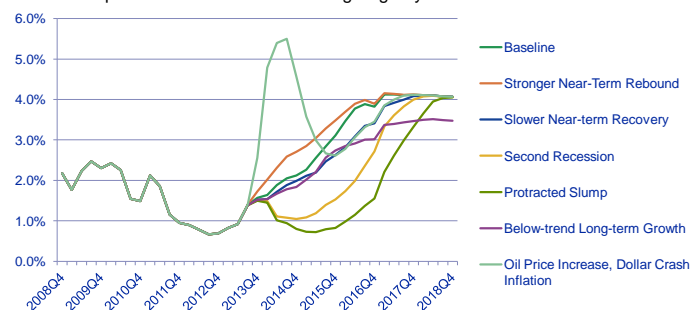
Risk scenario #2: Interest rates continue rising

- » Capital volatility
  - Rapidly rising interest rates could turn into a capital event for the GI industry
    - » Rising interest rates + higher than expected claims inflation could be very problematic for P&C insurers (lower asset valuations + increases in loss reserve liabilities)
    - » While interest rates would boost investment income and industry profitability over time, they could also curtail industry pricing momentum
  - Mitigation
    - » Strong liquidity, practice of holding bonds long term, unlikely need to liquidate investment portfolios

## Outlook

Will interest rates stay low or keep rising?

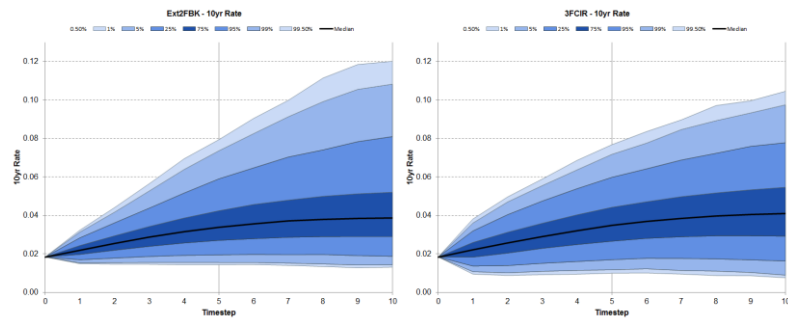
- » Of these two scenarios, a continued upward movement in interest rates is the higher risk scenario for P&C companies due to its greater impact on capital and its potential combination with higher than expected claims inflation for the industry
- » Economists predict rates will continue rising. E.g. 5-yr US Treasuries:





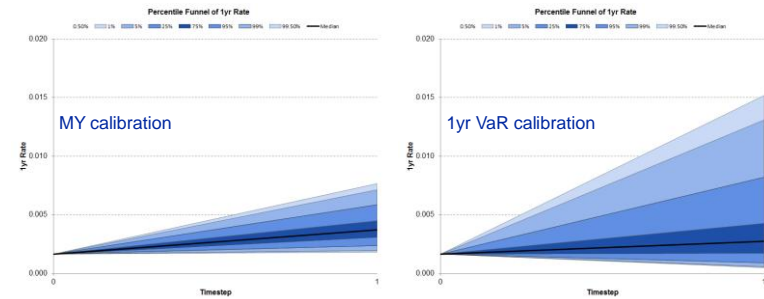
## Does my interest rate model exhibit enough variability?

- » Ext2FBK model v. 3FCIR model
  - Initial yield curves match
  - Short rate paths match (TVTP calibration)
  - 10-year rate paths match (TVTP calibration)



## Interest rate model calibration

- » Through-the-cycle v. Point-in-time calibration



## 2.2

### “New” Asset Classes

## Bank loans, CLOs, high-yield bonds, infrastructure debt

### Simplified modeling approaches

Not all asset classes are produced by default in ESGs. Two possible (simplified) approaches:

- » Model as an equity asset
  - Pick a representative ETF
  - Model the ETF as a child equity of a broader equity index modeled in the ESG using regression analysis on historical data
    - » Volatility based on historical analysis
    - » Beta exposure to a broad equity index
  - Adjust the parameter for the specific characteristics of the portfolio
  - Example with S&P / LSTA Leveraged Loan Index
- » Model as a bond portfolio

## Bank loans as an equity asset

Example: S&P / LSTA Index

The S&P/LSTA Loan Index endeavors to replicate the invested institutional loan market. As a result, it attempts to track as many loans with institutional tranches in the market as possible.

- » Historical regression versus a broad US equity index (MSCI USA)
  - Sensitive to time window (1997-2013 vs 2007-2013)



## Results

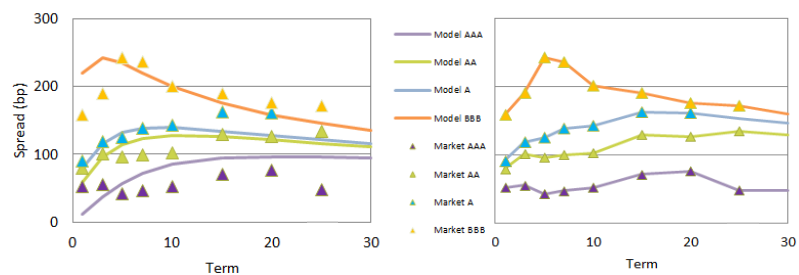
Asset	Total Return	Excess Return	Volatility	Sharp Ratio	Inflation Correlation
US Equity	4.20%	3.66%	16.8%	0.22	0.031
S&P LTSA	1.76%	1.41%	7.4%	0.19	-0.056
30% beta	2.21%	1.82%	8.0%	0.23	0.013
80% beta	4.12%	3.62%	14.6%	0.25	0.026
Bonds	3.91%	3.71%	8.4%	0.44	0.554

- » Child equity vs bond portfolio
  - Choice driven by materiality of the investment
  - Correlations with other economic variables
- » Other examples
  - S&P High Yield Dividend Aristocrat Index
  - Alerian Infrastructure MLP index

## Credit

Low yields: P&C companies have looked at lower credit quality

- » Need granular credit model
- » Custom calibration to a specific bond portfolio

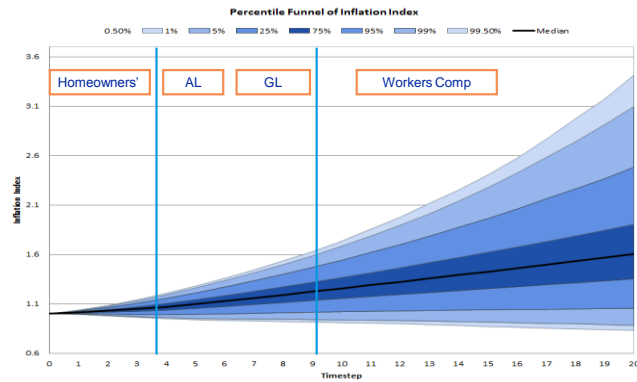


## 3 Usage & Trends – Liabilities

## Inflation and reserves

Inflation risk on reserves

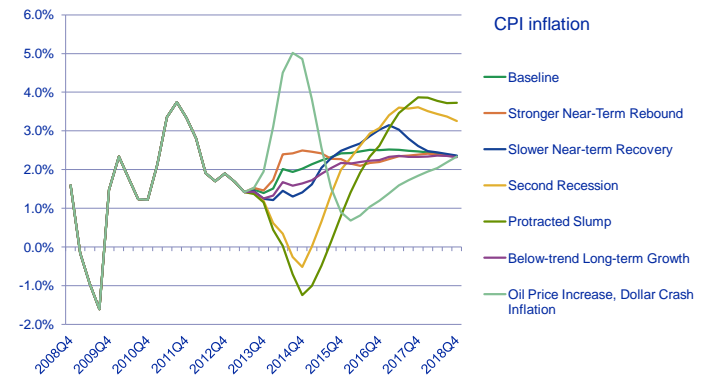
- » Inflation risk can be very significant especially on long-tailed lines of business



## Inflation projections

ECCA scenarios

- » A lot of faith in central banks



## Impact of inflation on loss reserves

Traditional reserving methods and capital models

- » 2 Questions
  - What inflationary assumptions underlie current reserve levels?
  - How much will current reserve adequacy be impacted if future inflation differs from expectations?
  - These questions cannot be answered when inflation is dealt with indirectly
- » LDFs reserving methods
  - Usually, no explicit inflation adjustment: Past inflation is implicitly reflected in the selected LDFs
  - And is projected forward (if no trends adjustments), without consideration for inflation variability
  - Usually undiscounted
- » Capital Models
  - Look at reserve variability, usually discounted reserves
  - Use ESG outputs
    - » Interest rates, inflation indices
- » Incorporate inflation as an explicit risk factor
  - By explicit consideration of inflation, its economic impact on the overall balance sheet can be gauged

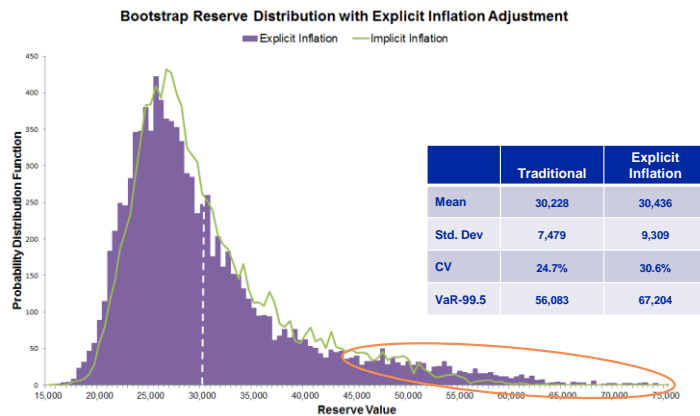
## Explicit consideration of inflation in reserving

3 steps using existing reserving models

1. Factor out the effects of inflation from historical loss data
  - Establish profile of loss costs
    - » What portion of the loss payment is medical, wage, legal fees...
  - Identify those economic indices which best measure the inflation in those costs
    - » Claims inflation v. CPI-like indices
    - » Gearing effect of deductibles
  - Determine the timing of the inflationary impact (accident date, report date, paid date, ...)
    - » E.g. for WC, the wage portion may be at time of accident while the medical portion is at time of payment
    - » Give consideration to the changing proportions of types of cost as the development period matures. E.g. medical may be paid early and wages later in the development of an accident year
  - Test these relationships on historical loss development patterns and find the combination which best explains the long term growth in claim costs
    - » E.g. Masterson
2. Forecast the reserve using current methodology
3. Replace the effect of inflation including an assumption of future inflation
  - Various economic inflation measures with different characteristics
  - Specific claims inflation calibrations

## Reserve variability

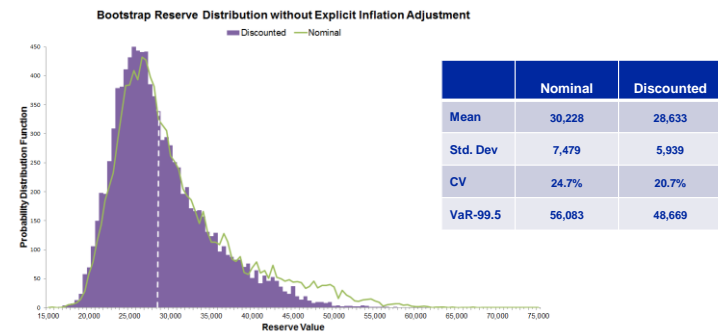
Bootstrap results – nominal reserve



## Discounting

No explicit inflation adjustment

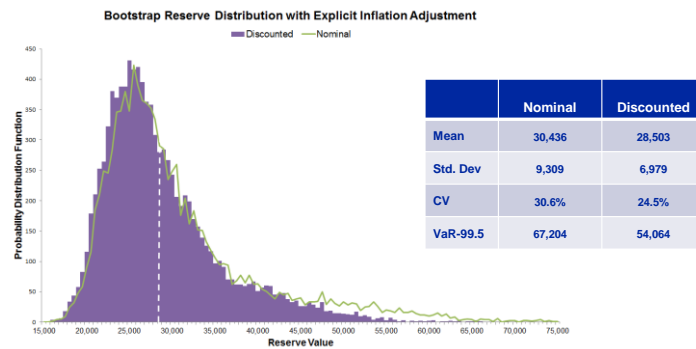
- » Discounted reserves have lower variability than nominal reserves
  - Much of reserve variability stems from uncertainty in tail factors
  - This is mitigated by larger discount factors



## Discounting

With explicit inflation adjustment

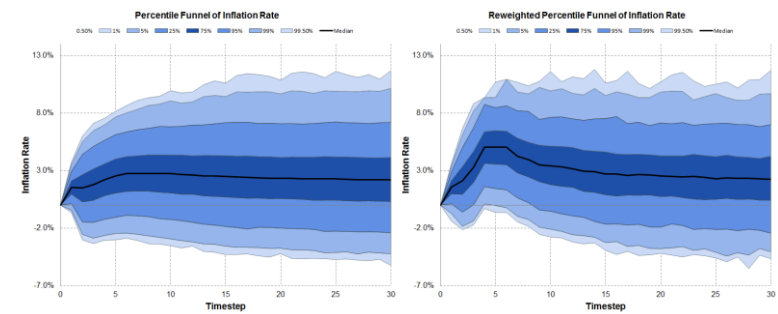
- » Discounting reduces variability further
  - Correlations between interest rates and inflation



## Inflation stress test

Hard to achieve without explicit inflation treatment

- » Requirement from some regulators / rating agencies
- » E.g. target inflation at 5% for year 4, 5 and 6

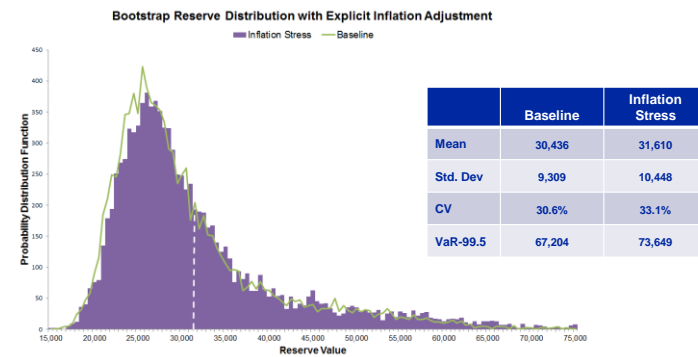




## Inflation stress test

### Results

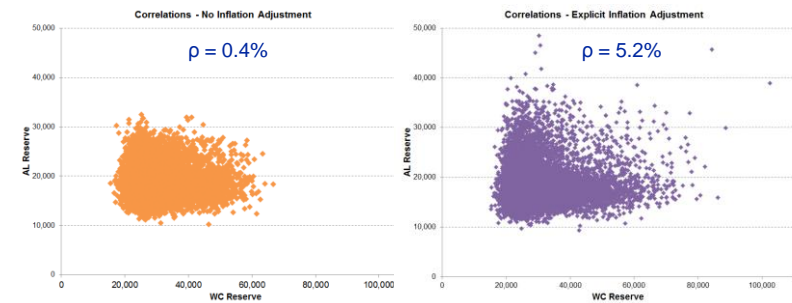
- » Noticeable impact
  - Even without leverage



## Induced correlations between lines of business

Same exercise with two lines of business

- » Inflation acts as a common driver between lines of business
  - Generates correlations between lines of business
  - Easy to explain

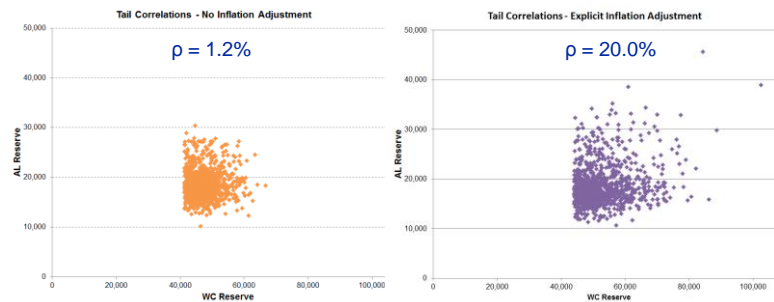


## Tail correlations between lines of business

Same exercise with two lines of business

- » Correlations increase in the tail
  - E.g. 90<sup>th</sup> percentile

%-ile	No Inflation Adjustment	Explicit Inflation
0%	0.4%	5.2%
50%	1.4%	5.2%
75%	0.0%	7.6%
90%	1.2%	20.0%
99%	-0.1%	41.0%



## Induced correlations between reserving and U/W

Apply ESG inflation to payment patterns for the new business

- » Same mechanism as induced correlations between lines of business
- » Inflation acts as a common driver between reserving and underwriting
  - Generates correlations between reserving and underwriting risks
  - Easy to explain
- » Not the only source of correlations
  - May need to impose additional explicit correlations using copulas

Other applications

- » Improve modeling of interactions between market risk and insurance risk
  - E.g. TIPS
- » Impact of future economic environment, at the line of business level, on:
  - Volume levels
  - Rates
  - Profitability

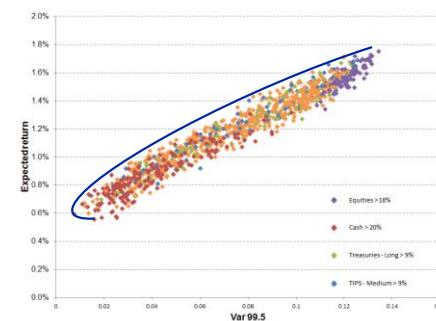
# 4

## Usage & Trends – Assets & Liabilities

## Strategic asset allocation

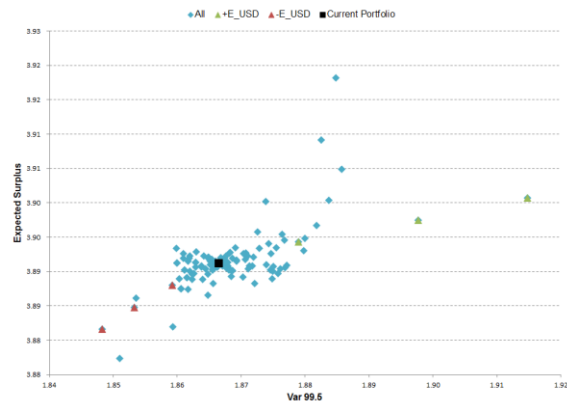
Asset allocation analysis which considers the overall risk profile of the company (insurance risks + asset risks + interactions)

- » Traditionally
  - Asset only
  - Expected return vs volatility
  - Strong assumptions
- » Common economic factors influence both u/w and investment risks
  - Economic risks needs to be aggregated across assets and liabilities
- » Consider company-level impact of asset allocation on risk profile
  - Dynamic triggers provide guidance on how to rebalance the portfolio given risk appetite



## Centering on the current portfolio

E.g. US Equities



## Capital modeling vs asset allocation

Should we be using the same ESG calibration?

- » Current ESG calibration used in ECM leads to issues for asset allocation work
  - Asset allocation can swing from Q to Q (and economy to economy)
  - Significant biases across asset classes particularly in credit, FX and property
- » These aren't new problems
  - Optimization applications in finance are notoriously difficult to use and unstable
  - One of the most broadly used solutions which addresses these issues and works is to use a Black-Litterman (BL) approach
  - BL combines an equilibrium approach to modelling risk-premia with more nuanced 'active views' using a Bayesian approach
  - However, BL approach uses an simple asset model (mean-variance framework)

## The Black-Litterman approach

Black-Litterman is a theoretically rigorous/justified way of applying a number of well recognised asset allocation principles.

- » Strategic asset allocations can be produced using the base case equilibrium calibration or weighted combination of equilibrium plus some fundamental views
- » Tactical asset allocations are produced from the weighted returns of equilibrium and tactical views
- » The (Bayesian) weighting recognises that 'views' (like risk premia) have some degree of uncertainty
- » The weighting parameter can be thought of as an estimate of the 'information ratio' in views - active managements' equivalent to a 'Sharpe ratio'
- » Weighting of views limits the 'tracking error' between strategic and asset allocation and tactical allocation
- » Weighting of views also limits the amount (and therefore cost) of rebalancing as views change

## Asset allocation practical example

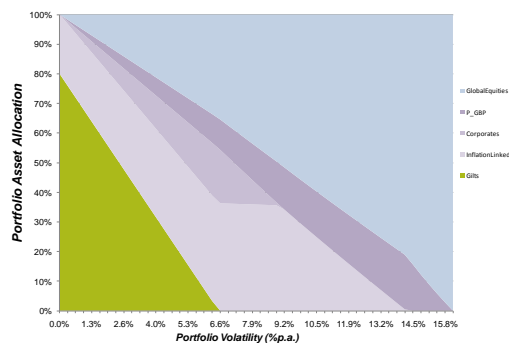
To illustrate how we can use the dynamic equilibrium calibration in tactical asset allocation work we take:

- » Dynamic Equilibrium calibration
- » Mean Variance optimiser
- » B&H standard TVTP calibration which compared to equilibrium embeds a number of fundamental and tactical views:
  - Higher expected returns on property and credit (justified as a recognition of liquidity premia)
  - Mean reversion in interest rates and yields
- » Black-Litterman weighting between Dynamic Equilibrium and Standard TVTP calibration

## Base case – Dynamic equilibrium calibration

80:20 Nominal / Index Linked bond benchmark – 5 year holding horizon

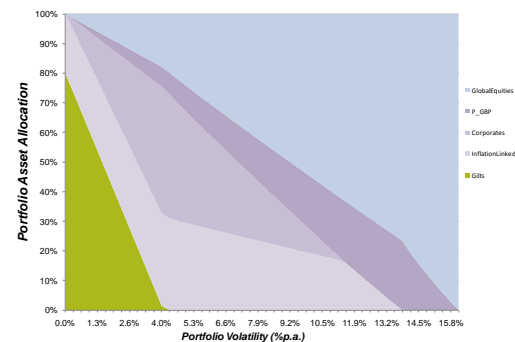
- » Asset allocation starts in matching assets and increasingly introduces corporate bonds, real estate and equities



## #1 – BL weighted dynamic equilibrium and views

80:20 Nominal / Index Linked bond benchmark – 5 year holding horizon

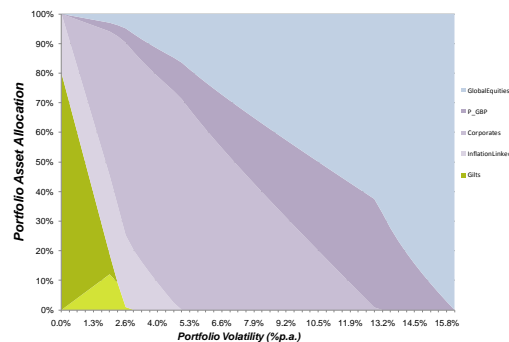
- » Weighting of 0.2 to views. Asset allocation again starts in matching assets but favours credit and real estate compared to base case



## #2 – BL weighted dynamic equilibrium and views

80:20 Nominal / Index Linked bond benchmark – 5 year holding horizon

- » Full weight to views. Asset allocation again starts in matching assets, is dominated by credit risky bonds for medium risk strategies and real estate and equities for higher risks.



## Summary

- » Emerging regulation and accepted best practice are driving P&C insurers to adopt more sophisticated tools for understanding the potential future behaviour of the asset side of the balance sheet and economic drivers of liabilities
- » Market and economic risks can make a material contribution to solvency capital and earnings uncertainty
- » Usage of ESGs within the P&C industry is increasing
  - More scrutiny of the ESG outputs
    - » Current economic environment
    - » Challenged by companies views
  - ESGs being used outside the asset module of an internal model
    - » Input in insurance risk models
  - More usage of economic capital models
    - » New challenges
- » Building successful ESG solutions requires users to access and build experience with these tools



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Loic Grandchamp  
P&C Product Manager  
Enterprise Risk Solutions – Insurance  
+1 212.553.2788 tel  
[loic.grandchamp@moody.com](mailto:loic.grandchamp@moody.com)

Moody's Analytics  
7 World Trade Center  
250 Greenwich Street  
New York, NY 10007  
[www.barrhibb.com](http://www.barrhibb.com)

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