Price Signatures
"Best Execution and Transaction Cost Analysis"

FXCG meeting

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Disclaimer

This document is intended solely for discussion purposes.

What do these have in common?

- Electronic FX trading

- The temperature in Stockholm

- The physical activity level of angry children

The temperature in Stockholm

Stockholm temperatures by year (1767 – 2016)

Stockholm temperature by 50-year period

- period 1767 - 1816
- period 1817 - 1866
- period 1867 - 1916
- period 1917 - 1966
- period 1967 - 2016

Source: https://bolin.su.se/data/stockholm.
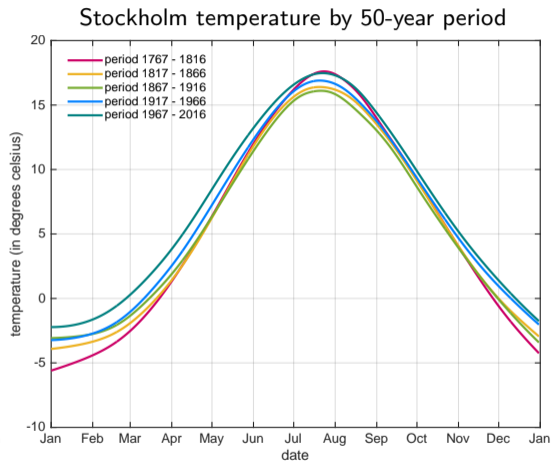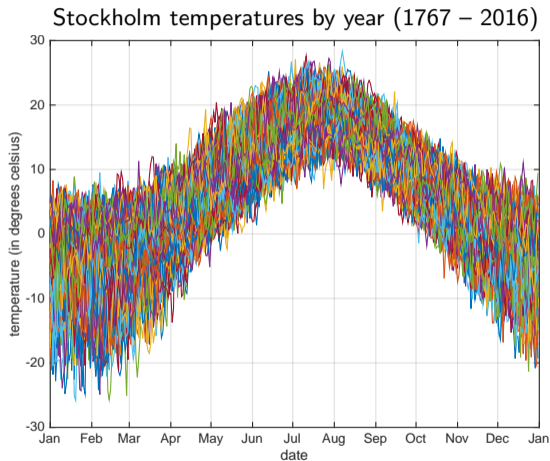
7-year old's physical activity level

Daily activity level of 432 children
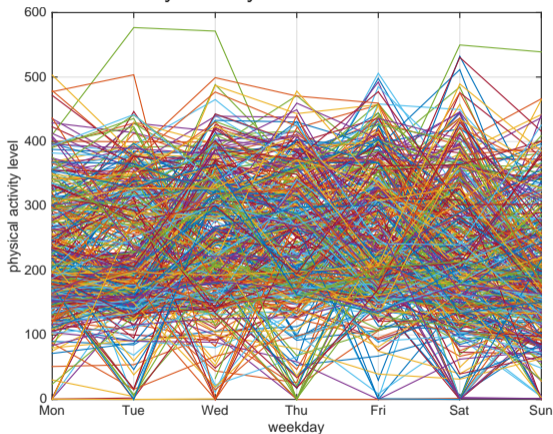
Activity level by emotional state
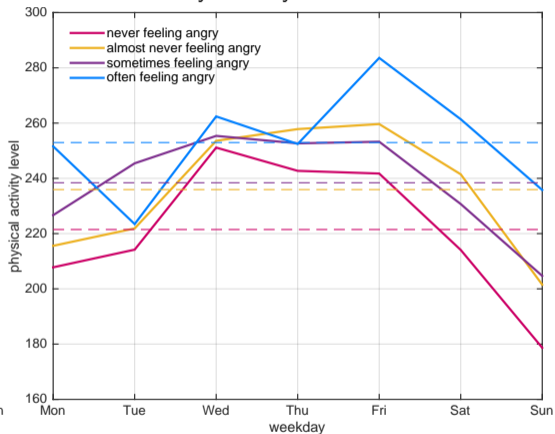
Market impact

30,000 post-deal price paths*
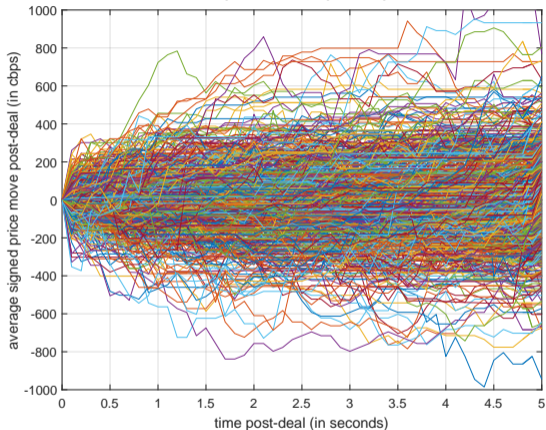
market impact by currency-pair
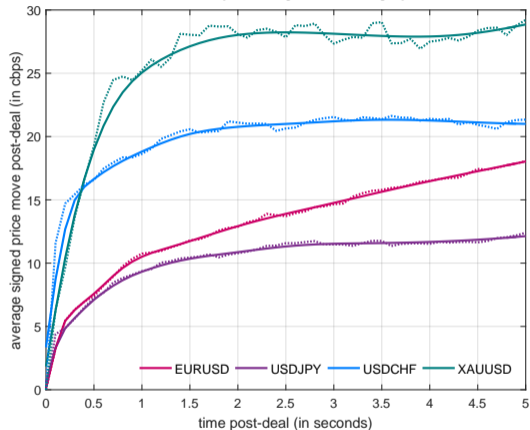
Source: Deutsche Bank.

* Chart draws only a stratified subset of the full sample. Paths are signed for direction of trade.

All these examples can be studied using Functional Data Analysis or FDA

The price signature

Define a price "signature" as:

$$S(\delta) = \frac{1}{q'\iota} \sum_n q_n d_n (P_{t_n+\delta} - P_{t_n}), \qquad \text{for } \delta \in [-\underline{\delta}, \overline{\delta}].$$

It is the *volume weighted (q), trade direction adjusted (d), average price movement, over an interval (δ) centred around the point of trading (t)*.

- it can be calculated over any and multiple subsets for comparison

  . . . by currency pair, by venue, by order size, etc

  . . . by time of the day, by trader / user, etc

- it can be applied more generally

  . . . to quotes, to rejects, to hypothetical backtest trading signals, etc

  . . . to construct volume signatures, spread signatures, liquidity or activity signatures, etc

Signature construction

Signature interpretation

signature interpretation
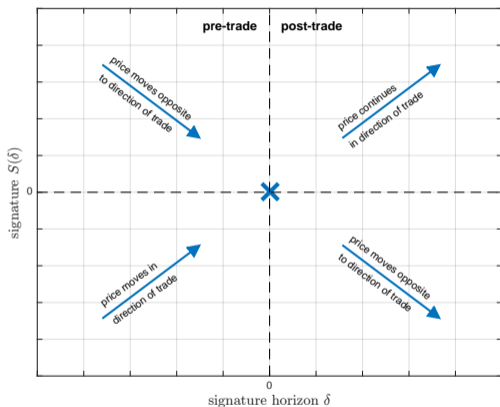
a noise trader's signature
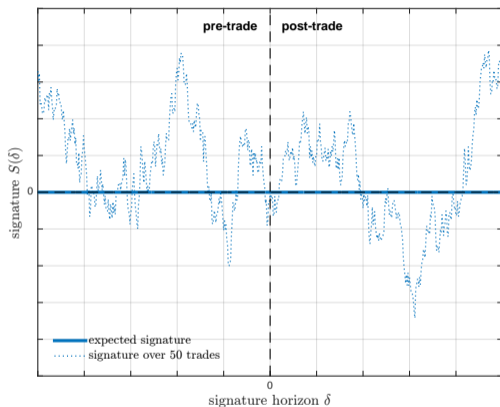
- post-deal ($\delta > 0$), the signature measures the marked-to-market revenues or margin
- pre-deal ($\delta < 0$), the signature measures the opportunity cost of not having traded earlier

Signature examples at macroscopic level
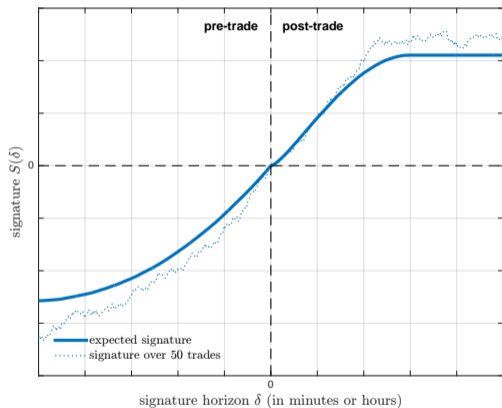
Momentum strategy
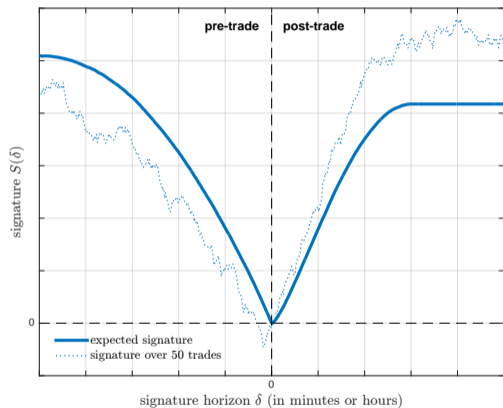
Reversal strategy

Signature examples at macroscopic level
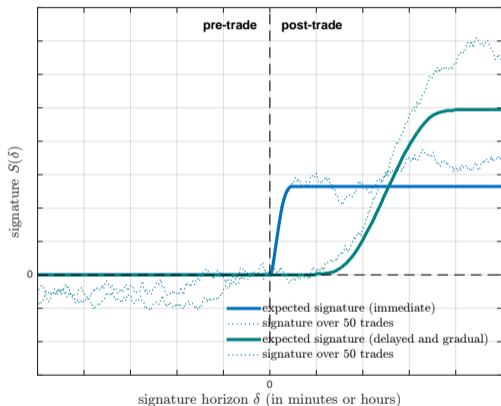
Alpha / impact
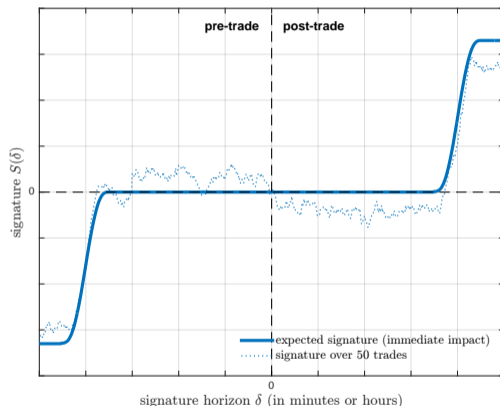
Sequential delayed impact

Signature examples at microscopic level
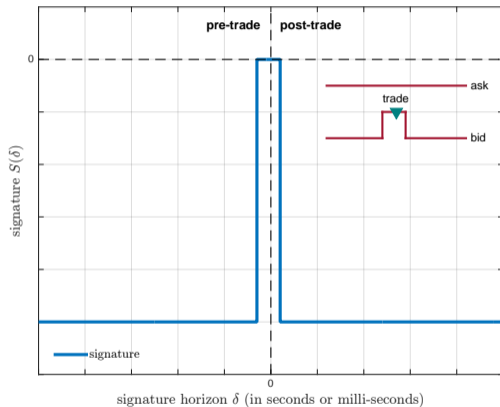
Adverse selection
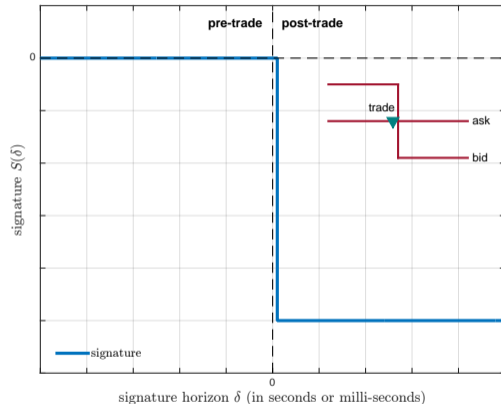
Latency arbitrage / run-over

FDA or functional data analysis

Two key questions are often asked:

1. is a signature statistically different from zero, i.e. $S(\delta) = 0$ or not?

    ... do I have true alpha or was it just a lucky episode?

    ... do I get systematically run over on my passive algo fills?

2. is one signature different from another, i.e. $S_k(\delta) = S_m(\delta)$ or not?

    ... is my momentum signal stronger in USDMXN than in USDZAR?

    ... is the market impact I incur across venues the same?

Different from the "usual" statistics, this involves inference of functions or curves $\rightarrow$ FDA provides the statistical foundations to answer such questions.

Ramsay and Dalzell (1991), Ramsay and Silverman (1997) pioneers of the contemporary literature.

Game theory context

- **Aggregation.** Traders in the FX market routinely place liquidity providers (LPs) in competition for their flow

- **Winner's curse.** Because "true" price is unobserved and the LPs are unaware of competitors' prices, the more LPs in the aggregator, the stronger the adverse selection on deals won

- **Prisoner's dilemma.** Externalising LP creates impact that adversely impacts internalising LP. When mixing them in aggregation process, all LPs may externalise and making everyone worse off.

- **Efficient execution.** Select a moderate number of LPs (say 5, not 50), trade full amount, and *do not mix internalisers and externalisers*.

See Oomen (2017a,b), and Butz and Oomen (2018) for further details.

Signature case studies

Case-study I : Aggregation versus LP exclusivity

A trader executes using an aggregator with multiple LPs but . . .

- trade request rejects complicate the workflow

- addition of LPs has meant spreads are gradually widening out

They are open to a radical change or experiment to improve matters.

DB proposes a "firm" feed and tighter spreads than what the trader receives in aggregate across all LPs, on the basis that they become the trader's exclusive liquidity partner.

. . . trader believes the flow at source is latency sensitive and directional

. . . DB believes the flow is benign at source, but that the aggregator design is the issue

Case-study I : Aggregation versus LP exclusivity

post-deal micro signatures
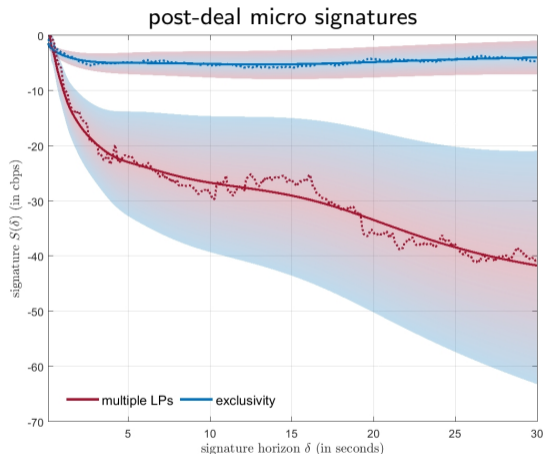
- Trader tries out exclusivity arrangement for one main currency pair

- It appears to radically lower post-deal impact
  (i.e. aggregator design explains the difference)

- But is it significant?

- FDA + resampling → yes, it is highly significant!

Epilogue

Trader adopts the exclusive feed
(with backup LP for resilience)

- ✓ improved trader experience
    - ... response time ↓
    - ... rejects ×
    - ... spreads ↓
    - ... costs ↓
    - ... workflow simplification ↑

- ✓ improved LP experience
    - ... volume ↑
    - ... winner's curse ×
    - ... prisoner's dilemma ×

	aggregator	exclusivity
Trader's execution setup		
# LPs	> 5	**1**
externalisers	probably	no
stack sweep	yes	N/A
DB liquidity configuration		
nominal spread	1.2	0.3
response time	100ms	1ms
reject rate	≈ 10%	0.0%
Trader's transaction costs		
observed spread	0.5	0.3
effective spread	> 0.5	0.3

Note: figures are for illustrative purposes only.

Case-study II : Consistency of LP risk management style

A trader executes using an aggregator with 7 LPs but is unsure it's working well.

- mixed experience on selected execution (impact, reject rates)

- regularly speaks with LPs' sales representatives about the liquidity offering, but can't quite identify (whether there is) an issue

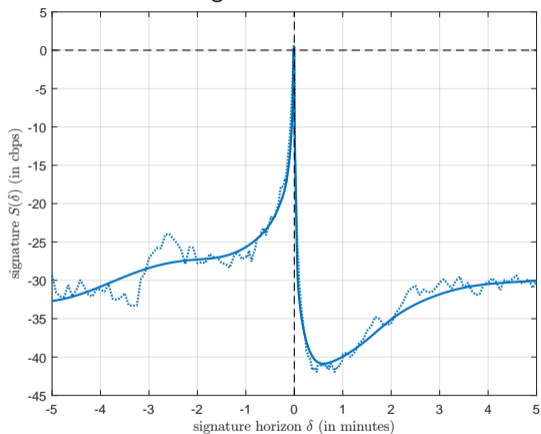A quantitative data-driven analysis is conducted using an anonymised trade set

Case-study II : Consistency of LP risk management style

macro signature across all trades

post-deal micro signature by LP
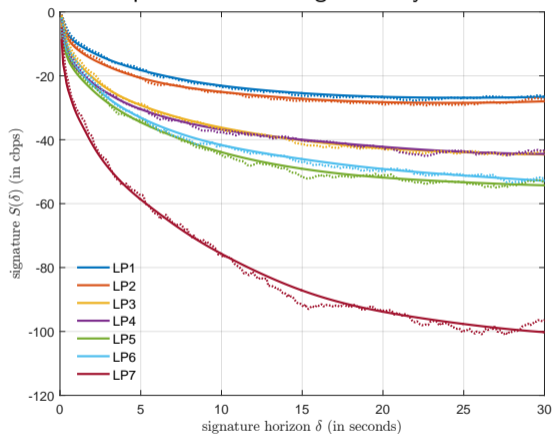
Case-study II : Consistency of LP risk management style

Apply FDA on the pair-wise micro signatures . . . does post-deal impact vary by LP?

	LP 1	LP 2	LP 3	LP 4	LP 5	LP 6	LP 7
LP 1		≈	≠	≠	≠	≠	≠
LP 2	40.8%		≠	≠	≠	≠	≠
LP 3	0.0%	0.0%		≈	≈	≈	≠
LP 4	0.1%	0.2%	73.6%		≈	≈	≠
LP 5	0.0%	0.0%	9.8%	17.5%		≈	≠
LP 6	0.0%	0.0%	28.7%	39.4%	79.2%		≠
LP 7	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	

Case-study II : Consistency of LP risk management style

micro signature by LP groups
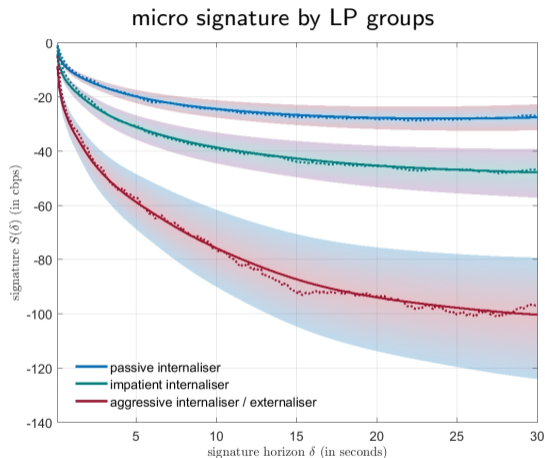
Natural classification into:

a) passive internalisers,

b) impatient internalisers,

c) aggressive internalisers or externalisers

(as discussed in Butz and Oomen, 2018)

# Case-study II : Consistency of LP risk management style

signatures over split sample

Epilogue
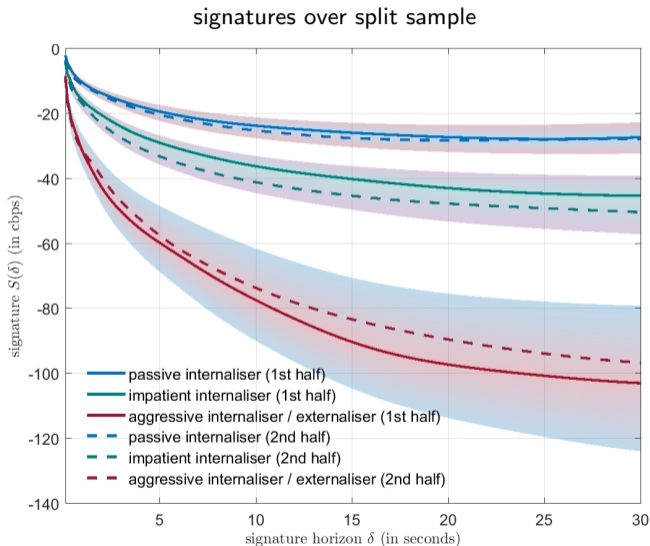
Trader reduces # of LPs and intensifies relationship with passive internalisers

- ✓ reducing post-deal impact

- ✓ reducing direct and indirect execution costs

- ✓ simplifying the liquidity pool, reducing overheads

Thank you for your attention!

Note: the paper is now published in *Quantitative Finance*, 19 (5), 733 – 761

References

Butz, M., and R. C. Oomen, 2018, "Internalisation by electronic FX spot dealers," *Quantitative Finance*, 19 (1), 35 – 56.

Oomen, R. C., 2017a, "Execution in an aggregator," *Quantitative Finance*, 17 (3), 383 – 404.

————— , 2017b, "Last look," *Quantitative Finance*, 17 (7), 1057 – 1070.

Ramsay, J. O., and C. Dalzell, 1991, "Some tools for functional data analysis (with discussion)," *Journal of the Royal Statistical Society, Series B*, 53, 539 – 572.

Ramsay, J. O., and B. W. Silverman, 1997, *Functional data analysis*. Springer, New York, NY.