

Credit Cycles, Dual PIT/TTC Ratings, & Stress Testing

Dr. Scott D. Aguais

Managing Director & Global Head of Credit Portfolio Analytics, Royal Bank of Scotland, Global Banking & Markets

December 7, 2011 – Presented to Ri\$kMinds, Geneva Switzerland

Overview:

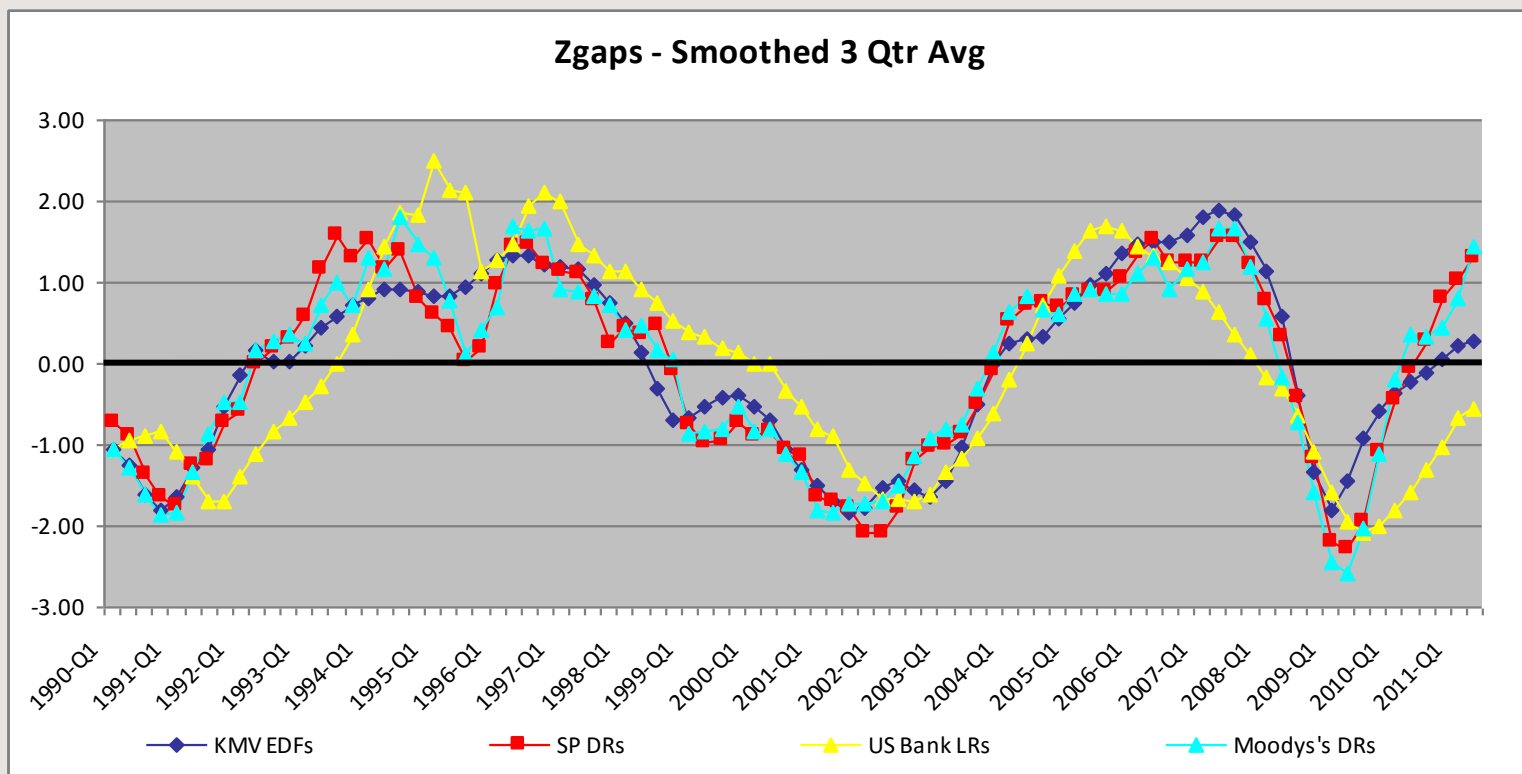
- Credit Cycles are Real & They Can be Measured
- Key Dual PD PIT/TTC Presentation Points Highlighted
- Dual PIT/TTC Rating Systems Consistently Support Multiple Business Objectives
- Using a PIT/TTC Ratings Framework to Develop a Portfolio-Wide Stress Test Approach Which is Based on Credit Cycle Behaviour
- Key Presentation Points Summarized

Global Credit Conditions Deteriorated Rapidly Starting in Mid-2007

Most Measures of Credit Risk Show Clear Cycles & Rapid Deterioration Over 2007-09 With Some 'Bounce back' in 2010

*Various Credit Cycles Indices Derived from Various PD, Rating & Loss Measures
MKMV EDFs, S&P Default Rates & C&I Loss Rates*

'Z-Gap'



Source: Moody's KMV, S&P, US Federal Reserve

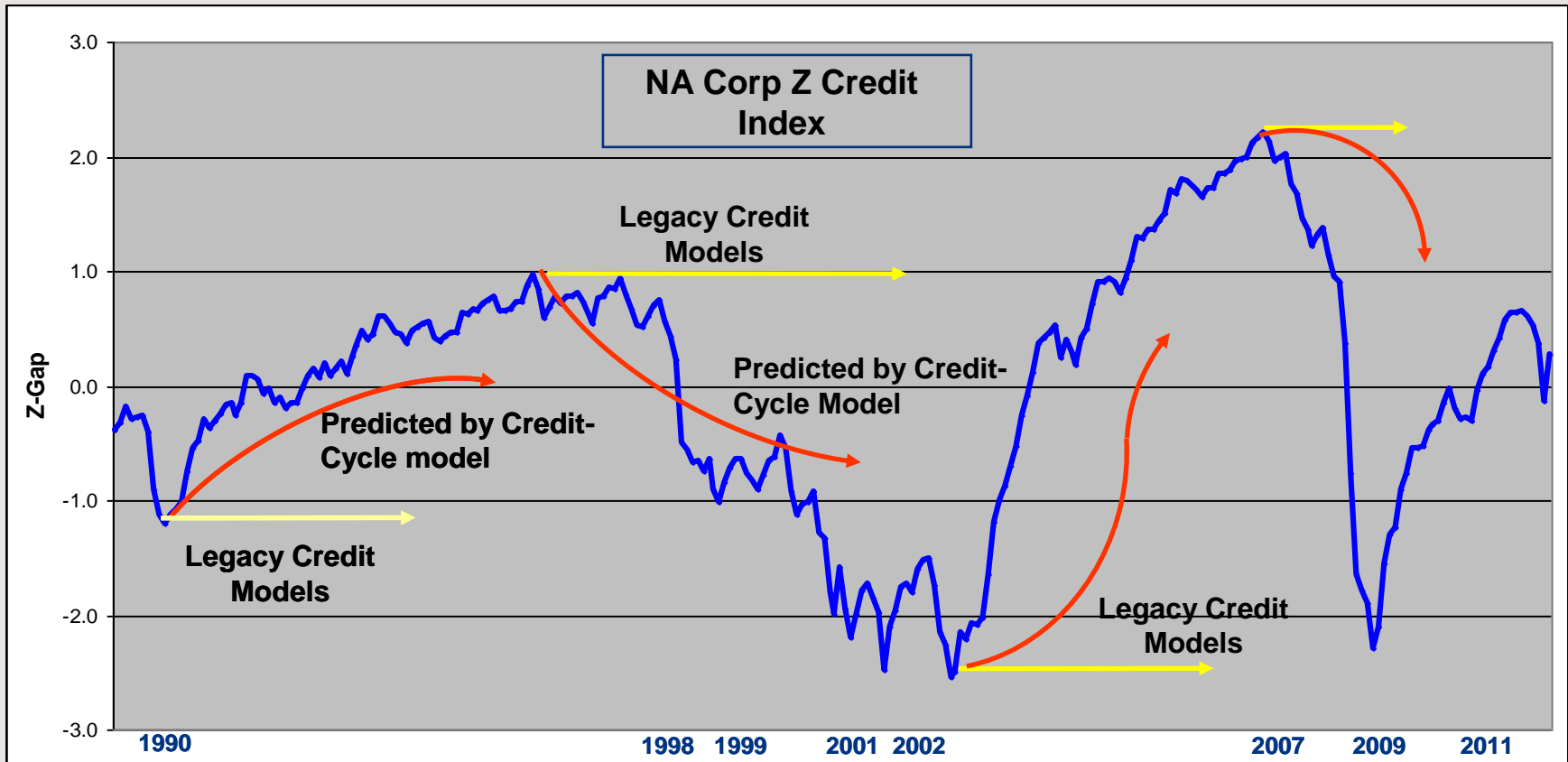
Key Points in the Presentation

- Systematic Credit Cycles are real & they can be measured empirically – the existence of credit cycles motivates a Dual PIT/TTC Rating approach
- Dual rating systems are better at supporting multiple business objectives – for credit ratings, ‘one size does not fit all’ – capital stability vs. ‘know your real risk’
- Current, legacy credit models do not incorporate empirical credit cycles as they assume systematic factors follow a random walk – this means that moving to a dual rating approach represents a true Kuhnian evolution
- Portfolio-wide stress testing capabilities are straight-forward to develop once you have developed the PIT/TTC credit-cycle framework
- Provides one consistent framework for stressing PIT PDs, LGD & EAD

A Component of the Credit Cycle is Predictable

Legacy Credit Models Are Blind To the Predictable Systematic Component of Credit Cycles

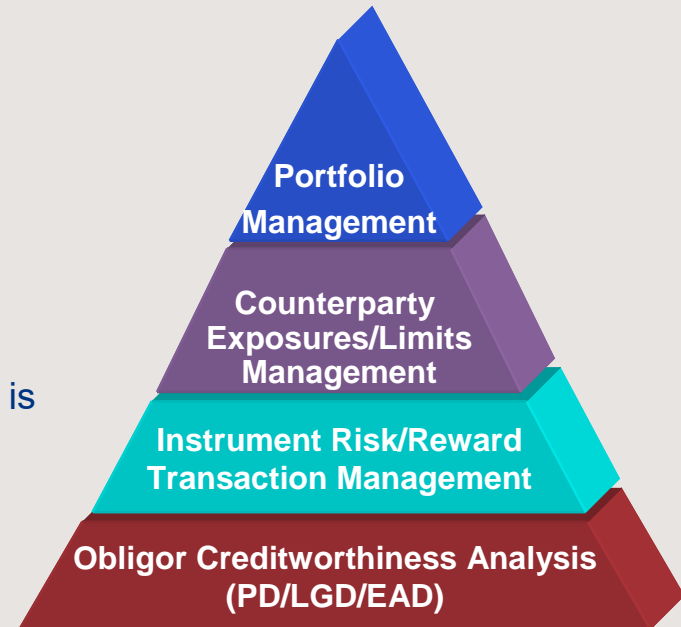
Current Models Assume Credit Factors Follow a Random Walk



Source: Moody's KMV, RBS-CPA research

Overview – Dual PIT/TTC Rating Systems

- In most Banks today, internal ratings (PDs) are ‘hybrid’ indicators which are mostly calibrated to ‘Through-the-Cycle (TTC) credit conditions
- But successful Capital Management (Basel II) & Credit Risk Management requires multiple, well-defined views of default risk:
 - 1-Year expected loss prediction – 1-Yr PIT
 - Regulatory Capital under Basel II – 1-Yr TTC
 - Economic Capital (Aggregate) – 1-Yr TTC
 - Discretions/Limits – 1-Yr TTC
 - Risk/Reward & Credit Pricing – PIT PD Term Structures (Including predicted credit cycles)
- A Dual-PD Approach including both ‘pure’ PIT & TTC measures is required to support the bank’s broad objectives:
 - Capital Stability not Pro-Cyclicality -- TTC
 - ‘Know Your True Risk’ -- PIT
- Pioneered Dual PIT/TTC Rating approach in 2005, which was approved under the AIRB Waiver for a large UK bank



Dual PD Ratings Design – PIT vs TTC – Problems & Objectives

■ *Problems:* At most banks, existing credit ratings are hybrid indicators:

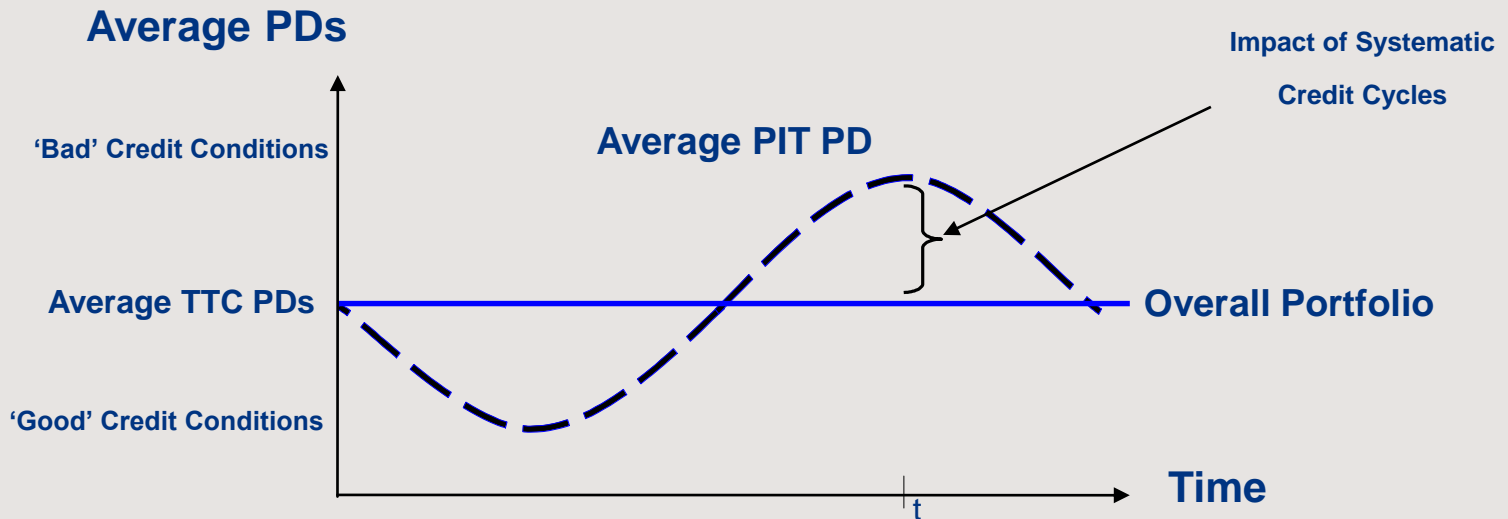
- **No credit cycle** -- understate the cycle & therefore they fail to track broad changes in risk over time,
- **Apples to Oranges** -- provide inconsistent measures, with the same grade implying different PDs for different asset classes,
- **Too Static & Not Dynamic Enough** -- get refreshed infrequently & so can be late in signalling financial distress,
- **Less Accurate Empirically** -- show less counterparty-specific variability than other indicators with better track records
- **Multiple PDs Required for Multiple Objectives.** – almost all banks have one rating or PD measure

■ *Objective:* Develop a Dual-PD Ratings approach to more accurately & timely PDs & grades on both a PIT and TTC basis:

- Consistently supports multiple regulatory & risk management objectives
- Each PD model needs to be classified as PIT, TTC or Hybrid
- Requires reasonable granularity & spacing in a bank's PD Master Scale
- Converts all current PD models to both 100% PIT & 100% TTC PDs -- creating apples to apples' & 'oranges to oranges' comparisons
- Explicitly incorporates measureable credit cycles to perform the PIT/TTC conversions & forecast credit cycles going forward

Impact of Systematic Credit Cycles – PIT PDs Move Much More than TTC PDs

- ‘Point-in-Time’ vs ‘Through-the-Cycle’ PDs:
 - ‘PIT’ PDs over 1-year represent ‘current credit conditions’ & reflect movements in systematic credit cycles
 - ‘TTC’ PDs over 1-year represent ‘average credit conditions’ & are developed using long-run average historical calibrations -- they are ‘conditionally neutral’ to systematic credit cycles



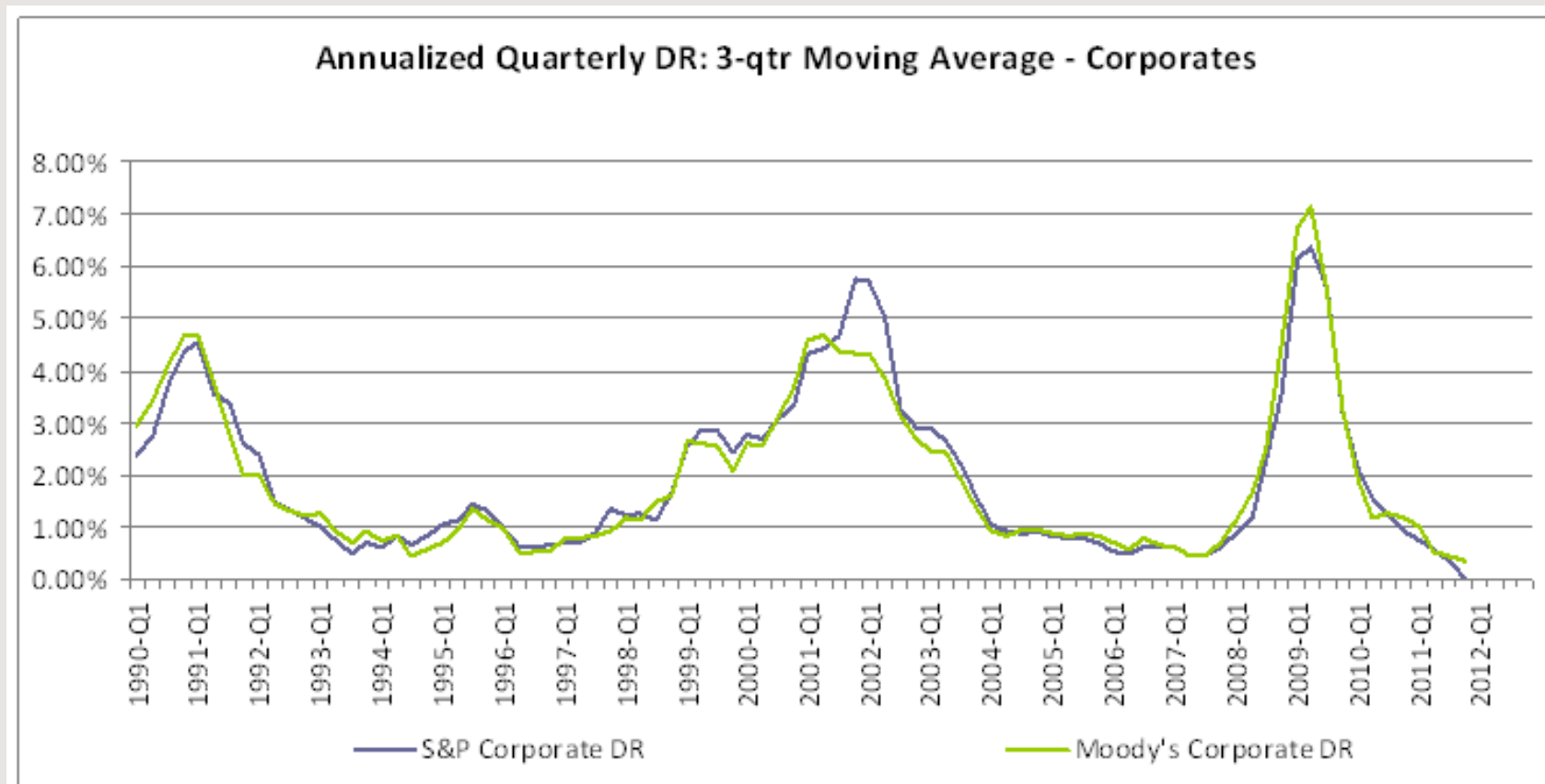
Empirical Evidence Supporting the Existence of Measureable Credit Cycles

Empirical Support for Believing in Systematic Credit Cycles

- Naked Eye !
- Unemployment rates, inflation rates, relative commodity prices, relative currency values & interest rates are often found to exhibit mean reversion – evidence also found in equity indexes
- Three empirical tests support the existence of credit cycles:
 1. *Forecast equations for systematic Z credit factors show statistically significant mean reversion & momentum*
 2. *In-sample simulations across a naïve model (no credit cycles) & estimated Z models shows statistically significant MSE reductions*
 3. *Out-of-sample – out-of-time back-testing results also demonstrate the validity of credit cycles*

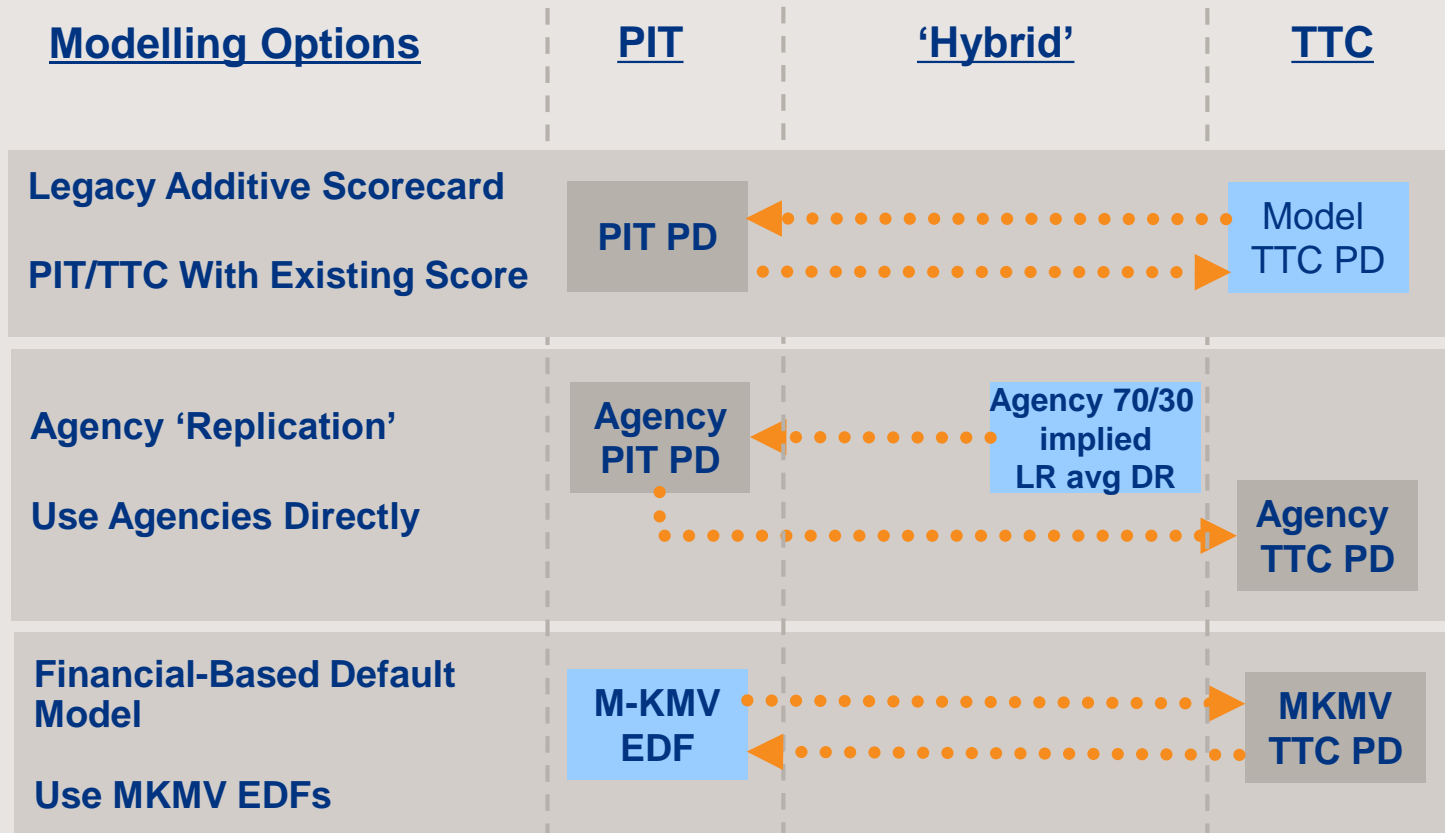
20 + Years of Rated Corporate Default Rates Behave as PIT Measures

Legacy Credit Models Are Blind To the Predictable Systematic Component of Credit Cycles



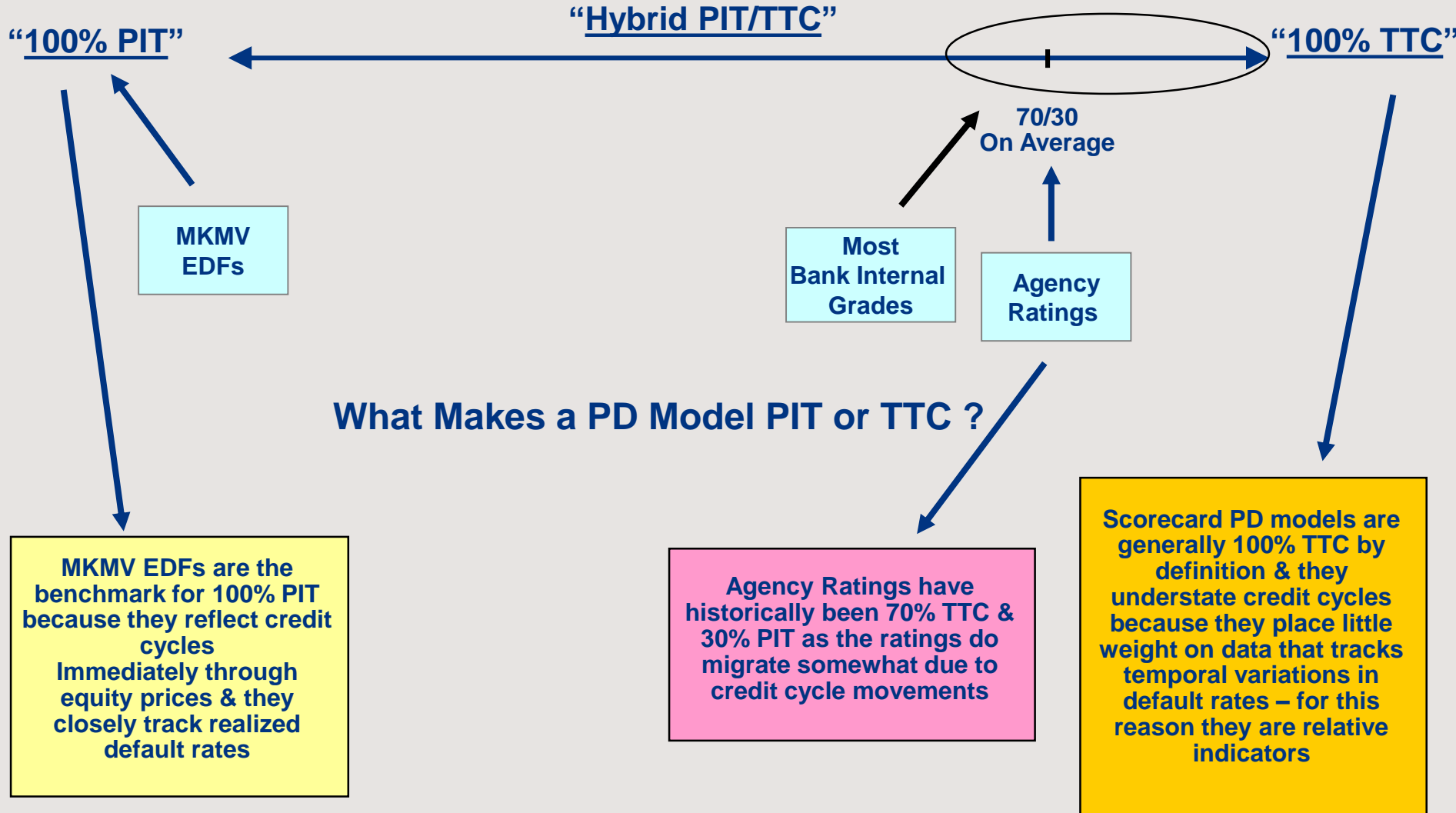
Source: Moody's & S&P

Applying Credit Cycle Adjustments to the Various Large-Corp PD Model Development Options



← Cycle adjustment

PD Models Come in Various 'Flavors' of PIT or TTC – 'Oranges, Lemons & Grapefruits'



Systematic Factors for Industry Sector & Region are Combined to Develop Credit Cycle Indexes (Zs)

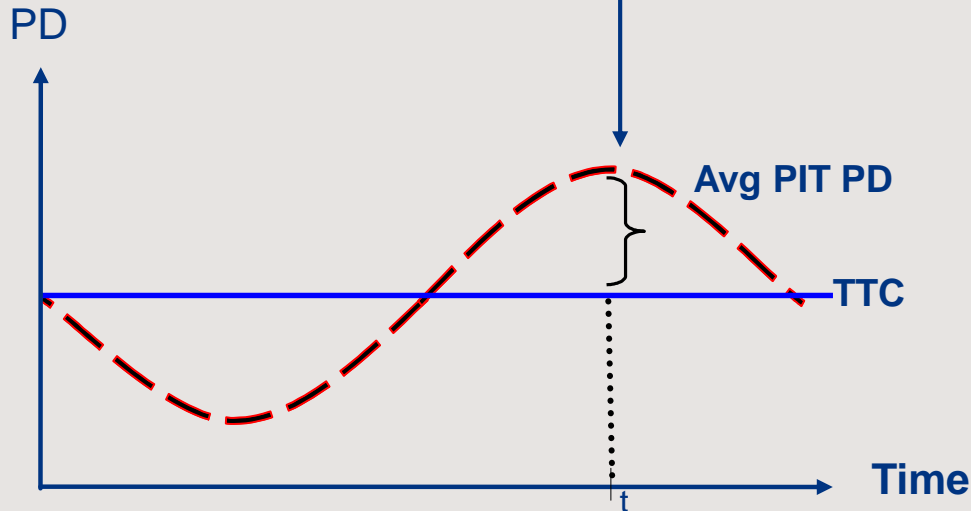
Industry Sector Z_S

- Aerospace & Defence
- Banking
- Chemicals & Plastic Products
- Construction
- Consumer Products
- Oil & Gas
- Finance, Real Estate & Insurance
- Hotels & Leisure
- Basic Industries
- Machinery & Equipment
- Media
- Medical
- Steel & Metal Products
- Mining
- Motor Vehicle & Parts
- Retail & Wholesale Trade
- Business & Consumer Services
- Technology
- Transportation
- Utilities
- Commercial Real Estate

Weighted Avg
 Spot Median $Z_{S/R}$ Gap
 LR Median $Z_{S/R}$ Gap

Regional Z_R
 (Corp/FI)

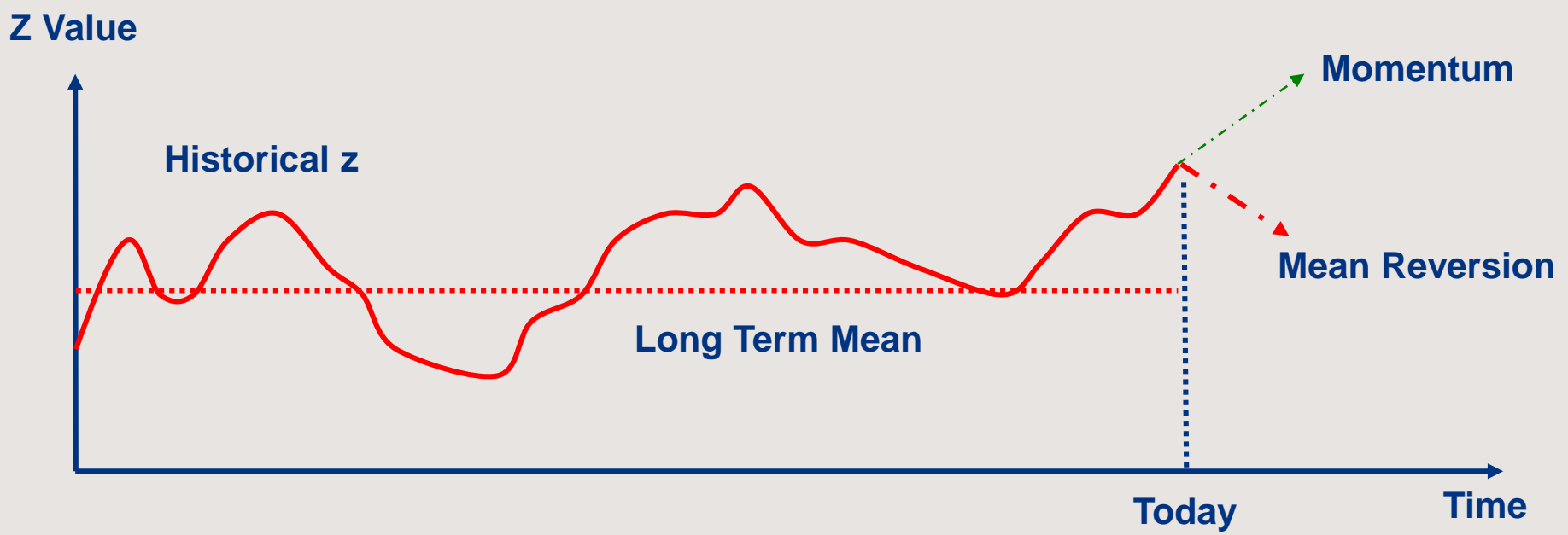
- Asia
- Continental Europe
- United Kingdom
- Latin America
- North America
- Pacific



Mean Reversion & Momentum Jointly Drive Credit Cycle Behaviour

Credit Cycle Behavior (Z) is Driven by Two Competing Influences – Mean Reversion & Momentum

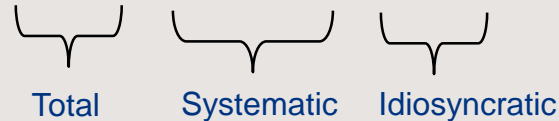
Almost All Data Exhibiting Credit Cycles Shows Two Competing Empirical Influences



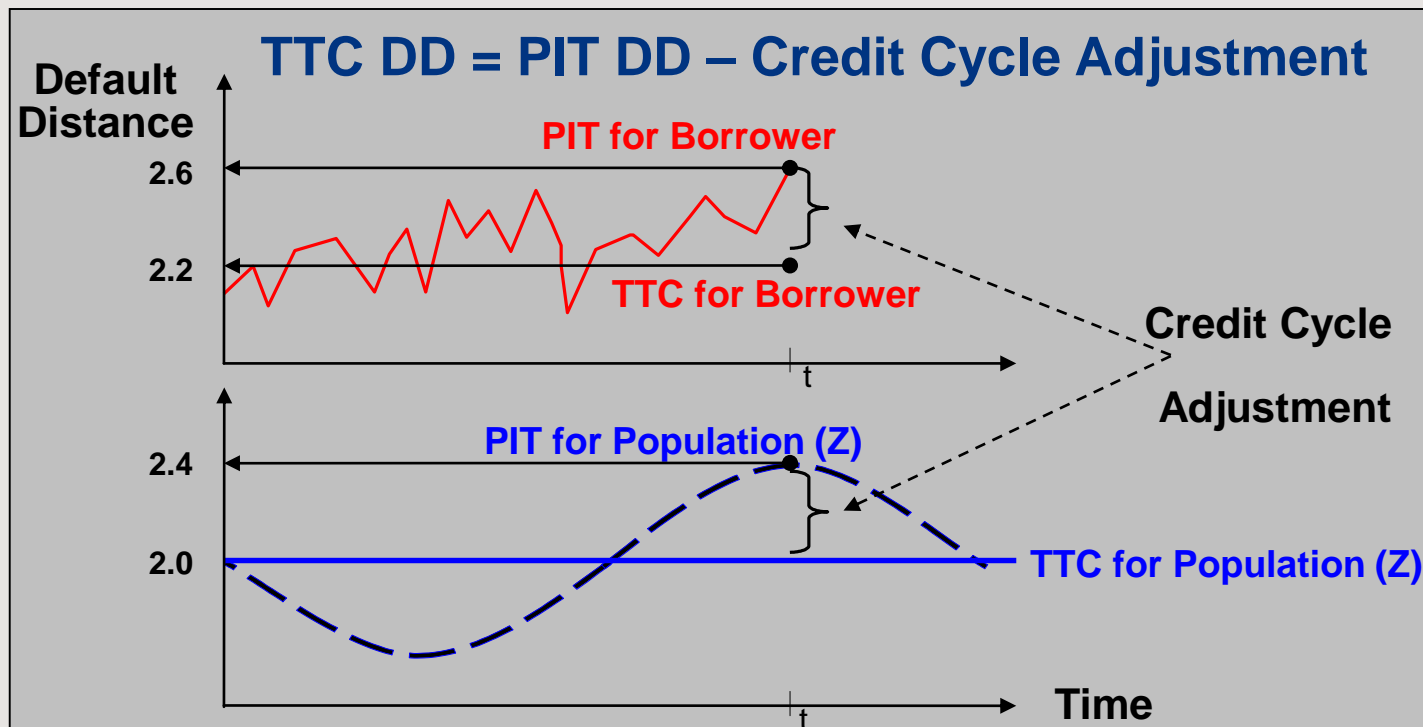
Relationship Between PIT & TTC Default Distance

- For a counterparty, TTC change synonymous with idiosyncratic (company-specific) variation

$$\text{PIT} = \text{CYCLE} + \text{TTC} \Rightarrow \Delta\text{PIT} = \Delta\text{CYCLE} + \Delta\text{TTC}$$

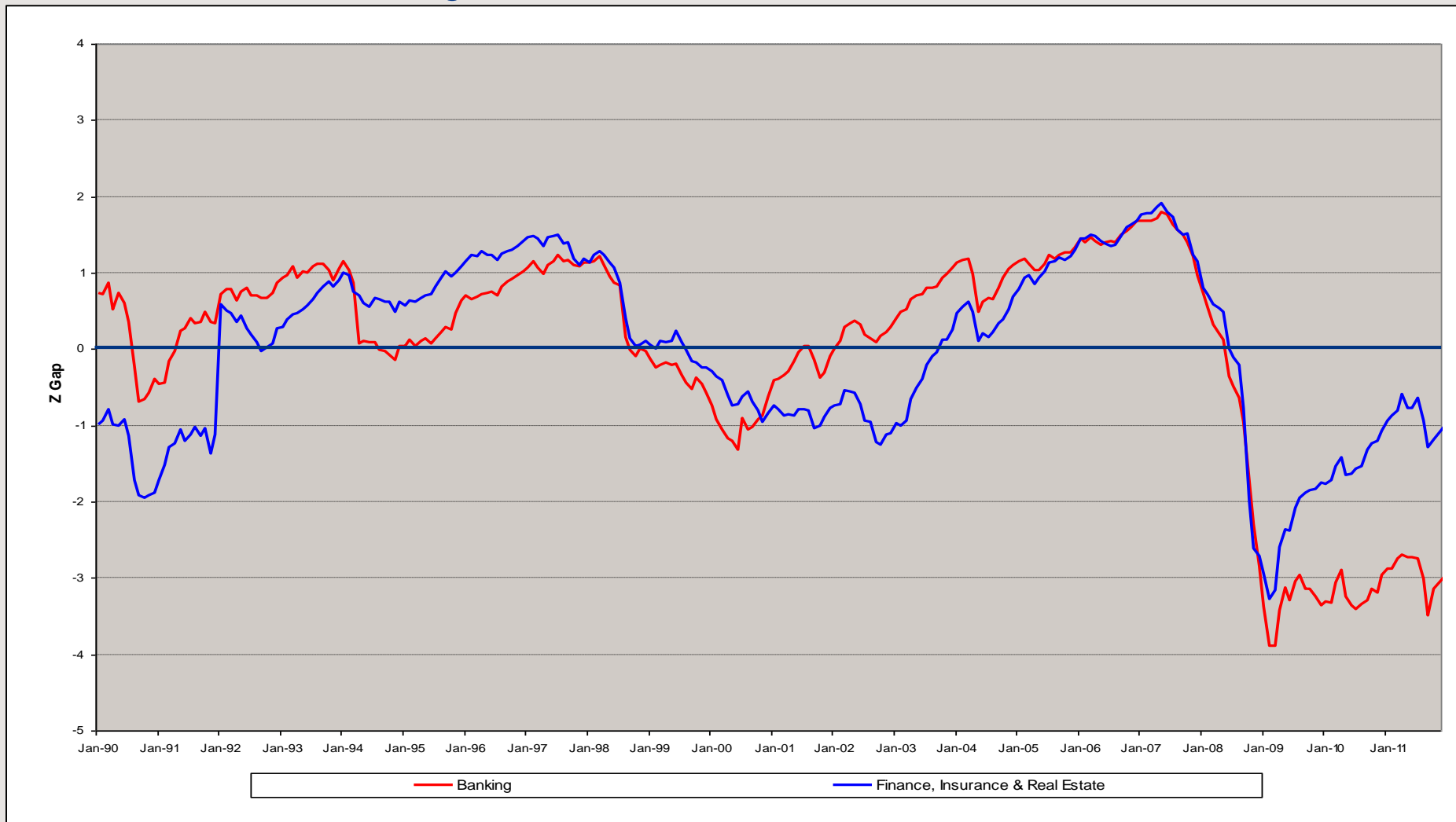


TTC PDs Impacted by Only the Borrower Idiosyncratic Factor
 PIT PDs Impacted by Both the Systematic & Idiosyncratic Factors



Examples of Industry Credit-Cycle Index (Z-Gap) Analysis

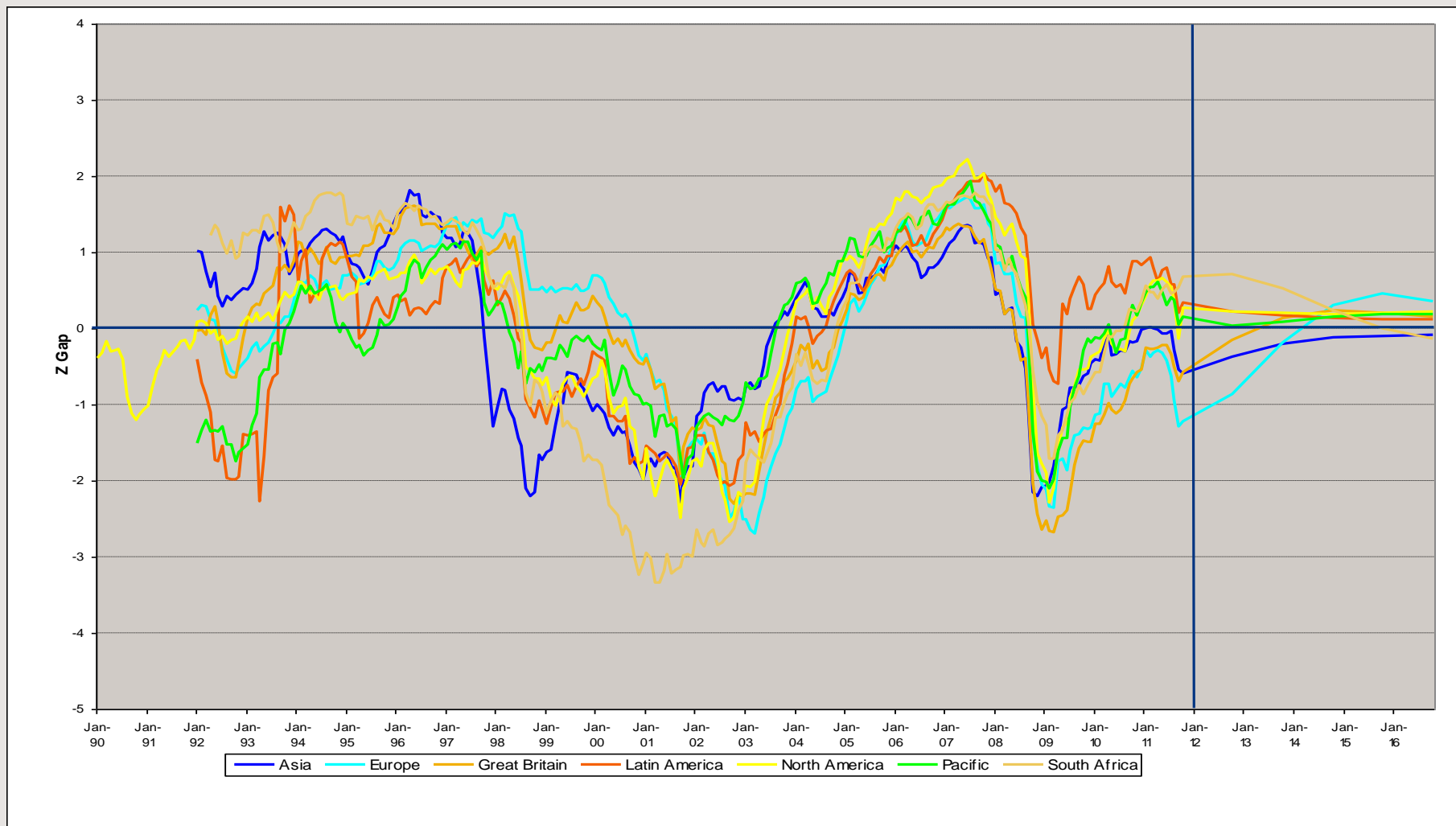
Banking & Finance, Insurance & Real Estate



Source: Moody's KMV, RBS-CPA research

Examples of Region Credit-Cycle Index (Z-Gap) Analysis

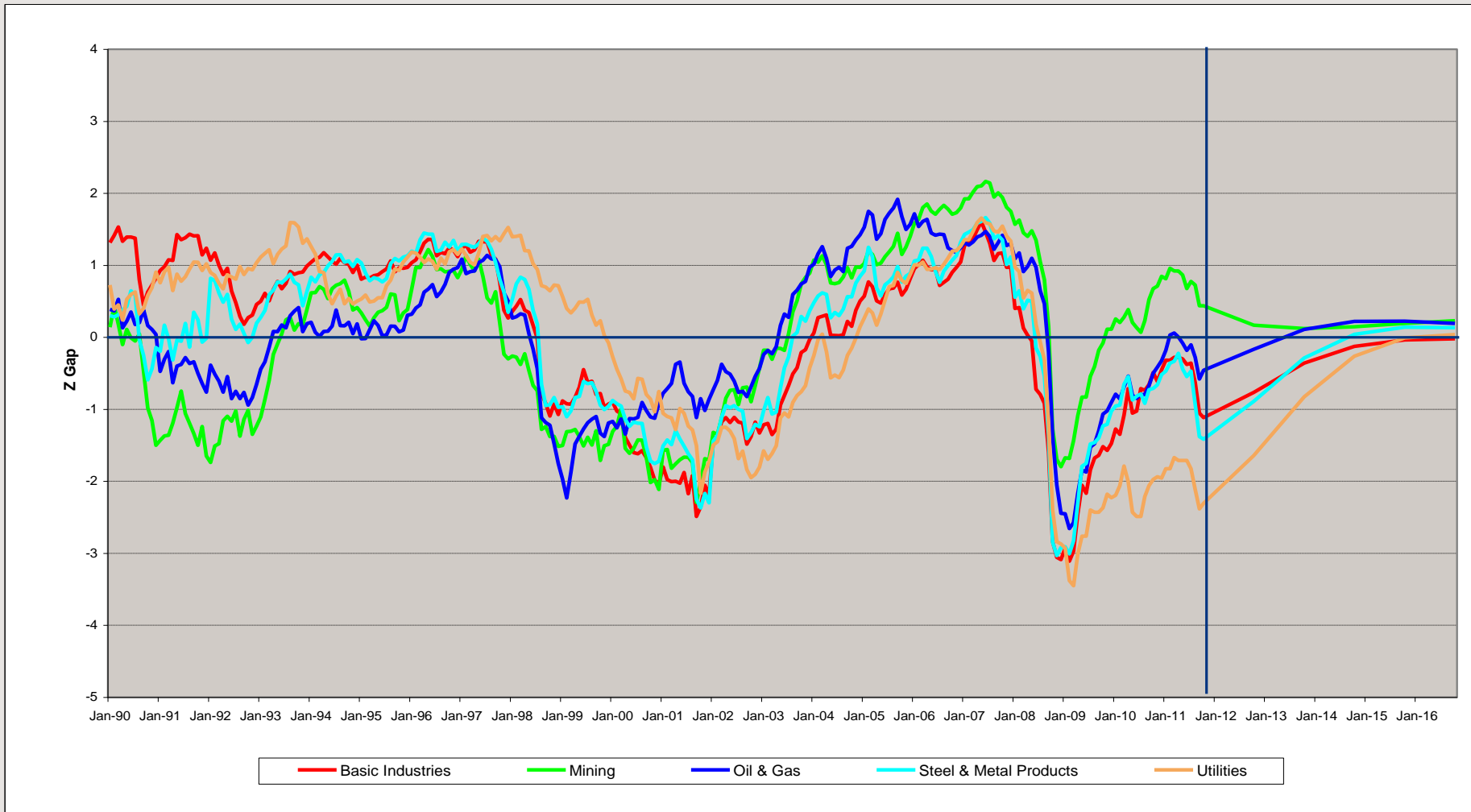
Corporates – Asia, Europe, UK, Latin-America, North-America, Pacific & South Africa



Source: Moody's KMV, RBS-CPA research

Examples of Industry Credit-Cycle Index (Z-Gap) Analysis

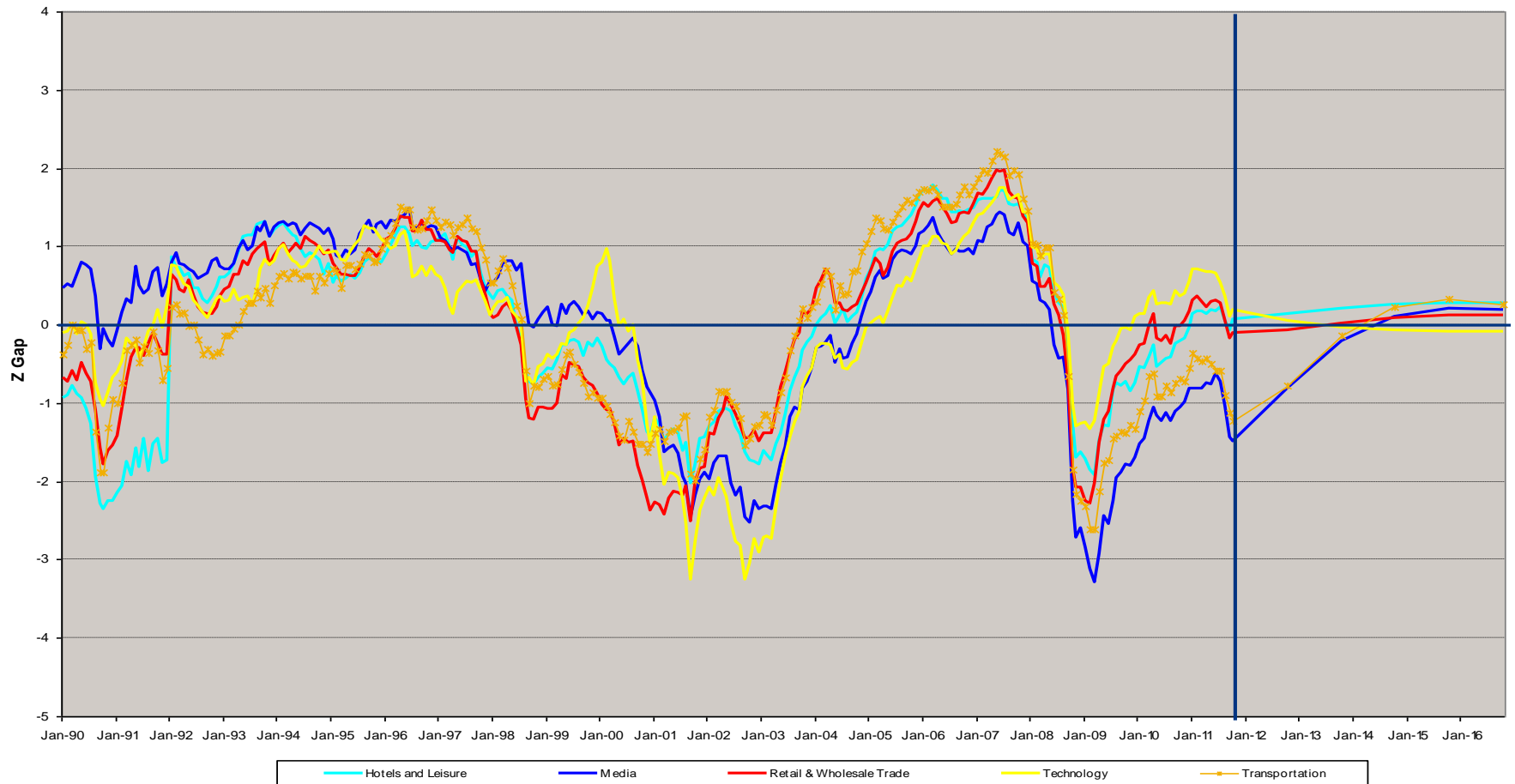
Basic Industries, Mining, Oil & Gas, Steel & Metal Products, Utilities



Source: Moody's KMV, RBS-CPA research

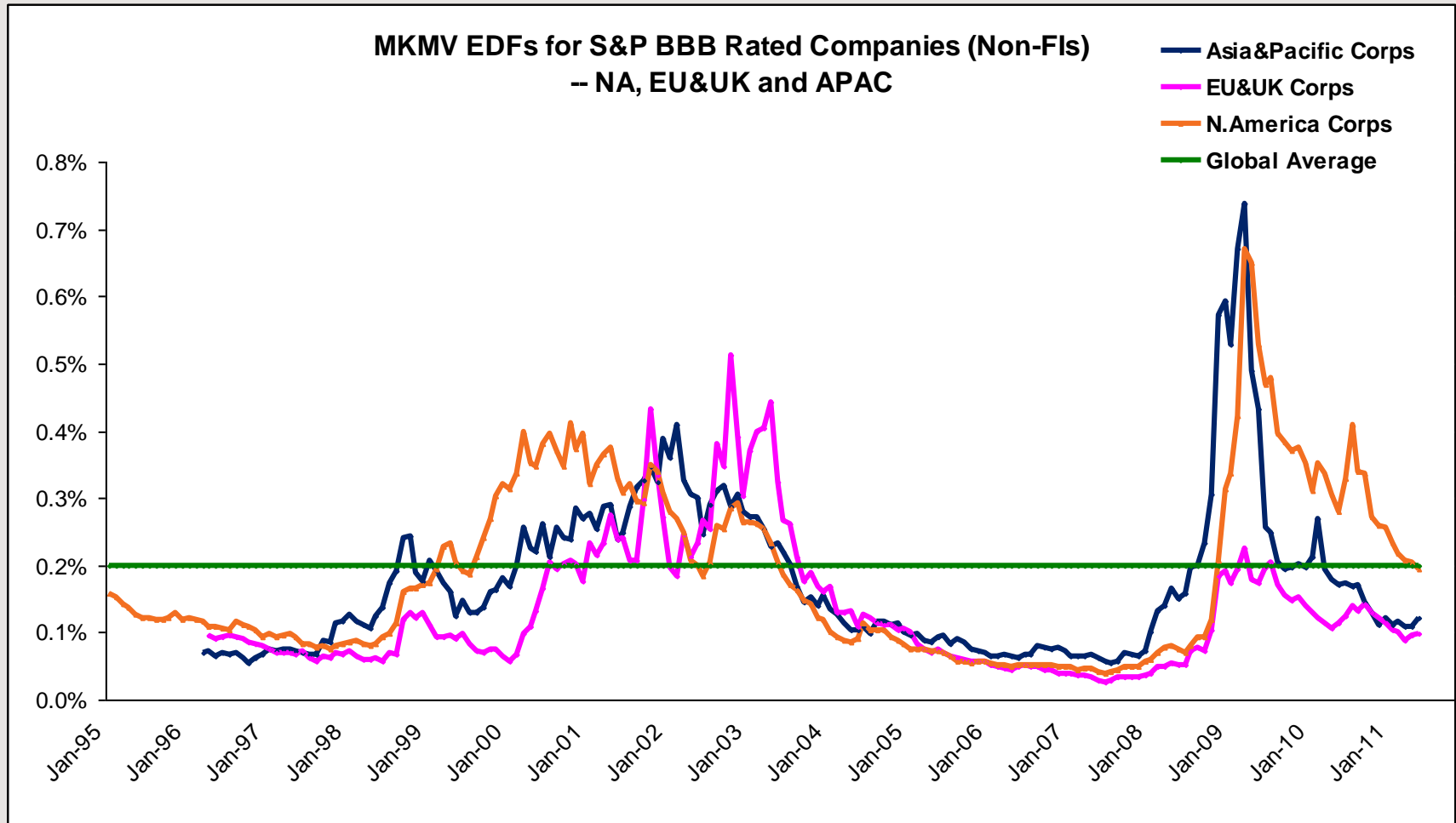
Examples of Industry Credit-Cycle Index (Z-Gap) Analysis

Hotels & Leisure, Media, Technology, Transportation, Retail & Wholesale Trade



Source: Moody's KMV, RBS-CPA research

MKMV EDFs for BBB Rated S&P Companies Move Substantially Across Credit Cycles



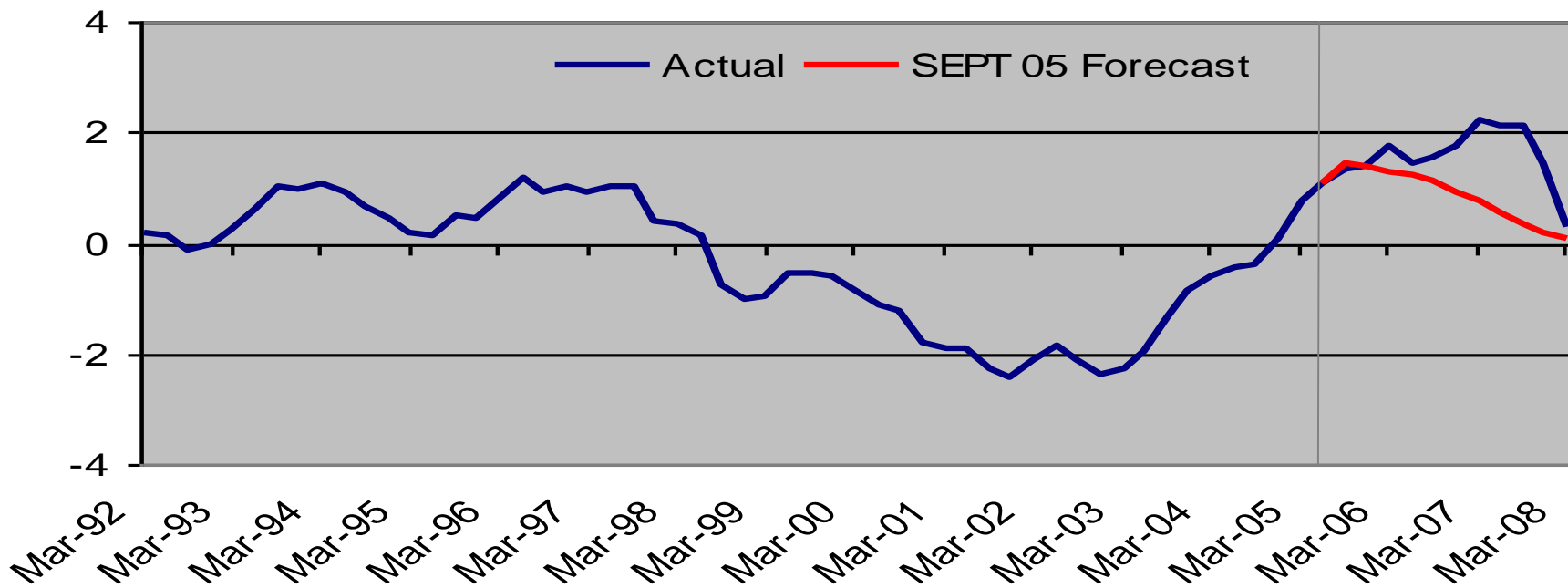
Source: S&P, Moody's KMV, RBS-CPA research

Examples of Ex Ante Credit Cycle Index Back Tests

Predicted Credit Downturn in the Hotel/Leisure Sector Occurred Later But Was More Rapid When it Did Occur

Industry Z – Hotel/Leisure Sector – Rapid Declines in Z Behaviour Caught up With the Ex Anta Forecast

Corporates: Hotels & Leisure



Source: Moody's KMV

Developing Stress Testing Capabilities fits Naturally Within a PIT/TTC PD Framework

Utilizing PIT PD Framework for Stress Testing:

- Developed & applied portfolio-wide or more narrowly for industries, regions or obligor types
- Approach is Banking-Book-centric with simplified Trading-Book assumptions until a full integrated market & credit risk factor structure is completed
- Leverages PIT PDs to most accurately stress PDs & therefore potential losses that are dependent upon systematic credit cycles
- Utilizes forecasts of macro risk factors (currently GDP & Equity Indexes) to summarize implications of a 'stress' macro scenario on portfolio credit conditions broadly
- Estimates statistical models between 'Macro-Z' factors & Z-industry/regions
- Applies a 'Macro-Merton' approach – therefore it is consistent with corporate PD modelling
- Develops conditional, 'stress' PIT PD term structures on a multi-year basis
- Provides a framework for computing & comparing conditional & unconditional portfolio EL estimates in 'PIT-Land'
- Implemented in 'batch mode' – sits right on top of a PIT PD batch process

Additional Components of the Credit-Cycle Based Stress Test Approach

(1) Develop credit-cycle based, systematic stress scenarios for EAD & LGD:

- EAD & LGD models estimated to include Z-Gap credit cycles
 - Stress LGD = f(LGD risk factors, region/sector Z-Gap)
 - Stress EAD = f(EAD risk factors, region/sector Z-Gap)
- Applying deterministic, stress scenarios to EAD & LGD provide stress values consistent with the stress PIT PD scenarios – all drive off the same Macro Z drivers

(2) Develop Qualitative Overlay to statistical models:

- Bridge from actuarial view to provision/accounting view – match stress default rates by setting some counterparty PDs to 100% and all the rest to zero
- Apply ‘add-factor’ approach to industry or region losses
- Solicit Credit Officer input by region, sector or counterparty

Stress Related Literature Review

Equity Risk Factor approach

- Credit-Metrics (Gupton, 1997), KMV-Portfolio-Manager (Kealhofer, 2001), & Algo-PCRE
- Used in estimating loss distributions through Monte Carlo simulations

Macro Risk Factor approach

- Wilson (1997, Credit Portfolio View)
- Inspired by APT work by Chen-Roll-Ross (1986)
- Deterministic scenarios using macro assumptions

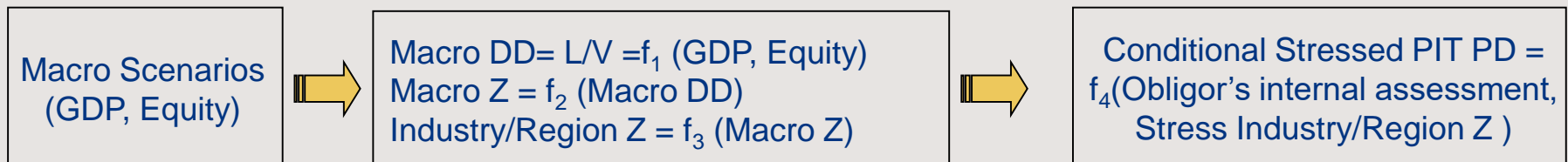
Our approach combines both.

Similar approach used elsewhere:

- Otani et al (BoJ, 2009)
 - Development of credit cycle Z-index
 - Zs based on Wei (2003) and Belkin et al (1998) formulation
 - Developed conditional transition matrix

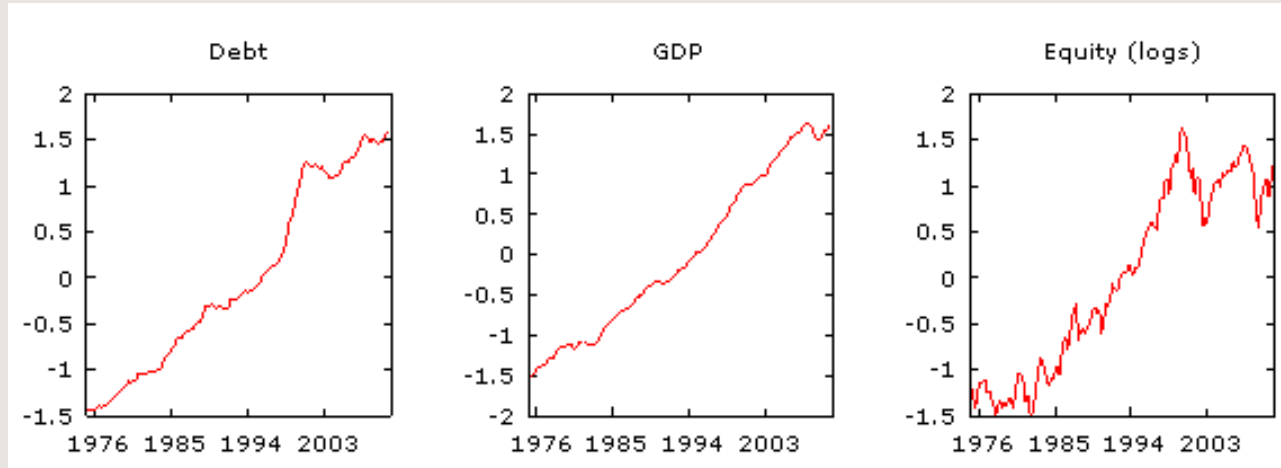
Model Overview – ‘Macro-Merton’ Credit Cycle Stress Test Framework

- View GDP & equity measures as asset-value proxies
- Project macro debt on the basis of trends in asset-value proxies
- Treat Debt/GDP & Debt/Equity as leverage measures
- Derive macro DDs (‘Default-Distance’) as ratios of leverage to historical, leverage volatility
- Convert macro DDs to macro Zs (by normalising mean & variance)
- Use bridging relationship to derive industry-region Zs from macro Zs
- Enter industry-region Zs into the PD, LGD, and EAD models and derive stress losses

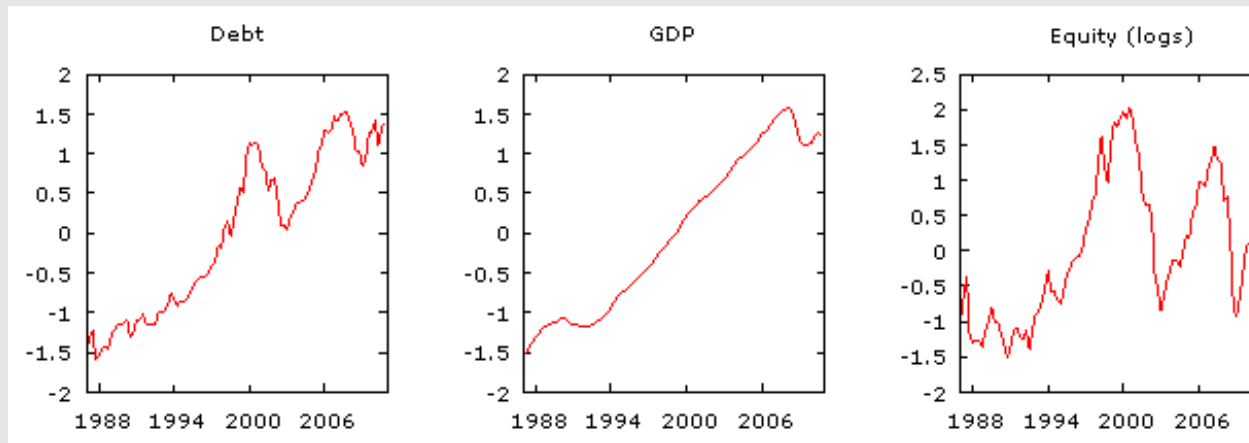


Raw 'Standardized' Data for US & UK Macro Z

Standardized US series



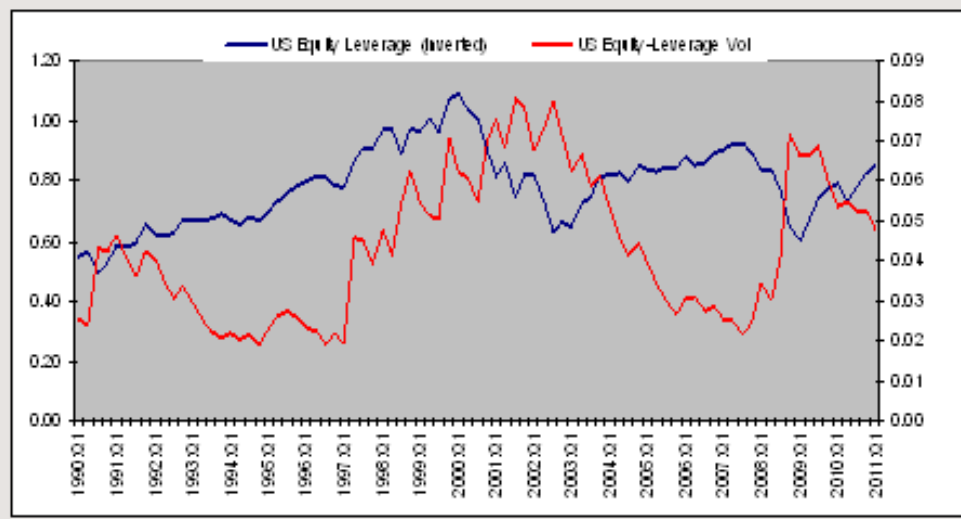
Standardized UK series



Source: >>>>>

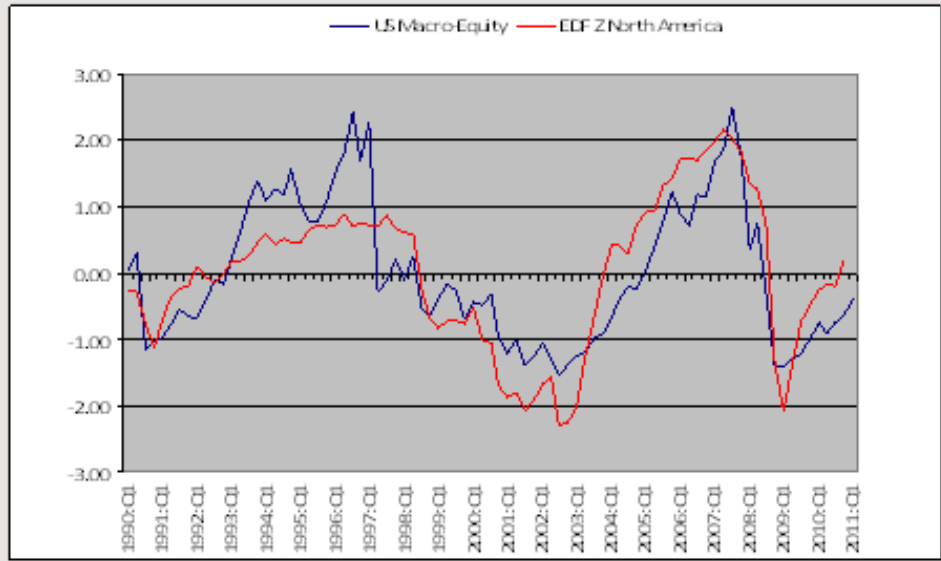
Components of the US Equity Macro Z

On the right see historical values of leverage and leverage volatility, which has larger proportional swings



Leverage (inverted) = $\ln((\text{MtM equity plus debt})/\text{debt})$.

US equity 'Macro Z' tracks North American Corp, EDF-derived Z quite closely

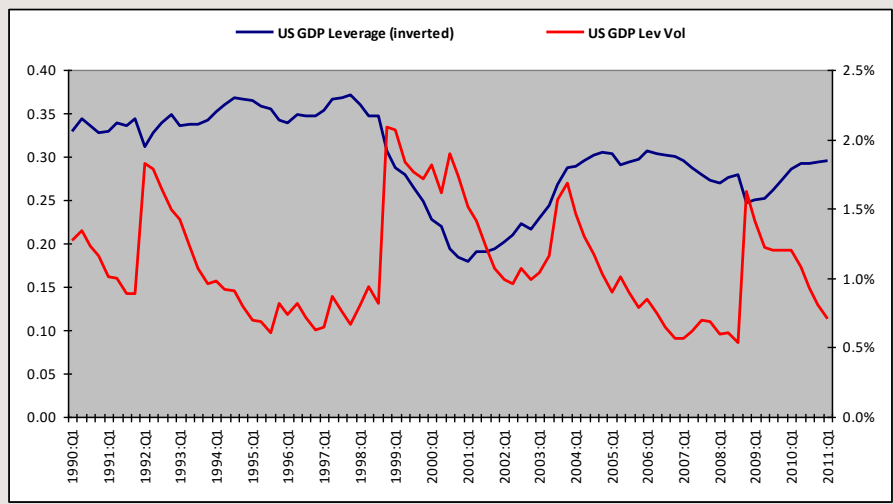


DD = Lev/Lev-Vol;
Z = DD normalized (mean = 0, std dev = 1)

Source:Moody's KMV, RBS-CPA research

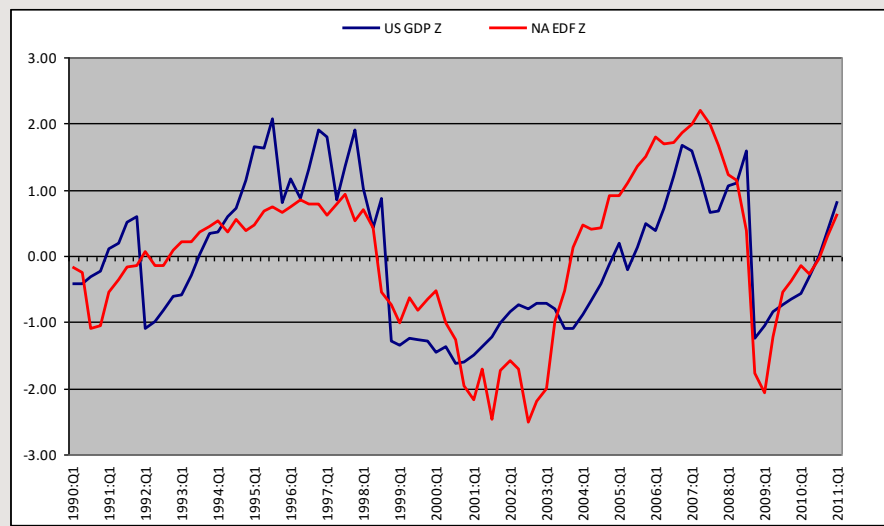
Components of the US GDP Macro Z

On the right see historical values of leverage and leverage volatility, which has larger proportional swings



Leverage (inverted) = $\ln((\text{GDP}/\text{debt}))$.

US GDP macro Z tracks North American Corp, EDF-derived Z rather closely

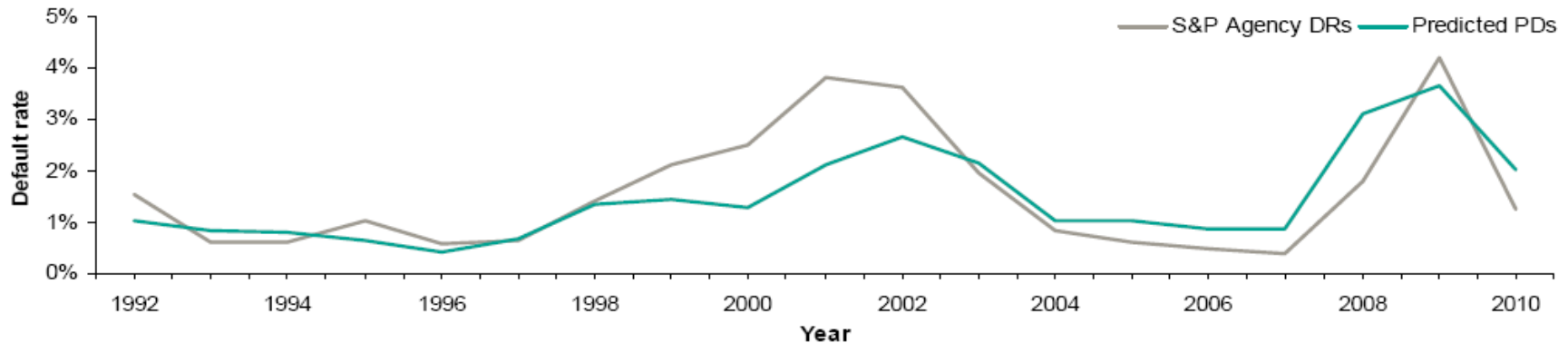


DD = Lev/Lev-vol;
Z = DD normalized (mean = 0, std dev = 1)

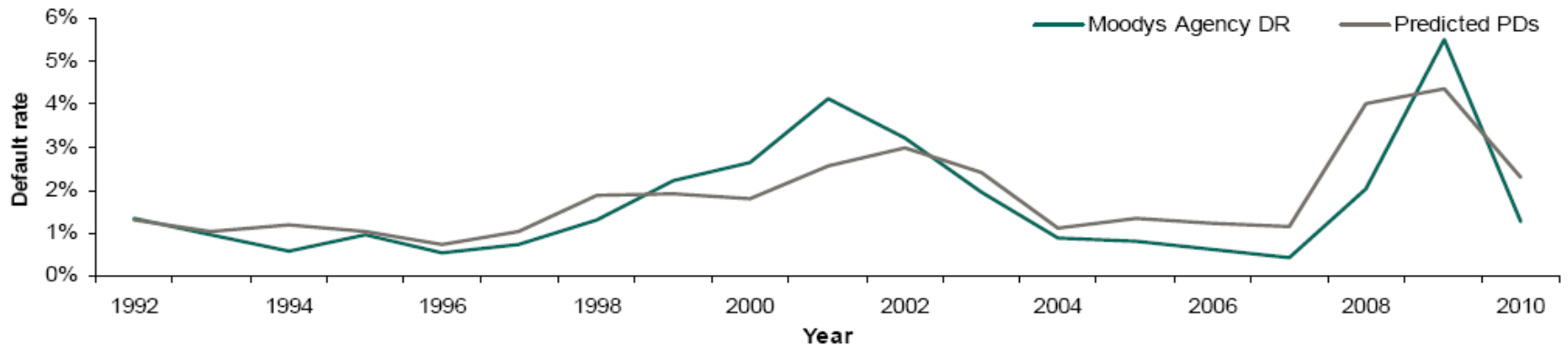
Source:Moody's KMV, RBS-CPA research

Stress Test Model Back-testing: Observed v/s Predicted Default Rates on Agency Rated Sample

S&P agency DRs vs. predicted PDs (1 year shocks applied to actual points)



Moody's agency DRs vs. predicted PDs (1 year shocks applied to actual points)



- Good fit but it under-predicts somewhat the observed 2001-2002 recession

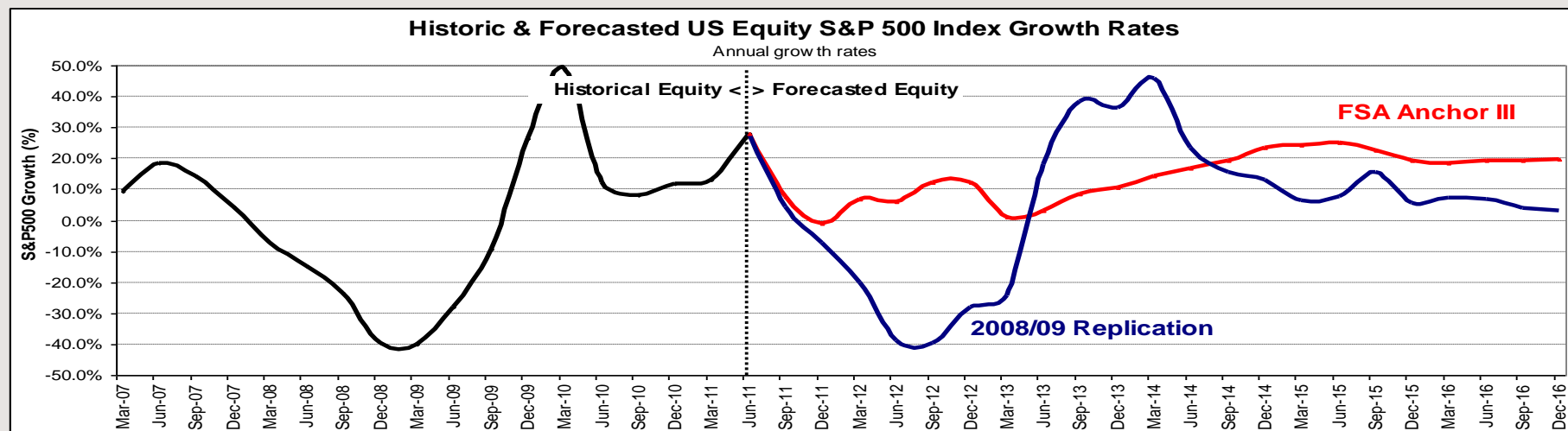
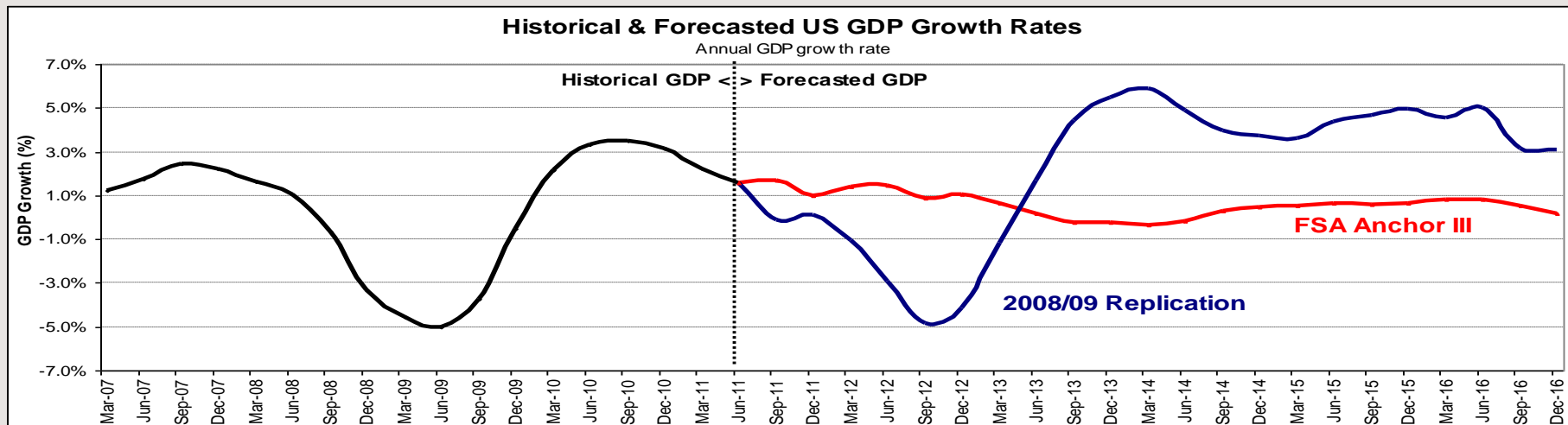
Source: S&P, Moody's, Moody's KMV, RBS-CPA research

Planned Model Improvements

- Understanding lack of fit for 2001-02 recession
 - Duffie's frailty argument – unobserved systematic factors
 - Model imperfections
- Using new systematic factors
 - Europe and Asia GDP and Equity (Lack of long time series)
 - Commercial Real Estate Index to model Property Sector Zs
 - Yield Curve dynamics to model Banking Sector Zs
- Enhance model volatility

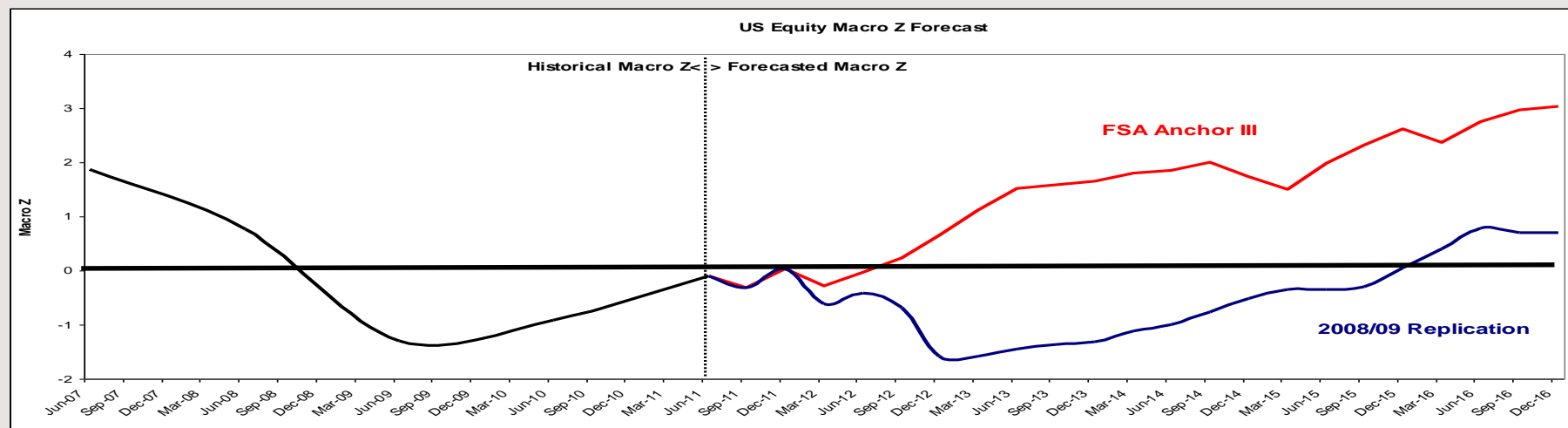
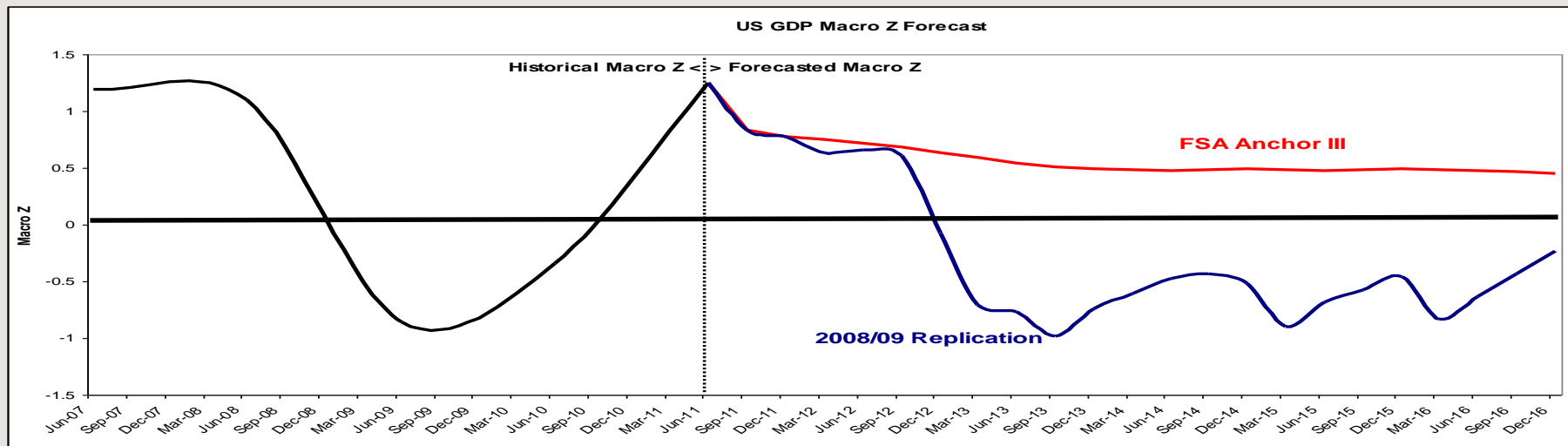
Example Stress Test – FSA Anchor Scenario vs ‘Replay of 08/09’ Scenario

US GDP & S&P 500 – History & Scenario Forecasts



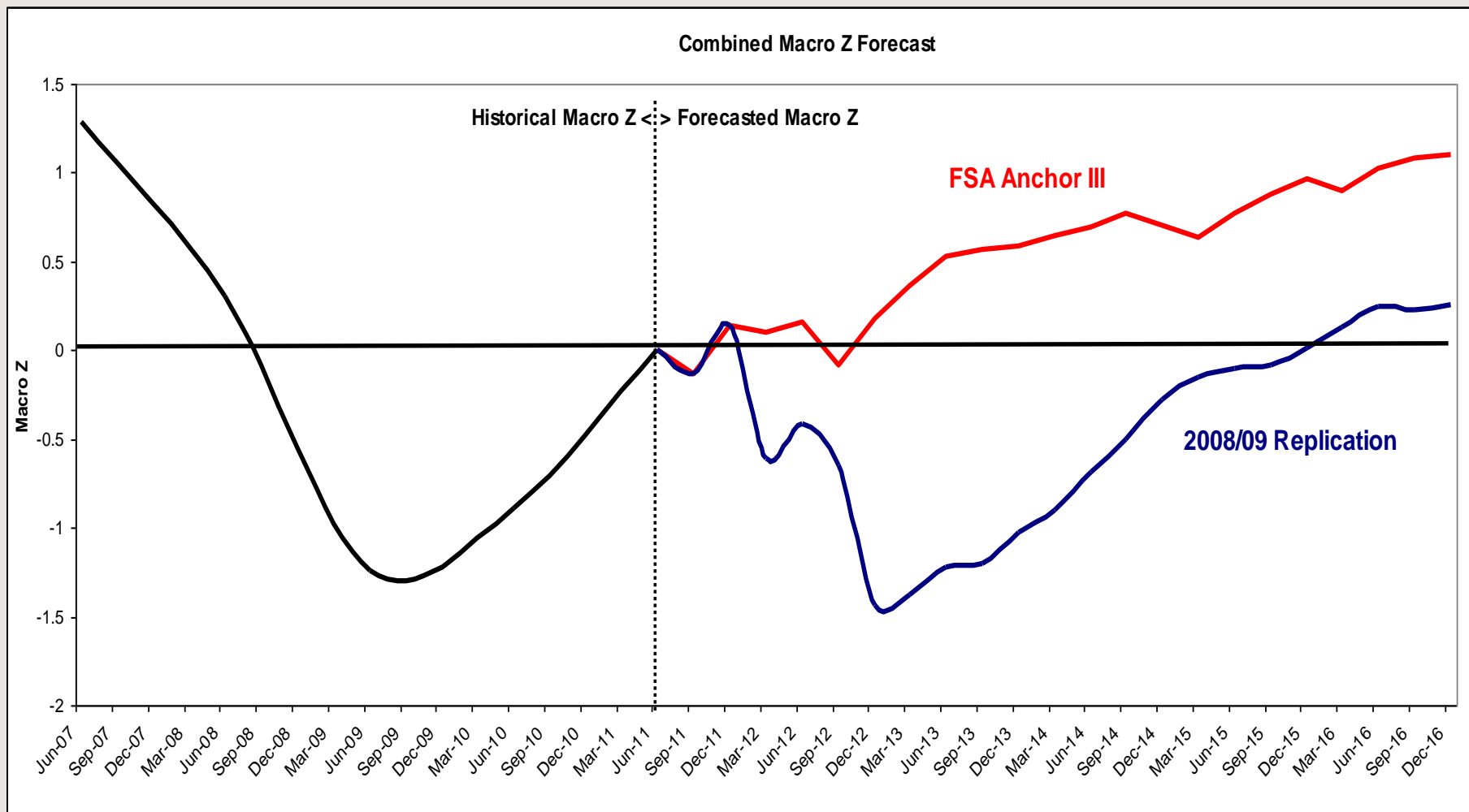
Example Stress Test – FSA Anchor Scenario vs ‘Replay of 08/09’ Scenario

US ‘Macro-Z’ for GDP & S&P 500 – History & Scenario Forecasts



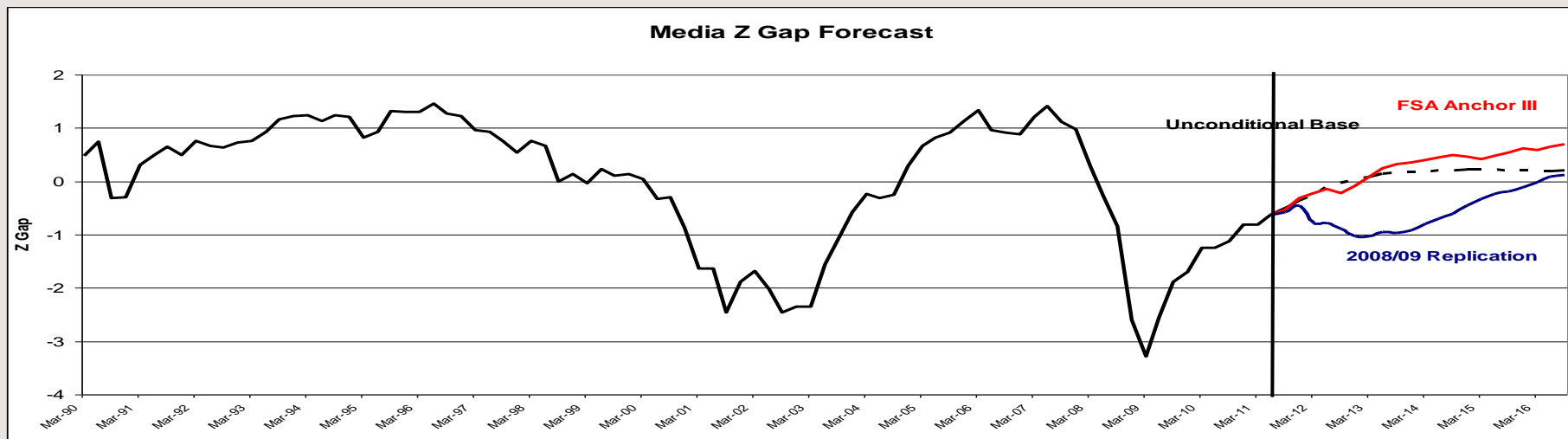
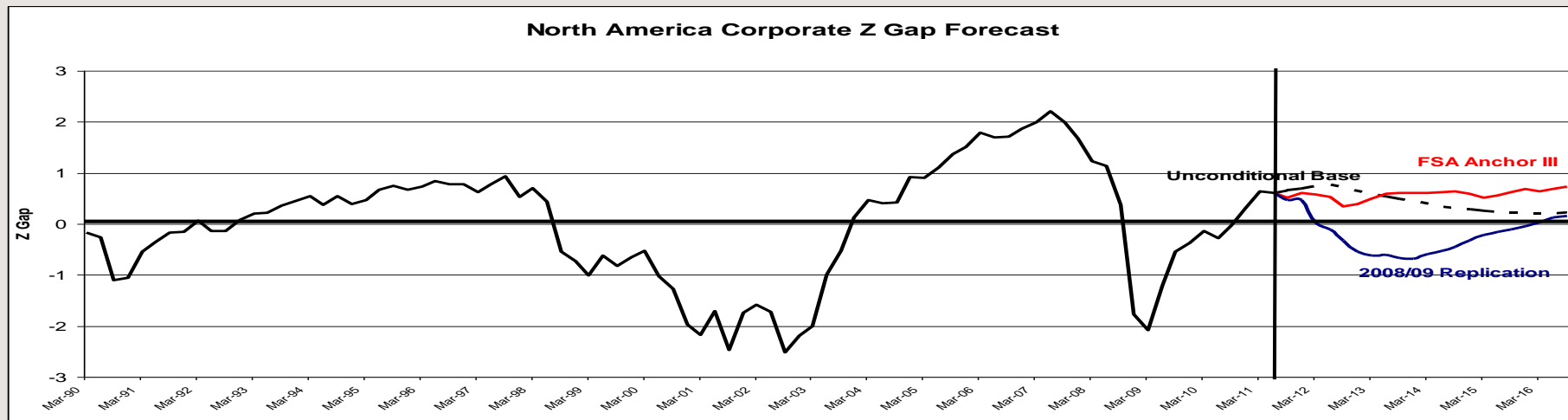
Example Stress Test – FSA Anchor Scenario vs ‘Replay of 08/09’ Scenario

US Combined ‘Macro-Z’– History & Scenario Forecasts



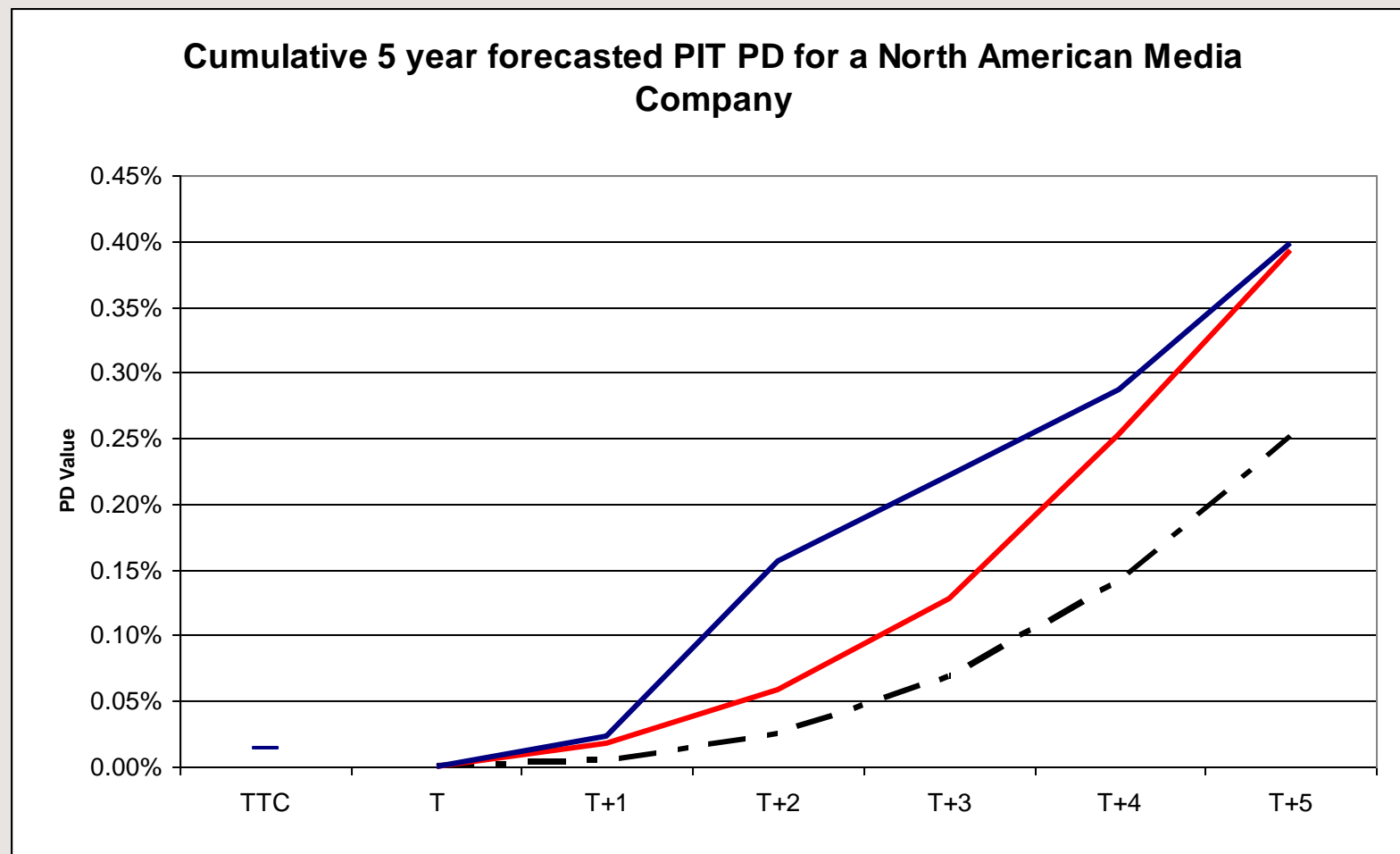
Example Stress Test – FSA Anchor Scenario vs ‘Replay of 08/09’ Scenario

US region & Sector Z-Gaps – NA Corps & Media



Example Stress Test – FSA Anchor Scenario vs ‘Replay of 08/09’ Scenario

PD Term Structure for a NA Media Company



Key PIT/TTC Points in the Presentation Summarized

- Systematic Credit Cycles are real & they can be measured empirically – the existence of credit cycles motivates a Dual PIT/TTC Rating approach
- Dual rating systems are better at supporting multiple business objectives – for credit ratings, ‘one size does not fit all’ – capital stability vs. ‘know your real risk’
- Current, legacy credit models do not incorporate empirical credit cycles as they assume systematic factors follow a random walk – this means that moving to a dual rating approach represents a true Kuhnian evolution
- A PIT/TTC ratings framework can be utilized directly to develop consistent, portfolio-wide stress tests incorporating credit cycles

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