Treasury Analytics

Application of Analytical Methods for Trading and Risk Management

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5th September 2013

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- Context
- Treasury Management – Global Best Practices
- Treasury Management – Analytical Framework
- How to Implement Best Practices
- Decision Support Systems
- Algorithmic Trading Systems
- Summary

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- **Global Financial Crisis and regulatory response – Dodd-Frank, EMIR/MiFiD/BIS proposals**
- **McKinsey report on Indian Banks**
- **RBI's concerns on Banks vs Markets – Governor Rajan's remarks**
  - Treasury has become the core of PnLs and Risk – externalities!
  - And hence Treasury Management becomes very central to the operations of banks
  - Presentation will focus on some Treasury Management Analytics


Treasury Management
Global Best Practices

- **Asset Liability Management**
- **Trading Risk**
- **Derivatives**
- **Credit Risk**
- **Liquidity Risk**
  - Funding
  - Trading
- **Contingency Funding Plan**
- **Operational Risk**

Treasury Management – Global Best Practices

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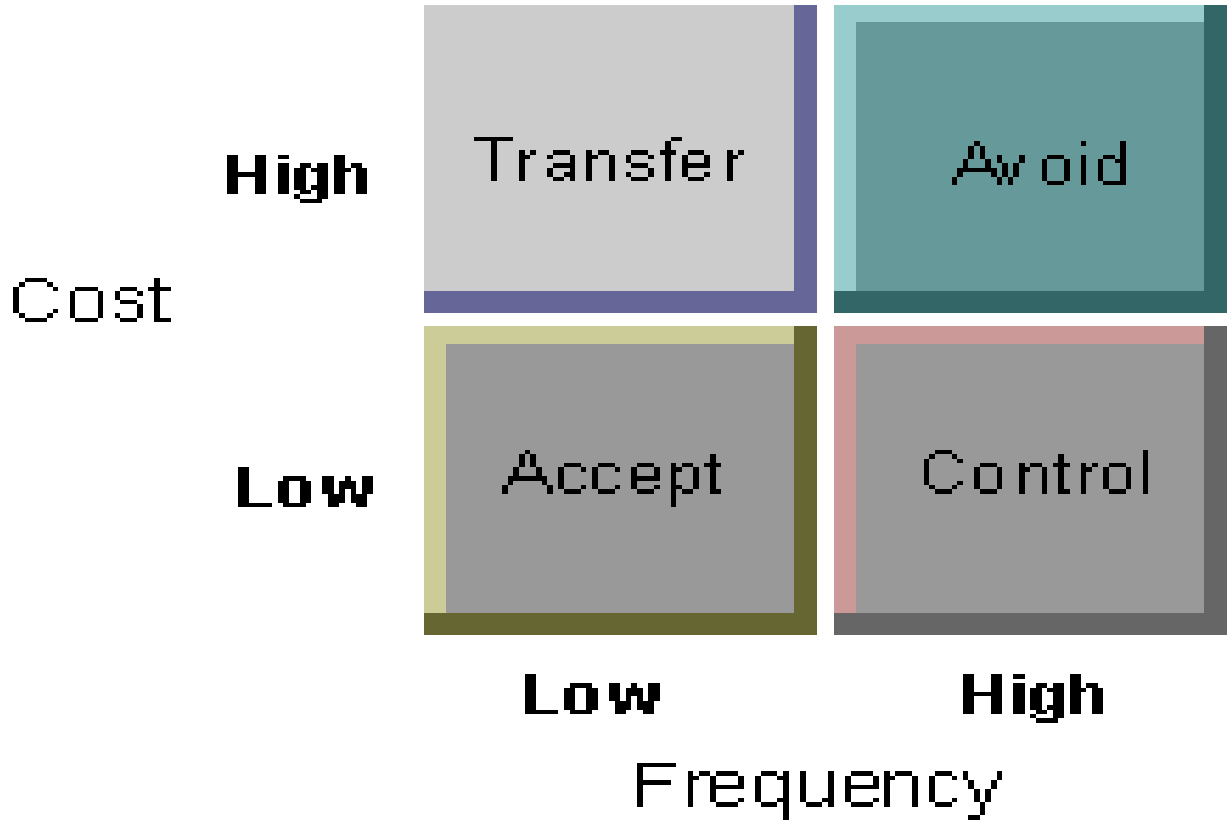
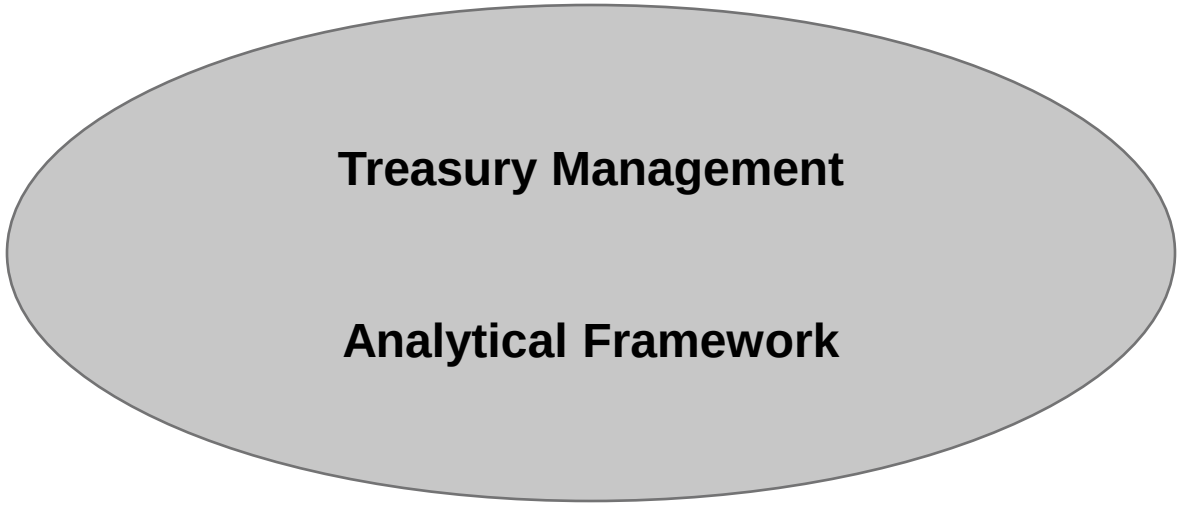
Best practice institutions

- take a proactive, not a reactive approach to Risk Management as part of Balance Sheet Management
- view Risk Management not from the perspective of compliance or control but from the perspective of value creation
- have a clear articulation of the amount of risk to be taken. They are quantified, pre-specified, and measurable

- The function is integrated with other business strategies.

Risk Approach




Treasury Management
Analytical Framework

- **Best practice institutions use an eclectic mix of analytical techniques such as gap analysis, simulation, duration, and value at risk depending on the structure of the balance sheet and target variable being measured.**

- **No single technique is regarded as better than the others by best practice institutions. They view these techniques as complementary diagnostic tools.**

Performance Measurement Framework

A Case example on:

- **Hedge/Arbitrage/Speculation**
- **Risk Based Framework**

Control Framework

- **Best Practice institutions ensure that the Risk Management limits are articulated to place a "ring fence" around operating managers rather than tying their hands with rigid limits. They strive for a judicious balance between "tight controls" and "loose controls".**

Hard Limits	Soft Limits
A Gap of +6.52%	A Gap of +8%
Duration of portfolio viz., 3.25	Duration of portfolio viz., 3 & 4

- *KNOW WHAT YOU DO NOT KNOW:* ***BACK TESTING***

- *THINK THE UNTHINKABLE:* ***STRESS TESTING***

Treasury Management

How to Implement Best Practices
Strategies and Tools

Treasury Management Analytics – Strategies and Tools

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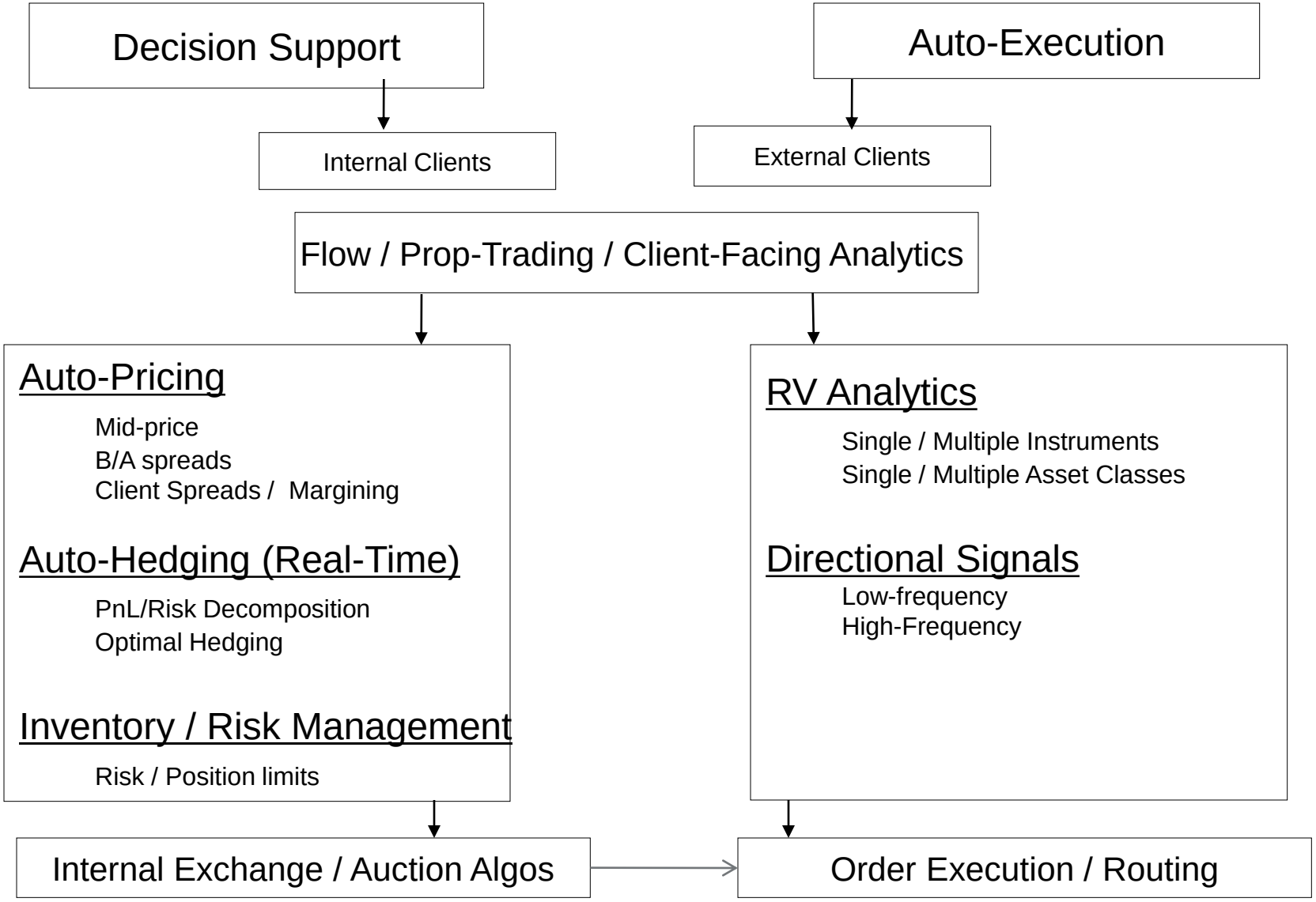

Treasury Management Analytics - Coverage

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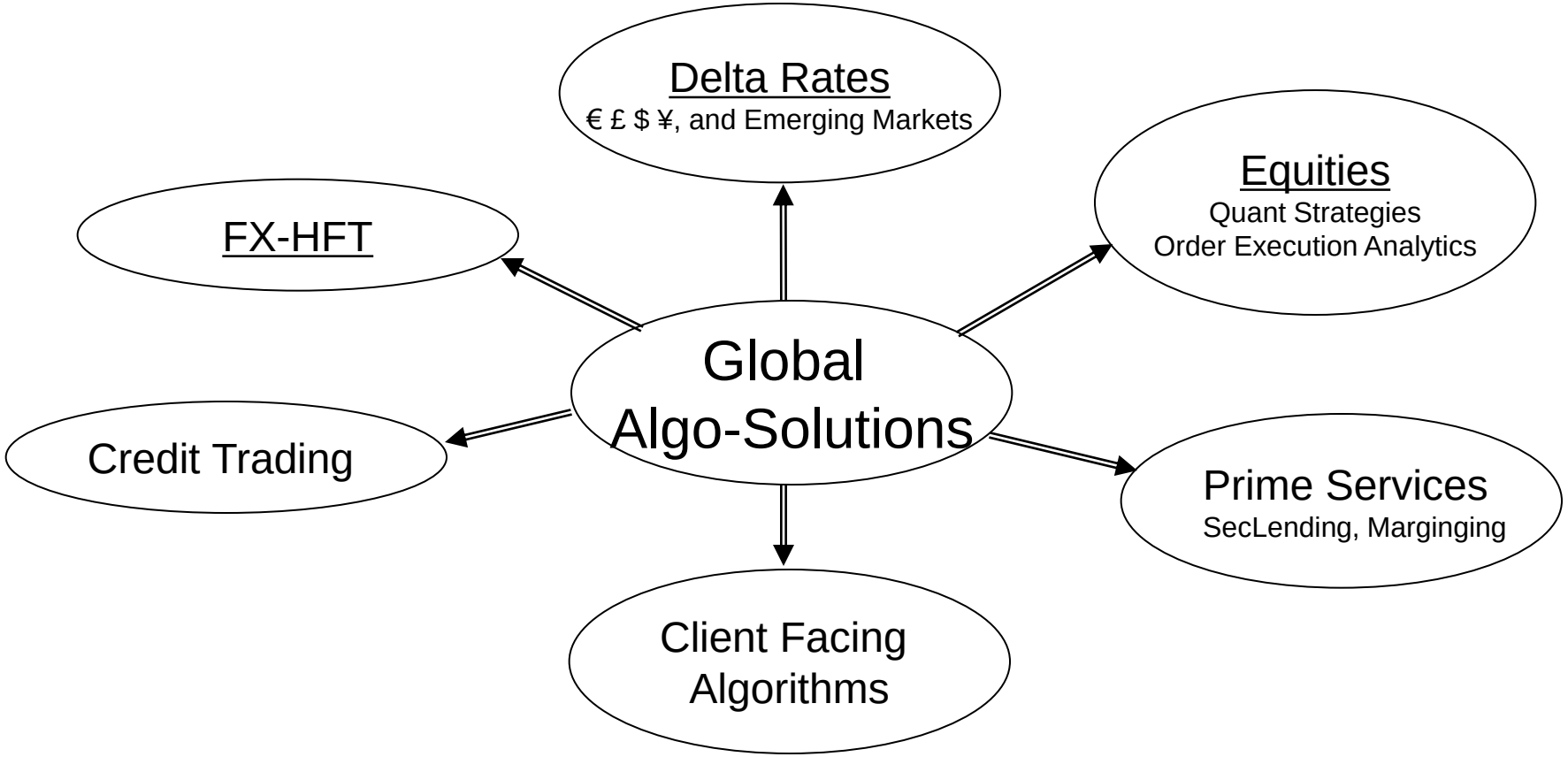

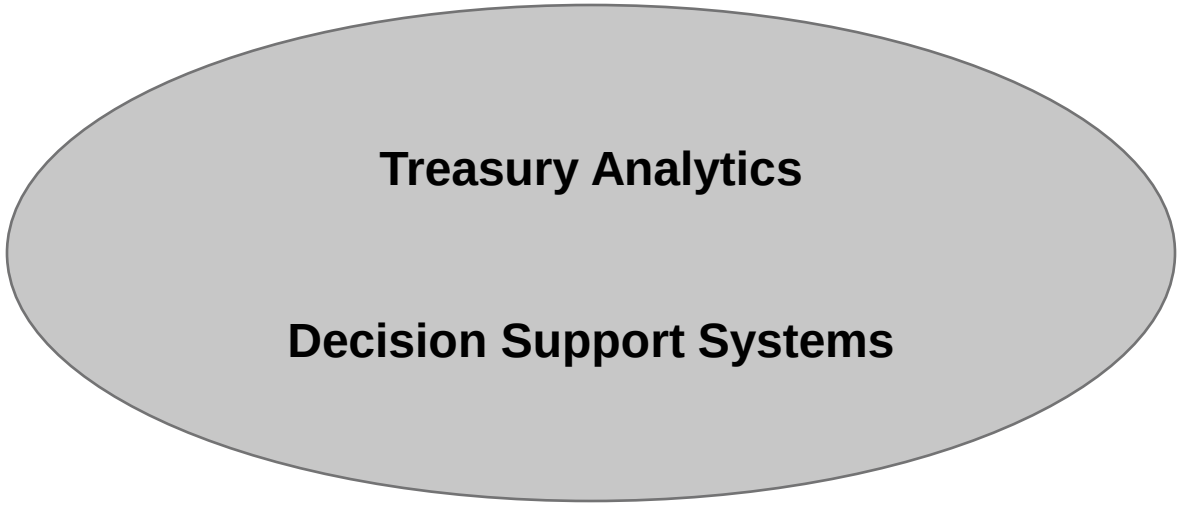
Treasury Analytics
Decision Support Systems

Treasury analytics – Decision Support Systems

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- **Fixed Income asset Valuation of asset class / portfolios**
- **Portfolio optimization**
- **Risk management**

Treasury analytics – Decision Support Systems

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- Treasury Model Curve
  - Back testing done over long history of 10 years to identify fit across maturity segments
  - Identify relative values among off-the-run notes and bonds
  - Develop strategies along the yield curve
  - Need a good curve

- Relative Value Models
  - For security selection (Treasury Model, STRIPS Model, T-Bill Model)
  - Identify rich and cheap issues in any sector
  - Compute a theoretical value for a security and compare market to theoretical
  - Theoretical obtained by valuing each cash flow with Model spot rate curve
  - Model spread = Market – Theoretical
  - Buy at high spreads. Sell at low spreads

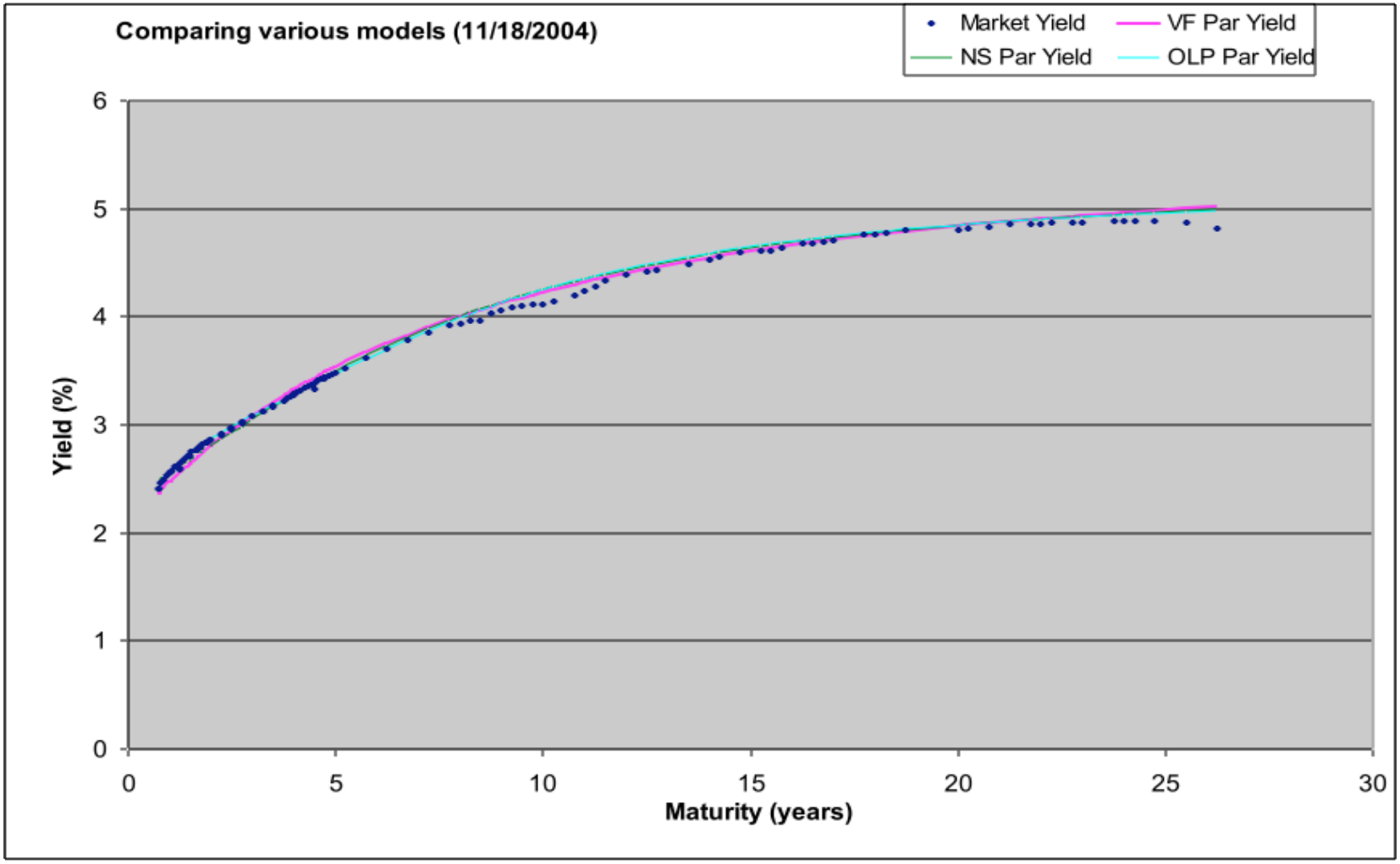
YTM

$$P = \frac{C}{(1+y)^{t_1}} + \frac{C}{(1+y)^{t_2}} + \ldots + \frac{C+S_n}{(1+y)^{t_n}} \qquad (1a)$$

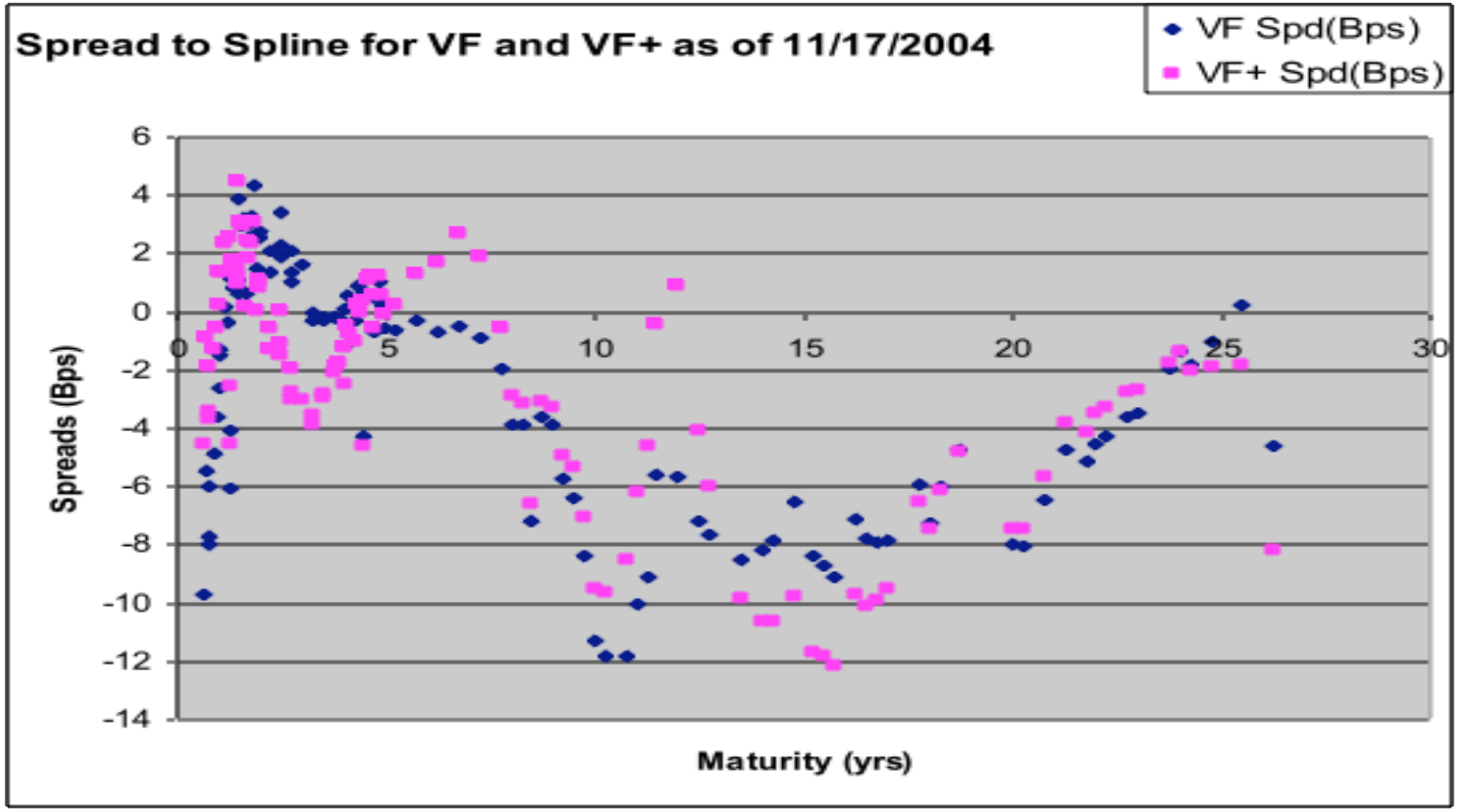
ZCYC

$$P = \frac{C}{(1+(r_{t_1}/v))^{(vt_1)}} + \frac{C}{(1+(r_{t_2}/v))^{vt_2}} + \ldots + \frac{C+S_n}{(1+(r_{t_n}/v))^{vt_n}} \qquad (1b)$$

Yield Curve


Comparing various models (11/18/2004)
Market Yield
VF Par Yield
NS Par Yield
OLP Par Yield
Yield (%)
0
1
2
3
4
5
6
0
5
10
15
20
25
30
Maturity (years)

Yield Curve Analytics



- Horizon Return Analysis
  - Horizon Returns are projected total returns over a three- or six month horizon. Sometimes called Rolling Yield
  - Yield Curve does not change over the horizon
  - Horizon prices are computed assuming that securities "roll-down" the Treasury model curve over the horizon
  - The return captures the combined effects of yield, duration and curve slope
  - The benefit of buying an issue on the steep part of the yield curve and rolling down the curve is explicitly accounted for
  - Because our methodology used to estimate the model curve retains as much of the shape of the yield curve as possible, we get more accurate estimates of roll-down
  - Aging of current issues and special financing is accounted for
  - Value of convexity can also be considered
  - Horizon return = yield return + roll down return + convexity bias

    = yield * holding period in years – duration * roll down in yield + 0.5 * convexity * $(vol)^2$

Treasury analytics – Decision Support Systems

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- Principal Components Analysis
  - Portfolio Risk management
  - Curve Neutral Portfolio Positioning
  - Curve Bets
  - Yield Curve Scenario analysis
  - Return attribution

- Butterfly Model
  - Take on market direction or slope exposure within a cash and /or duration constraint eg. Buy barbells and sell bullets when flattening is expected
  - Enter into curvature (relative value) trades e.g. identifying sectors cheap / rich compared to history; buy a cheap sector, sell two rich sectors around it; expect center to richen to wings
  - Alternate Butterfly strategies
    - Cash Neutral and Duration Neutral Weighting
    - 50-50 Weighting
    - Volatility Weighting
    - Beta – Weighting (Regression)
    - PCA Weighting

Illustration of Interest Rate Swap Analytics

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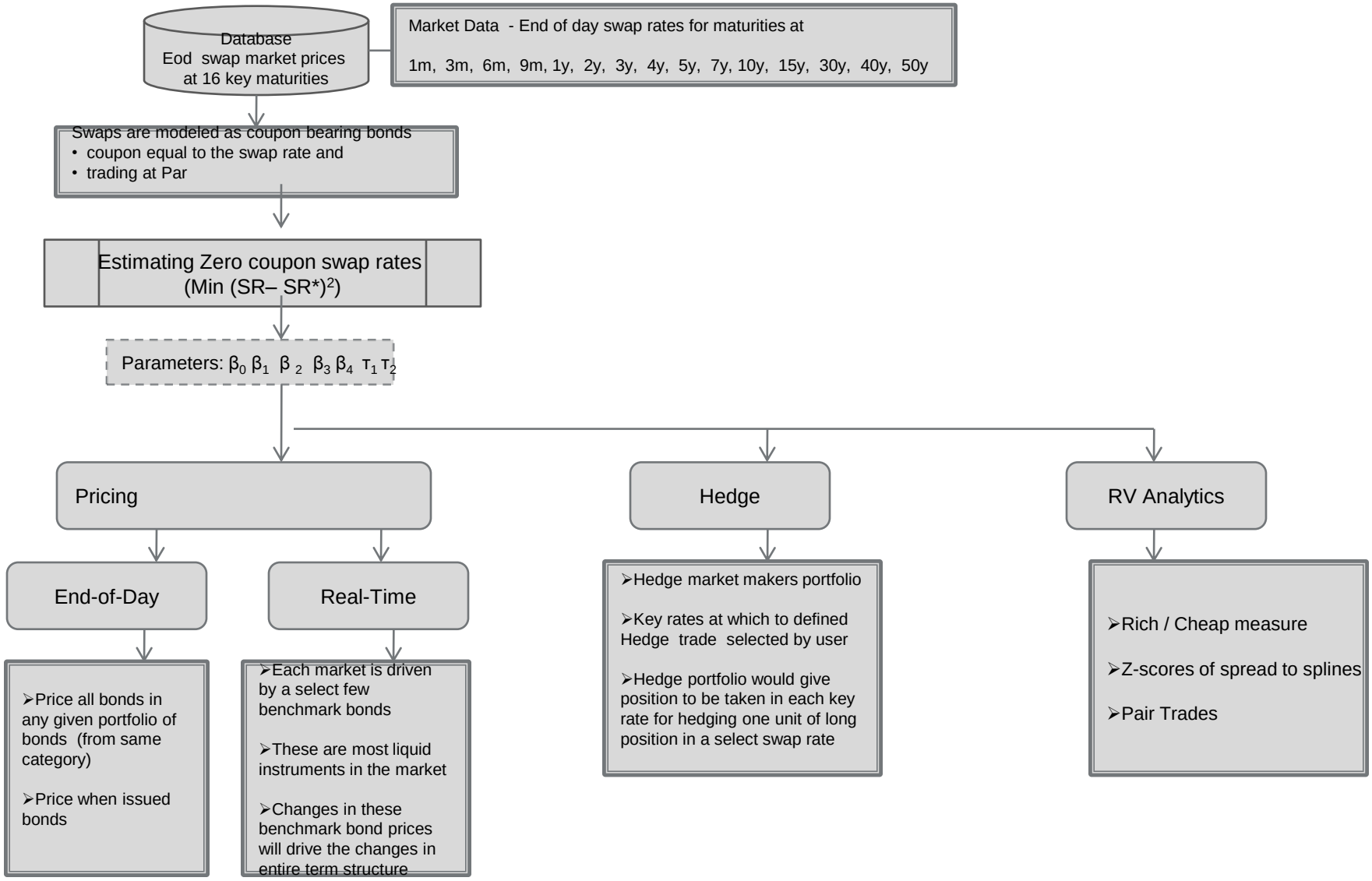
System Flow Chart: Multi-factor Bond/Swap-Curve model for Pricing , Hedging and RV Trades



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Portfolio Optimization

- Creating a Portfolio
  - Ex-ante : identify the behavior of the underlying reference index
  - Create portfolio : define the objective function and constraints for optimization
    - Duration matching portfolio
    - Target Risk / Return portfolio
    - Incorporate Views of Traders to build portfolio (Black Litterman Framework)
    - HEDGE – Replicating Portfolio, which replicates characteristics of original portfolio with another set of benchmark instruments
  - Ex-post : analyse the portfolio for robust characteristics like given returns , minimal draw-downs, high Sharpe ratios

- Applications of the Replicating Portfolio
  - Dynamic Rebalancing / Hedge
  - Track the returns of underlying index without holding the index
  - Create instruments that can provide returns / hedge against movement of multiple risk factors (eg. Inflation index)
  - Risk management : Replicating portfolio forms proxy for actual liability portfolios in calculating various enterprise risk measures, such as VaR, Tracking error or Expected Shortfall
  - Sensitivity Analysis : The replicating portfolio has the same characteristics as the original portfolio. Hence the various sensitivities (greeks) can be easily estimated on a higher frequency
  - Economic Capital calculation
  - Benchmarking Investment Manager Performance

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Risk Management

- Treasury Risk Analytics
  - Value at Risk Modeling using variance-covariance, parametric, non-parametric and stochastic volatility methods
  - Risk Attribution by risk factors, product, portfolio and currency
  - Counter party risk
  - Evaluating Potential Future Exposure
  - Compliance with various regulations such as Basel, Dodd-Frank act
  - Sensitivity analyses of foreign exchange instruments, Interest Rates, basis spreads to address quantitative disclosures, trading risks, liquidity and collateral requirements

- Treasury Credit Risk Analytics
  - Monitory and control credit risk
  - '**What If**' analysis of potential trades, sensitivity and close out risk analysis
  - Development of risk reduction trading and clearing strategies
  - Design appropriate stress tests and scenarios that will highlight key risks
  - Counterparty Credit Risk
  - Exposure Management for derivatives portfolio
  - Exposure Aggregation and grading as per Internal Rating Model for the Counterparty
  - Building Internal Rating Model and modeling CVA and Potential Future Exposure

Treasury analytics – Decision Support Systems

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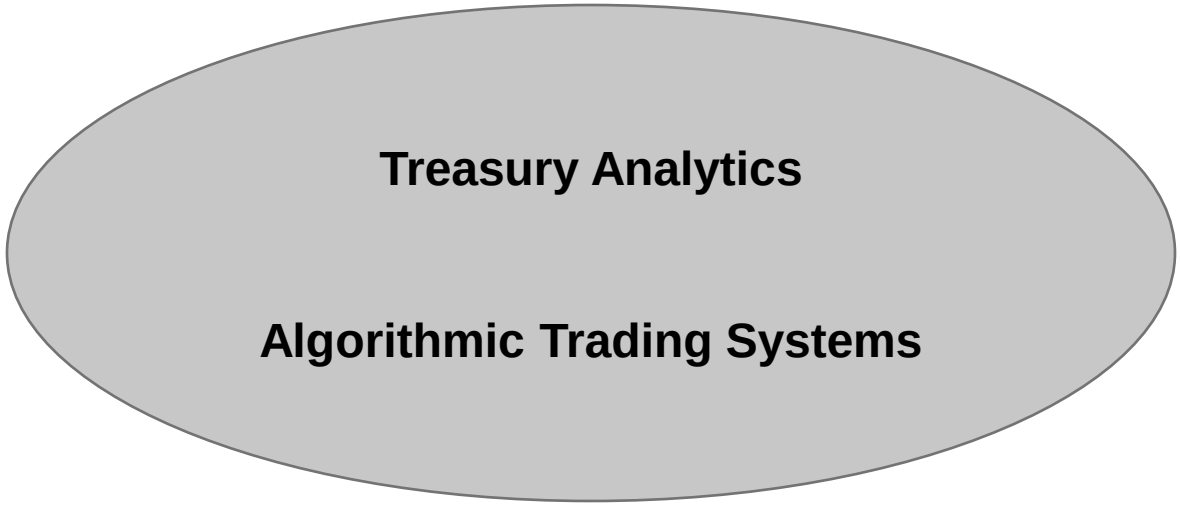
Risk Management

- Risk and Compliance
  - Derivative exposure regulatory reporting during quarter ends - FIN 39, credit value adjustments (CVA) , fair value disclosures for derivatives and off balance Sheet risk instruments
  - Prospective and retrospective hedge effectiveness testing
  - Enterprise wise policy limit reporting of the derivative position limits, Investment/Reverse Repo Limits and intercompany exposures
  - Process documentation with process maps, standard operating procedures (SOP), and data dictionary

- Model Validation
  - Model Validation scope definition and delineation
  - Qualitative Validation and Qualitative Validations
  - Testing, Sensitivity Analysis and Stress Testing


Treasury Analytics
Algorithmic Trading Systems

Algorithmic Trading Systems

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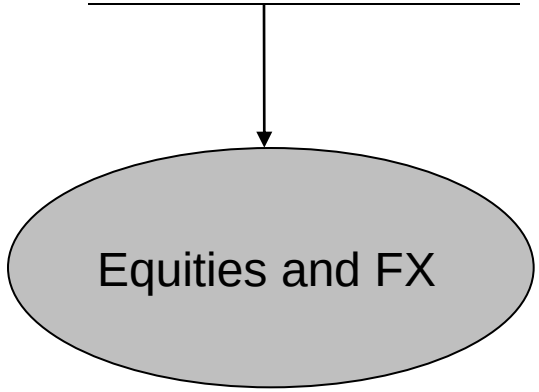
- Algorithmic trading is any type of computer-assisted mathematical / statistical model based trading activity which handles the timing, submission and management of trades and orders.

- Encompasses ‘model-based trading’, ‘program trading’, ‘auto trading’, ‘black box trading’ and ‘high-frequency trading’, across single or multiple pools of liquidity.



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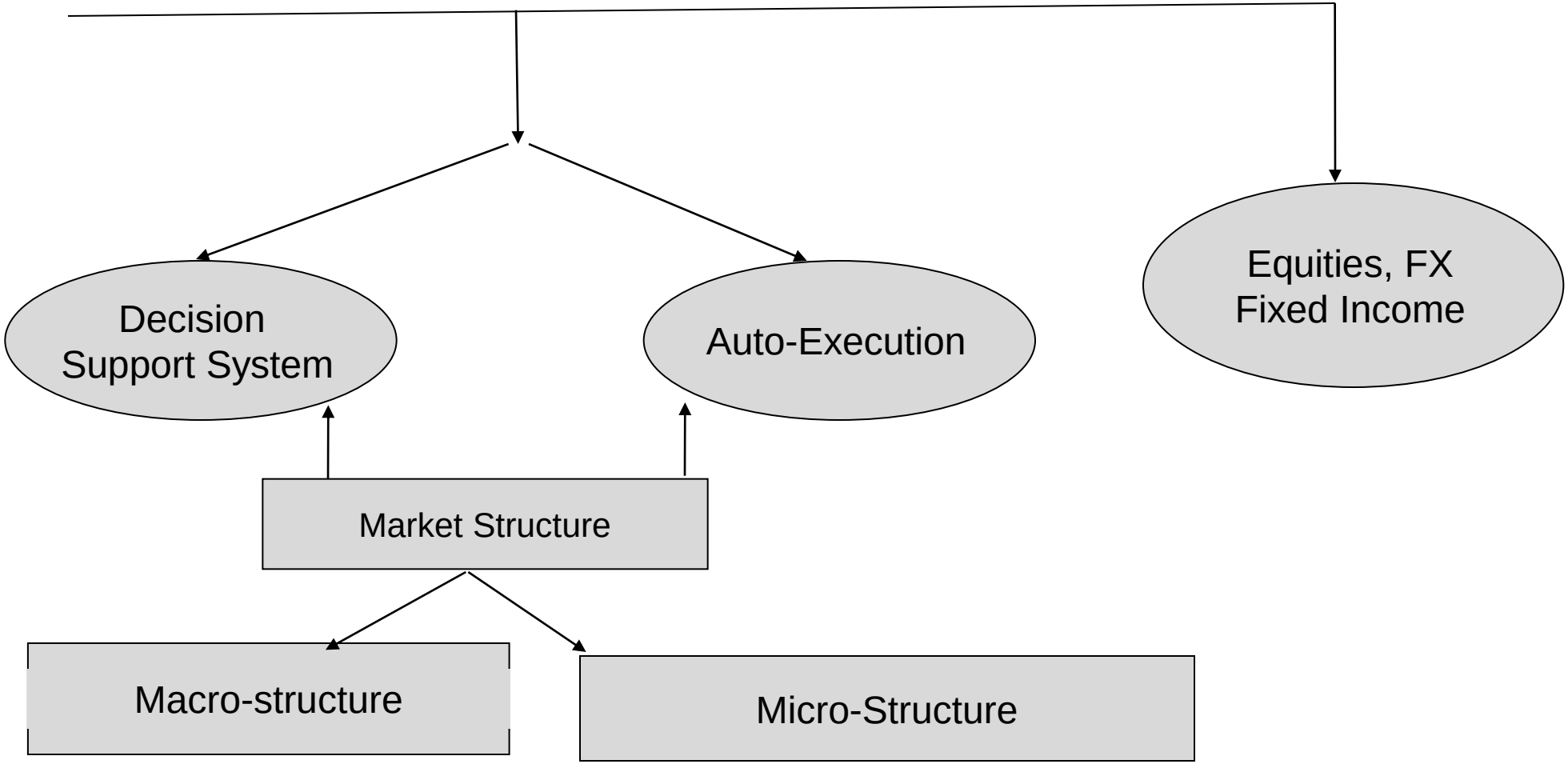
- More generally, Algorithmic Trading could be defined as any automated routine that processes incoming market data and provokes trading activity.



Algorithmic Solutions - Summarizing

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- Increasing Electronic Trading and post-crisis Regulatory pressure on "transparency" => changes in the microstructure of FI / FX markets towards an "Equities-like" structure => facilitating and highlighting the need for Algorithmic Strategies

- Increasing sophistication of Clients' (Multi-Asset and High-Frequency) Trading Strategies => increased demand for Algorithmic Solutions for => Dynamic Pricing, Hedging and Real-time Risk Management.

- Globalizing (across Regions and Product areas) Algorithmic Development efforts => Synergy, Business Continuity, and Scalability of Quant, Data and IT infrastructure

- Increased demand for Client-Focussed Algorithmic Solutions => Algorithmic Spreading, Client Quality and Interactive Analytics