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Alternative Execution

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The New World of Equity Trading and Modelling

Alpha generation models

Alpha Generation

- **Investment**
  - **Fundamental**
  - **Macroeconomic**
  - **Statistical**
- **Trading**
  - **Pairs Trading**
  - **Statistical Arbitrage**

Risk Analysis & Control models

Risk Analysis

- **Investment Risk**
  Quant Models
  - VAR
  - Optimization
  - Implied Alpha
  - Long/Short
- **Client Reporting**
  Risk and Performance Attribution
  - Transparency
  - Simplicity
  - Absolute Returns
- **Trading and Modeling Risk**
  Pre & Post Trade Analytics
  - P&L Stop Loss
  - Sensitivity limits
  - Impact and delay costs

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Quantitative Models

- Quantitative Strategy – Equity Research – (Mid 1980s –Now)
  - A series of models have been developed from Quant Strategy teams focusing into:
    - Stock Screening Models
    - Pairs Trading
    - Industry/Sector Rotation models
    - Alpha generation strategies

- Portfolio Trading Strategies – Equities (Late 1990's – now)
  - These teams are focusing on customizable risk analysis, portfolio construction and pre/post trade analytics. Products include:
    - Optimization solutions
    - Marginal Contribution to Risk
    - Long/ Short portfolio portfolio construction and risk analysis
    - VAR
  - Most applications provided can be used as engines that host customer created inputs (e.g. covariance matrices)
  - Solutions can be customized for intra day problems as well as specified types of models.

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Historical Overview (I)

- 1960- late 1980s

A lot of pioneering research on:

- fundamental analysis,
- macroeconomic models
- risk models (Markowitz-CAPM-GARCH)

The foundations of Financial Engineering were developed

- Early 1990's
  - Advances in computational technology and databases helped improve the models and run accurate back tests. Non-linear models were hugely explored.

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Historical Overview (II)

- Late 1990's
  - Innovative fundamental models (CART)
  - Advanced risk models.
  - More improvements in technology.
  - Who cares…..
- Last 4 years
  - Commissions are down.
  - Alternative Investments and hedge funds are the theme of the day.
  - New ways are needed to make money.
  - Real time models and short term analysis on the rise.
  - Hybrids/Structured products

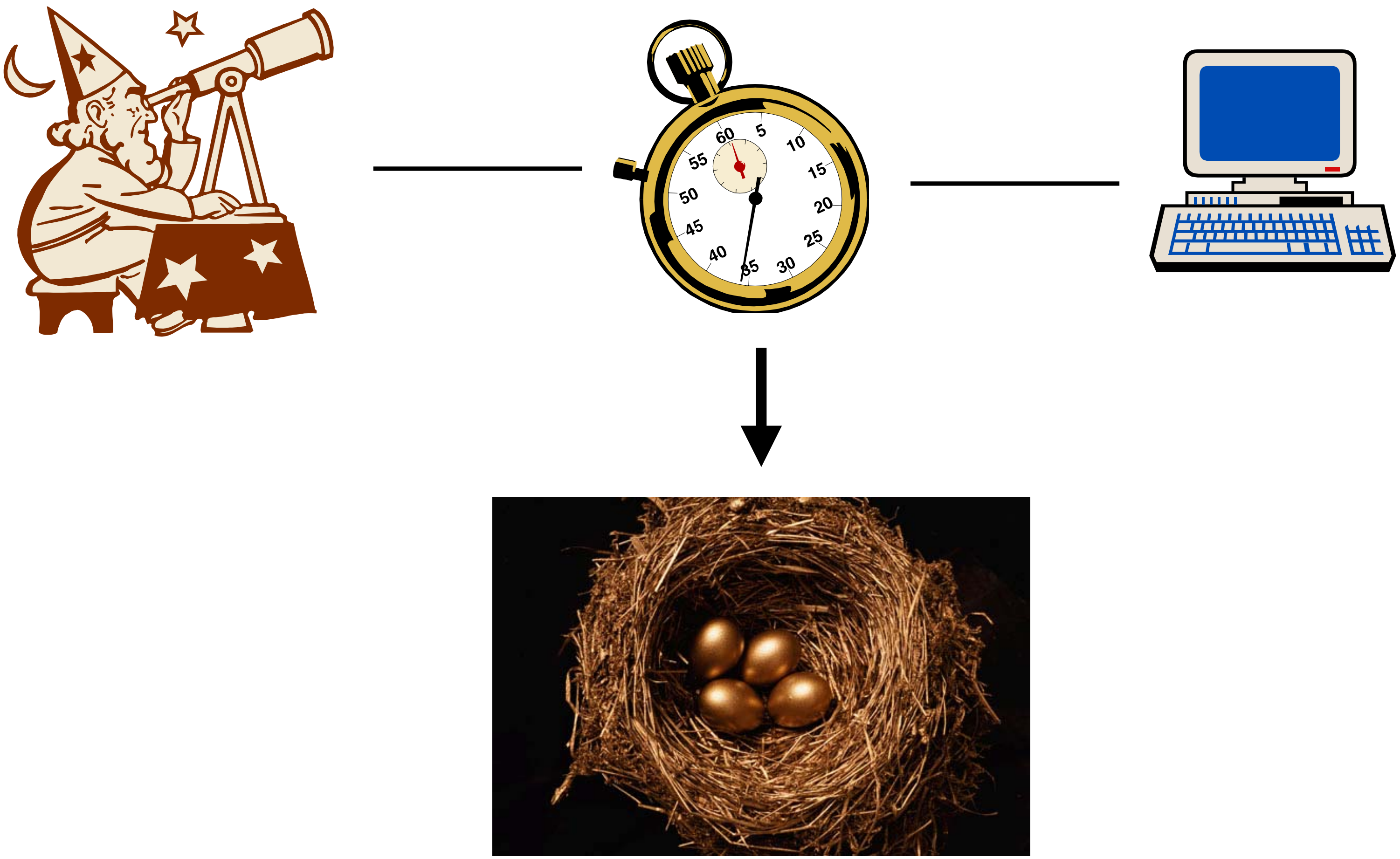
Elements of Good Models

- Quantitative Accuracy
  - Real life assumptions
  - Uncertainty considered
  - Accurate back tests

- Perception of Reliability
  - Sophisticated Investors test against internal data
  - The industry needs convincing and reliable models
  - No time and expense for theoretical models

- Analytical Simplicity
  - Simple Models
  - Transparent
  - Multi-assets
  - Derivatives

New World….



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So what is the industry focusing on?

Alpha generation and Statistical arbitrage models

Good technical infrastructure

"Smart Servers"

State of the art risk management tools

What is an Algorithmic trading “Smart” Server?

“A Smart Server is an intelligent trading destination that auto-executes trades according to a pre-defined trading strategy”

Equity Trading Solutions

Execution

Not Outsourced

- Direct Market Access (DMA)
    - No broker intervention
    - Lowest Commission
- Direct Strategy Access (DSA)
    - No broker intervention
    - Low Commission but above DMA

- Portfolio Trading
    - Limited Broker Service
    - Low commission
- Cash Trading
    - Full broker Service
    - Highest Commission

Execution

Fully Outsourced

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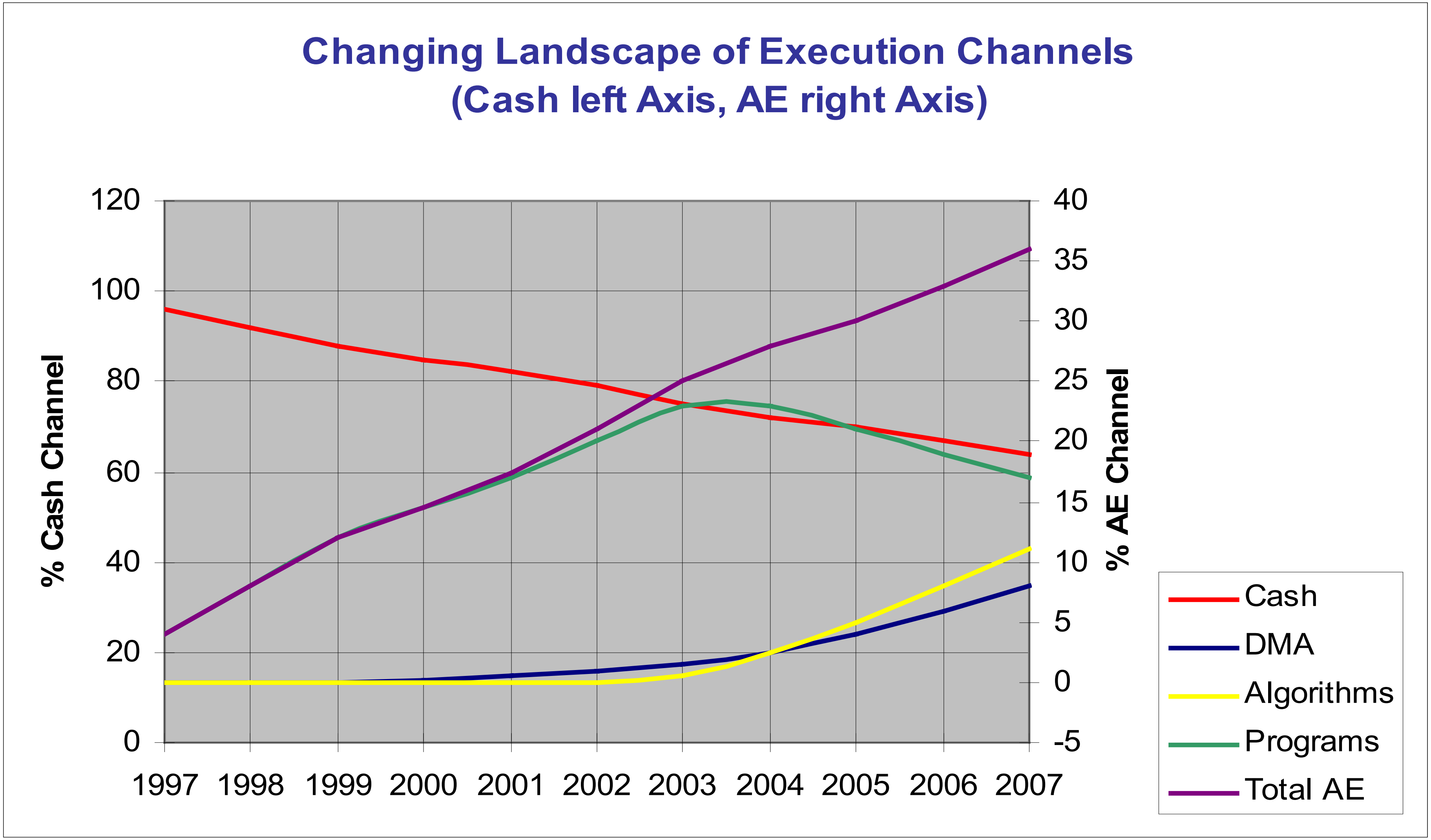
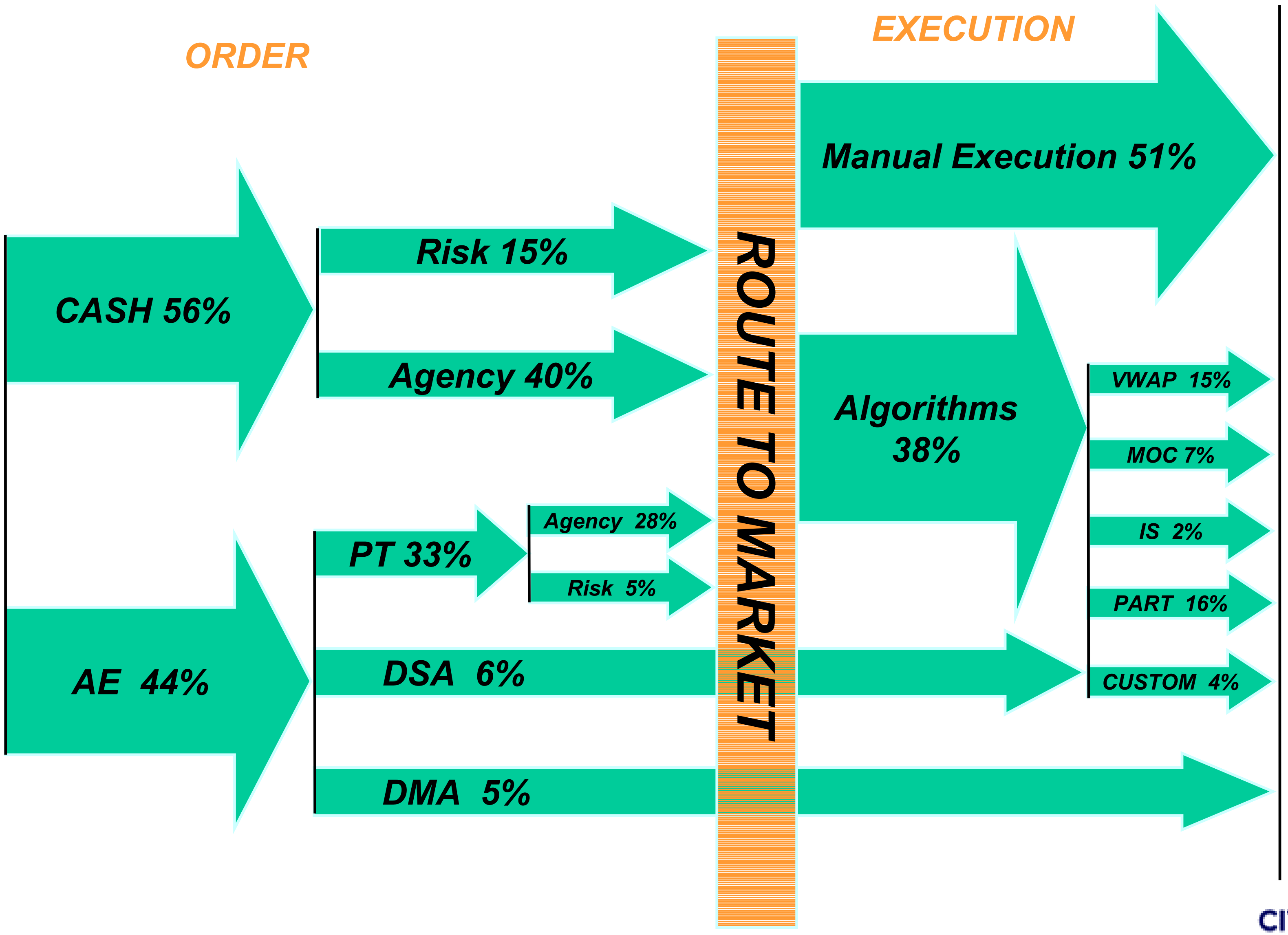
Execution Landscape is changing



Distribution of Citigroup European Flow



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Alternative Execution Products

Long Established

- Portfolio Trading
    - Agency
    - Risk (Capital Commitment)
- Strategies
    - Global Portfolio Trading Strategies (GPTS)
    - Best Execution Consulting Services (BECS)

More Recently Developed

- Algorithmic Trading
    - Internal
    - Direct Server Access (DSA)
- Direct Market Access

Where can Algorithmic Trading potentially lead?

Head of Complex Adaptive Systems Research Group at HP, "Rise of the Robots: Increasing market efficiencies By Eliminating Human traders"

Dr. Dave Cliff

"Full Control and ownership of the decision process". Accountability, Discretion, Responsibility.

Ideal Toolkit

- Customizable trading strategies based on price and volume patterns
- Market participation (e.g. VWAP)
- % Follow
- Portfolio based implementation shortfall
- Optimal Trade scheduling
- Pairs trading
- Smart Reloading (Smart Iceberg)
- Auction Management
- P&L stop loss
- Sensitivity limits
- Optionality (“Greeks”)
- State of the art optimization (Min-Max)

- Customizable functions
- Volume
- Price
- Aggression

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What does a Smart Server utilize for incremental Performance

- Bid-Ask Spread
- Volatility risk
- Volume Depth
- Temporary Abnormalities in the market

Bid / Offer Spreads

Bid / offer spreads vary widely by country .....

Country	Spread (bp)
UK	42
Germany	24
Portugal	44

Bid / Offer Spreads

... and by size

	UK	France	Japan
> $10bn	30	20	26
$5bn - 10bn	76	26	28
$2.5bn - 5bn	62	32	36
$1bn– 2.5bn	90	60	42
< $1bn	298	82	52

Source: CGM - Spreads in Basis Points

The Market

- 4 top asset managers that use Algorithms in Europe
  - Average of $50bn each in 2003, 41% Smart
- Top 4 Brokers on Algorithms:
  - In excess of $880bn in 2003 in Europe

Algorithmic Trading Historic Milestones

’90’s	->	Rapid Portfolio Trading growth
’90’s	->	Electronic Exchange connectivity simplified
		Requirement to handle multiple orders efficiently.
’97	->	Brokers build internal algorithmic teams, all PT flows through group.
’00 +	->	Execution tools are provided for Asset Management firms
’00 +	->	Increased awareness, centralised dealing desks looking for suite of tools
’03	->	Brokers aggressively market algorithmic products
’05	->	Brokers might consider opening up internal tools to asset managers (CSFB,Lehman, ML, UBS, Citigroup)

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What is driving the use of DMA & DSA?

- Lower Commission Cost
- Anonymity
- Speed (DMA)
- Performance (DSA)
- Legislation (e.g. MiFid)
- Development of centralised dealing desks
- Increased number of Hedge Funds
- Sophistication of Order Management Systems (OMS)

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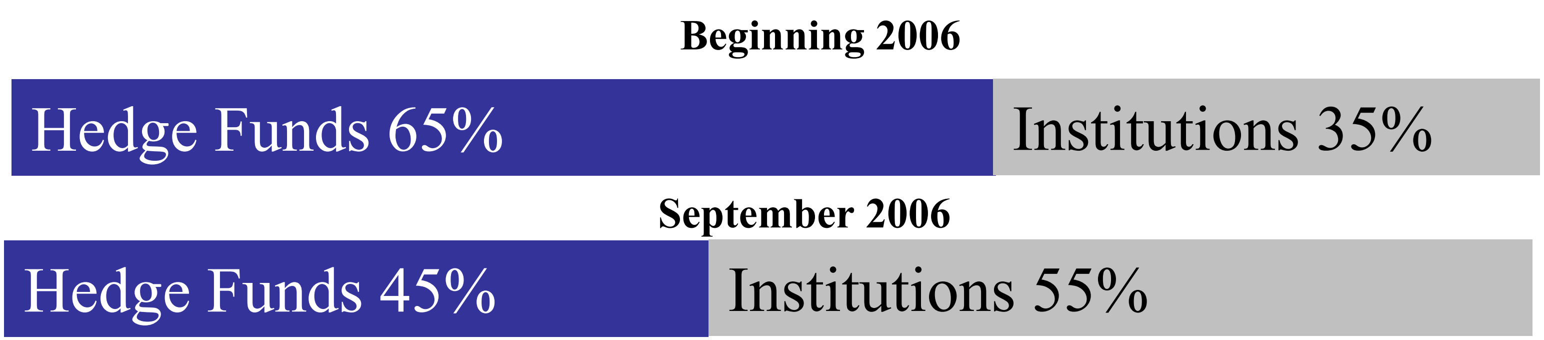
Why DMA & DSA did not pick as quickly in Europe as in the US?

- The use of DMA & DSA demands an increased level of resources from the buy desk (more traders and better technology)
- Limited experience and comfort from the buy side trader
- OMS deployment and utilisation has not been as quick as in the US
- Price of risk trading
- In some houses Portfolio Managers are still responsible for execution with no time to focus on DMA and DSA

What is the client base for DMA/DSA?

- Traditional Asset Management institutions
- Hedge Funds
- Private Bank and Equity Firms
- Other Brokers



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DMA and DSA offering

Both DSA and DMA

- We have been slow to enter this space but we are now offering a solid and competitive platform in Europe that supports a whole range of order types with several innovative characteristics.
- Designed and tested rigorously to ensure stability. Client feedback suggests the offering is excellent in terms of speed, performance and latency.
- We are continuously expanding the number of vendor partners

DSA

- We provide fully transparent systems and models. “Glass box” offering rather than “black box” solution.
- Designed to deliver flexibility to the user through configurable constraints
- Combined with state-of-the-art Pre and Post Trade systems (BECS)
- We use our traders to educate our clients

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Is Algorithmic Trading and DSA new?

- Algorithmic Trading is not new. Initially these systems were developed internally by brokers in an effort to improve the performance and lower the volatility on the quality of execution .

- DSA is a more recent offering. Over the last 3-4 years algorithms and OMS advanced enough that the sell side started to offer direct electronic access to their trading engines.

What are the advantages of DSA?

- Helps deliver better execution by improving performance and reducing volatility
- Enhance the buy-side's control over its orders
- Empower traders to focus on difficult trades that require manual intervention
- Maintain anonymity

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What makes algorithmic trading "smart"?

The design of trading algorithms presents numerous mathematical and financial engineering challenges.

These fall into two main categories

- Subdivision of the "parent" order into smaller "child" orders (trade scheduling)
- Trading tactics deployed to achieve the best price for their children

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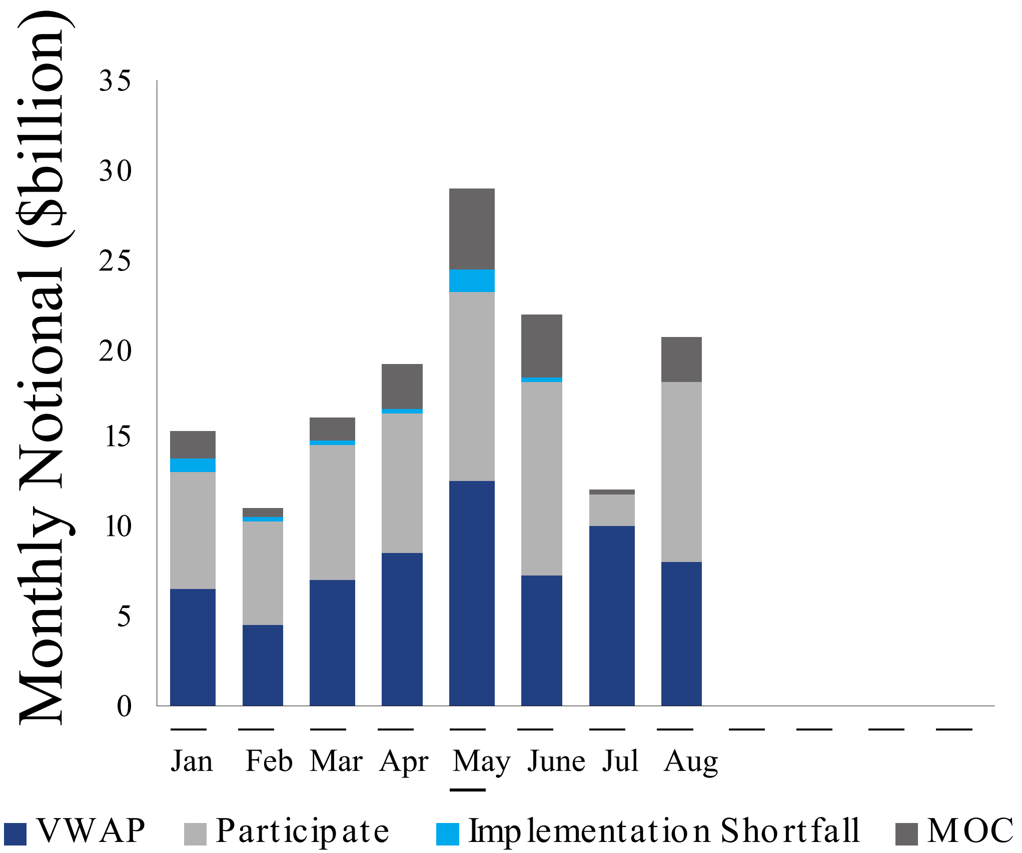
What is the common DSA offering?

Almost 1600 in 17 markets. Global Access now possible

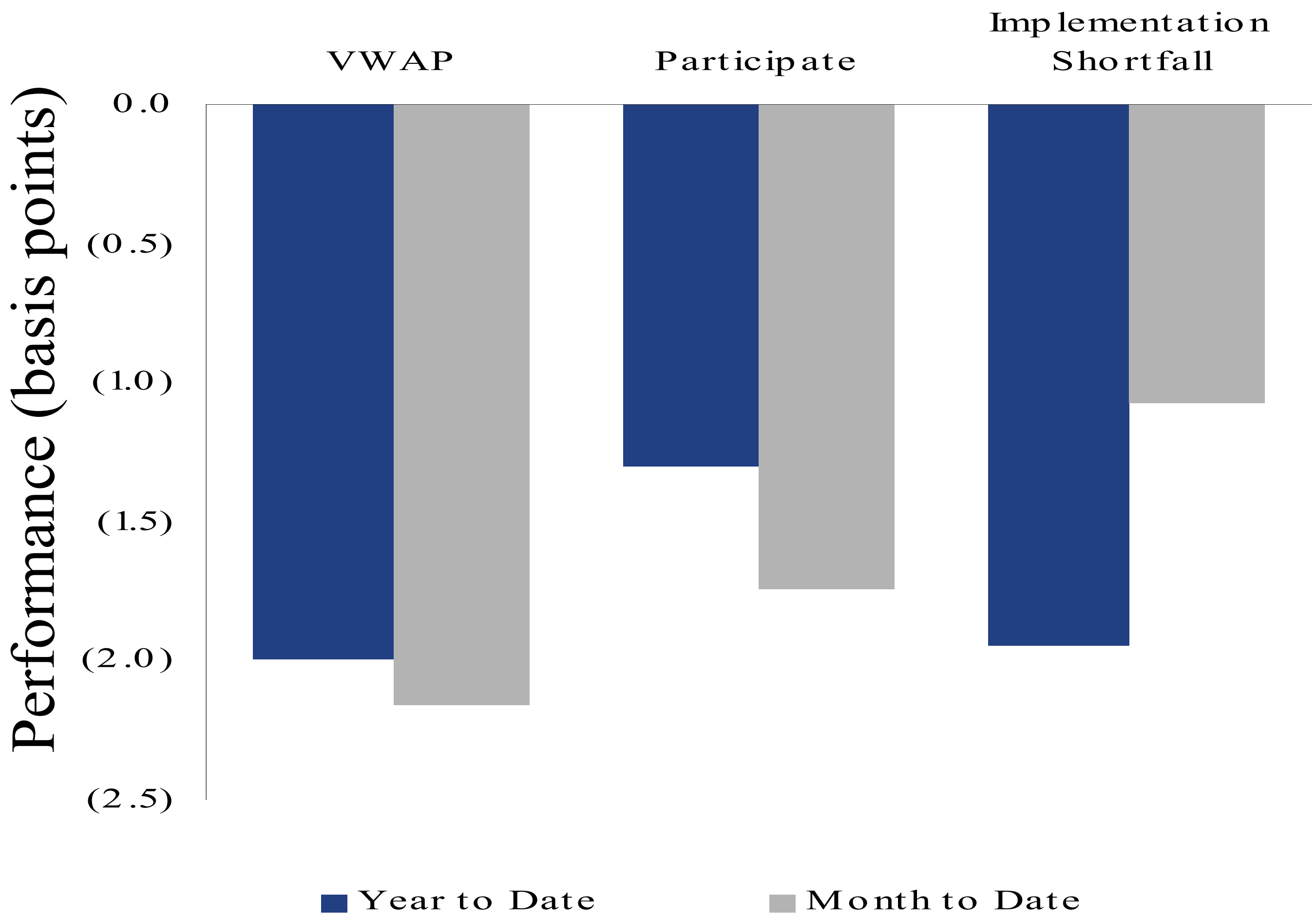
- Models
  - VWAP
  - Participate
  - Market on Close (MOC)
  - TWAP/Smart Slice
  - Implementation Shortfall (IS)

- Current Functionality
  - Start, Stop, Duration
  - Min, Max,% Volume
  - Price Limit Benchmark
  - Sector, Index and Price Limit Tolerances
  - Trading Style

Volumes in 2006 for European Algorithms



Performance of European Algorithms



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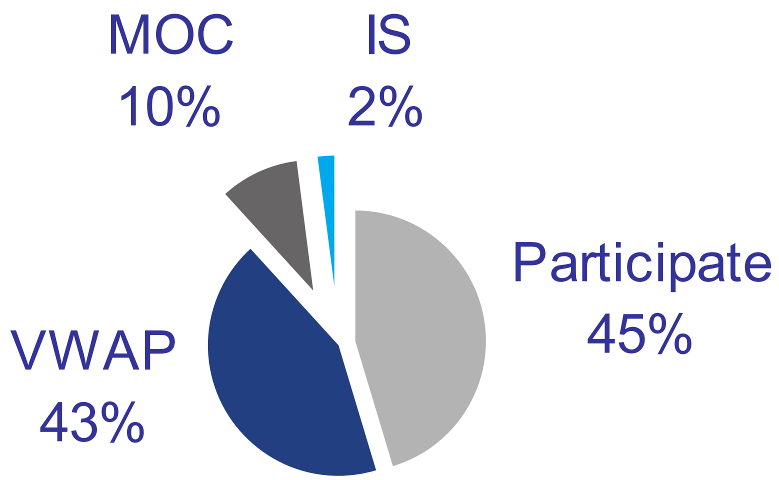
What clients really use?



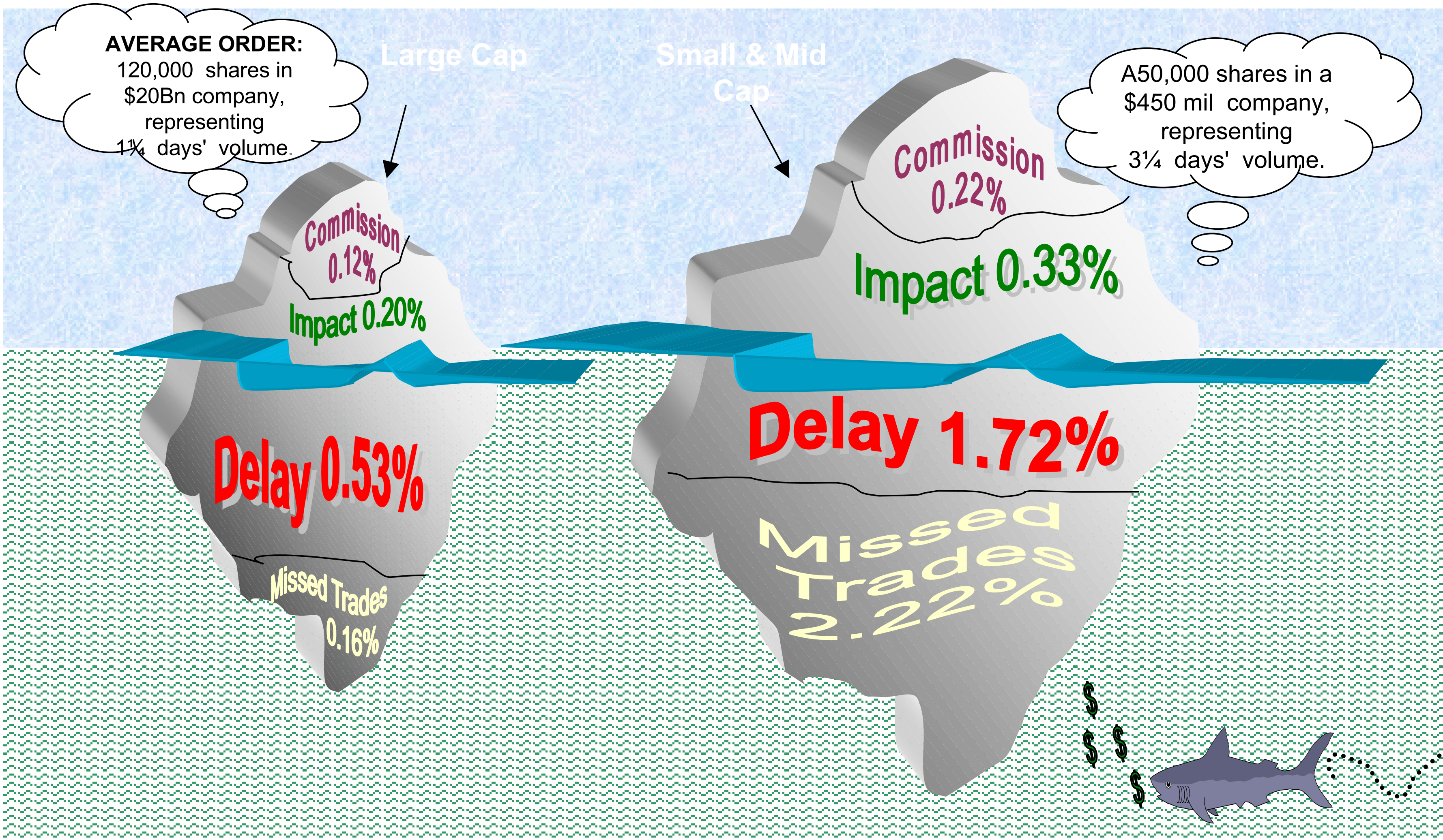
Challenges…

- New Strategies and Products that differentiate as from the competition
- A significant proportion of DMA and Algorithmic Trading business at the competition is generated as an add on to Equity Swap and Prime Brokerage business – our historic lack of capacity in these areas means we have not competed for this type of business
- Some clients expect a bundled front end offering such as Passport (MS), Redi(GS) – we support multi-broker platforms where all our clients can access our products

Other Products

- Portfolio Construction
- Risk Analysis
- Trading Strategies
- Optimization
- Beta Management
- Portable Alpha
- Index Changes
- Structured Products
- Pre and Post Trade Analytics (BECS)

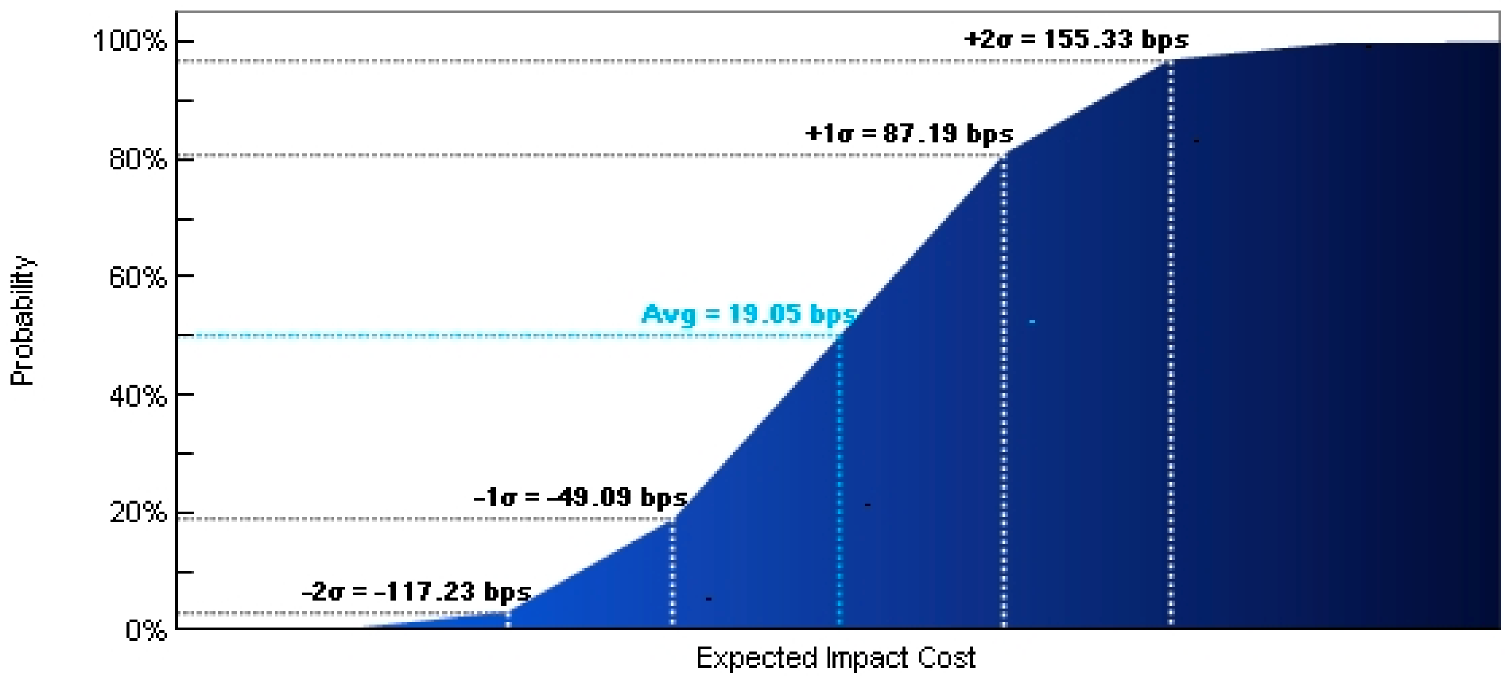
The Plexus "Iceberg" of Transaction Costs



Forecast Trading Impact

Buy 50,000 VOD.L – Expected Impact 19bps

Optimal Time To Fill: 2 Hours 8 Minutes (25% of Day)



Data Confidence: 1 2 3 4 5 6

Source: BECS

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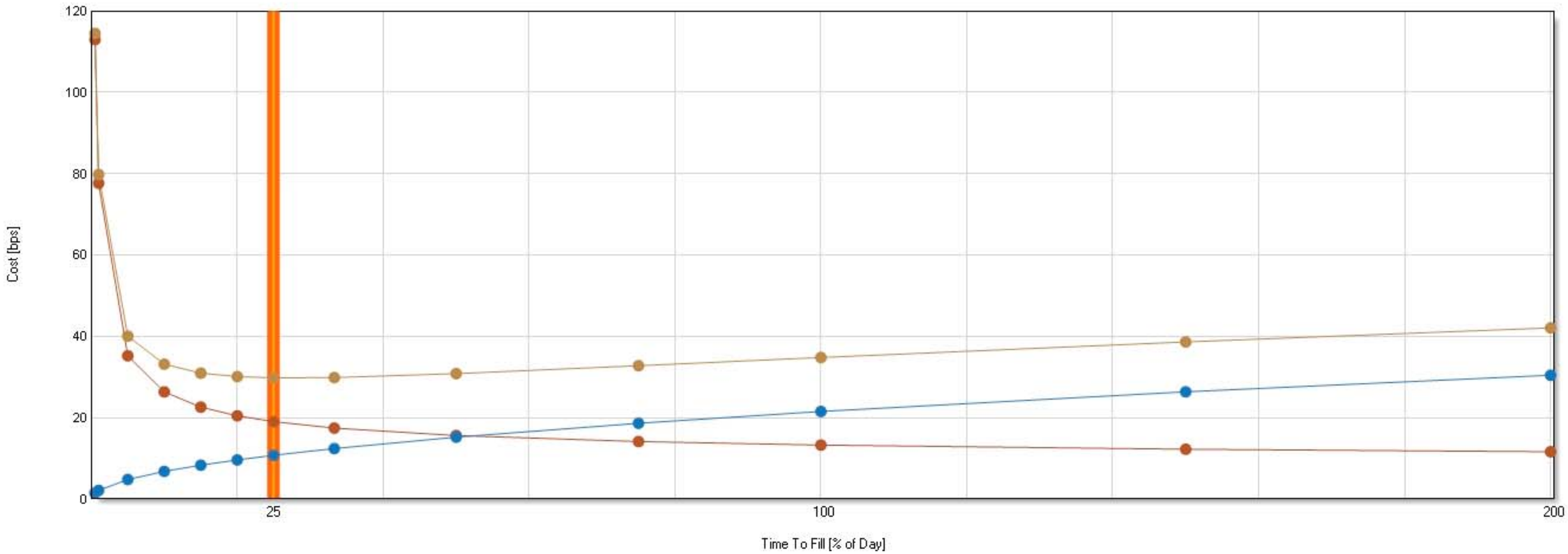
Optimal Execution

Buy 50,000 VOD.L



Expected Impact Cost	**19 [bps]**
Risk Cost	**10 [bps]**
Impact and Risk Cost	**29 [bps]**
Risk Tolerance	**MEDIUM**

Source: BECS

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Conclusions

- Quant models and electronic ways of trading are here to stay
- Portfolio Trading, Algorithmic Trading and Direct Market Access are the way ahead
- Established business are converging towards the same way of execution
- These products are not here to replace traders or "cannibalise" regular cash business but rather to compliment them and support the

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