



Price Signatures

“Best Execution and Transaction Cost
Analysis”

FXCG meeting

Frankfurt, June 2019

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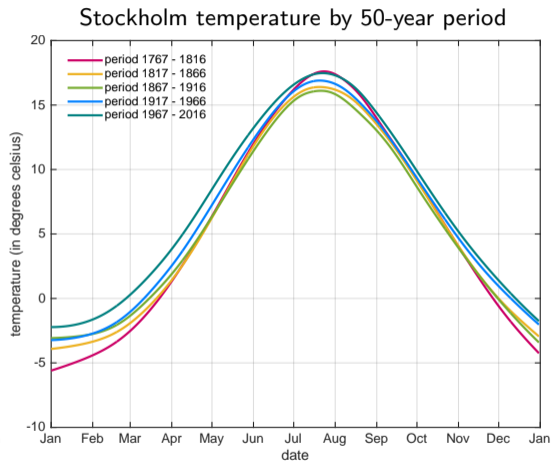
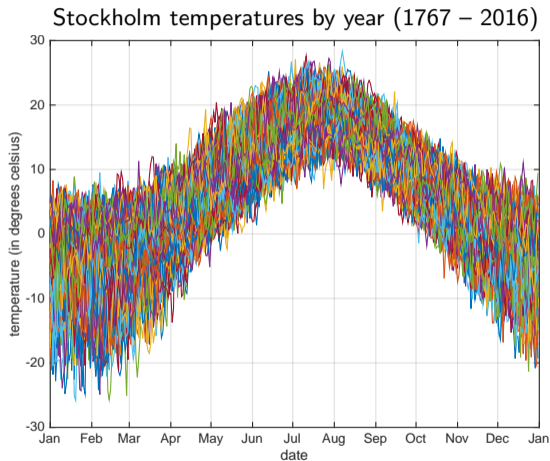
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What do these have in common?

- Electronic FX trading
- The temperature in Stockholm
- The physical activity level of angry children

The temperature in Stockholm

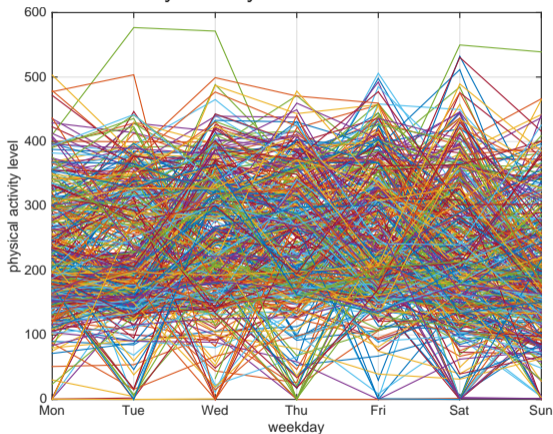


Source: <https://bolin.su.se/data/stockholm>.

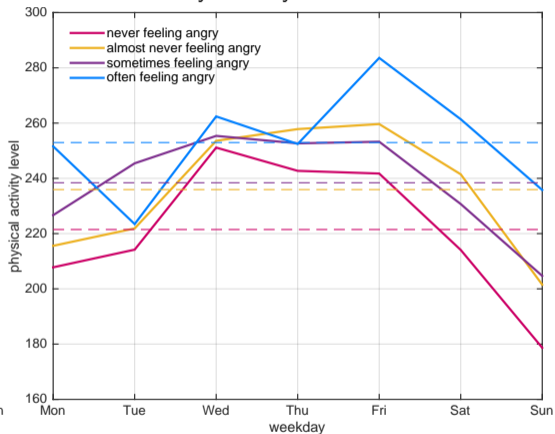
7-year old's physical activity level



Daily activity level of 432 children



Activity level by emotional state

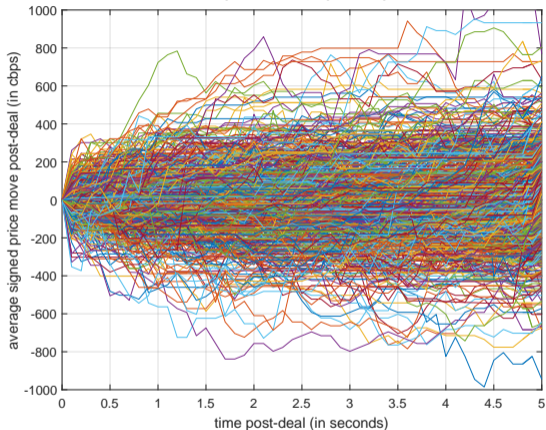


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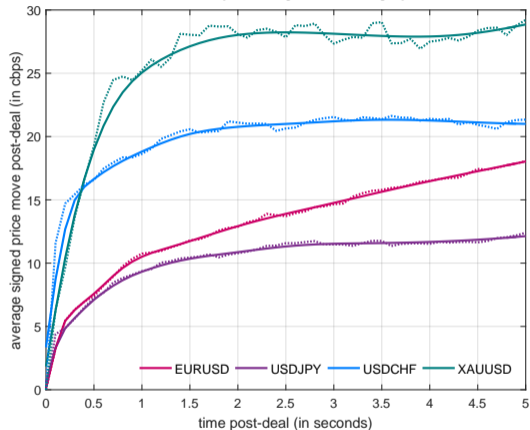
Market impact



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:

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

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

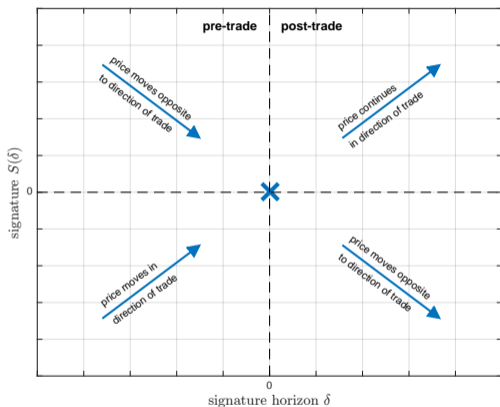
Signature construction



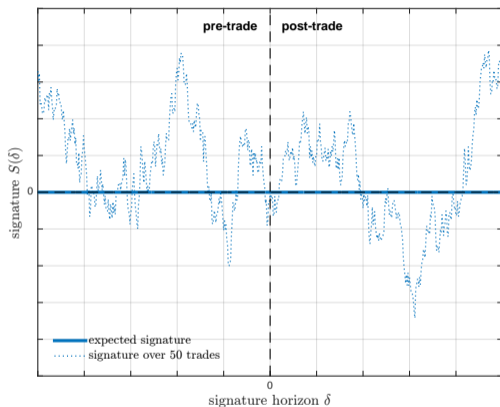
Signature interpretation



signature interpretation

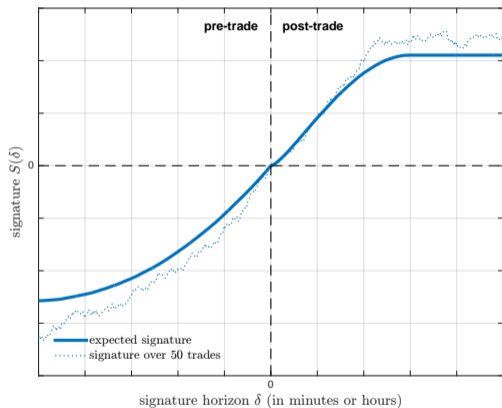


a noise trader's signature

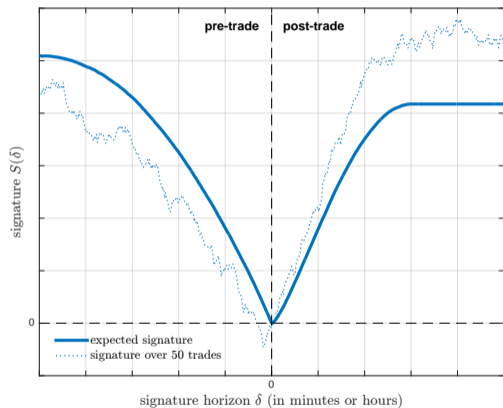


- post-deal ($\delta > 0$), the signature measures the **marked-to-market revenues** or margin
- pre-deal ($\delta < 0$), the signature measures the **opportunity cost** of not having traded earlier

Signature examples at macroscopic level

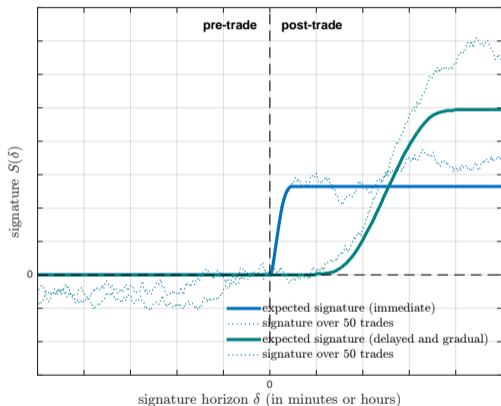


Momentum strategy

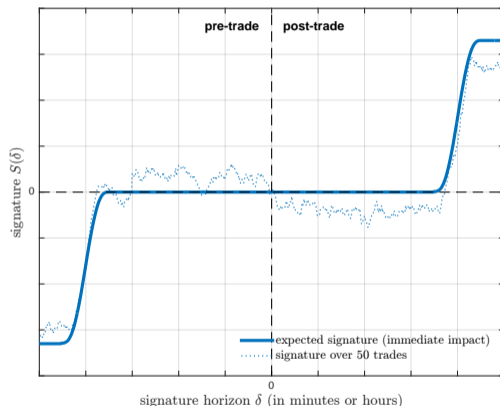


Reversal strategy

Signature examples at macroscopic level

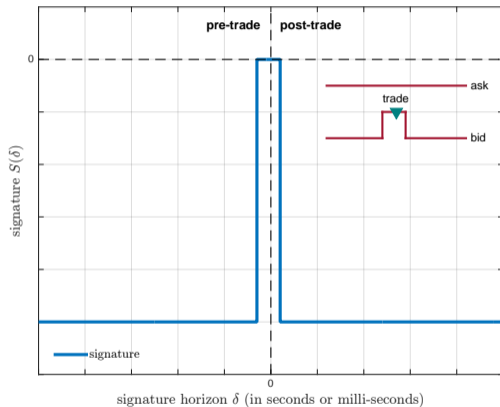


Alpha / impact

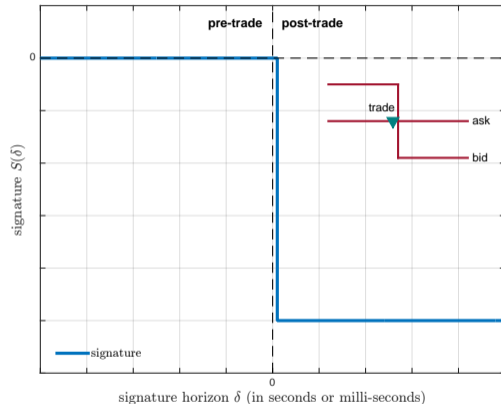


Sequential delayed impact

Signature examples at microscopic level



Adverse selection



Latency arbitrage / run-over



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** → FDA provides the statistical foundations to answer such questions.

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



- **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

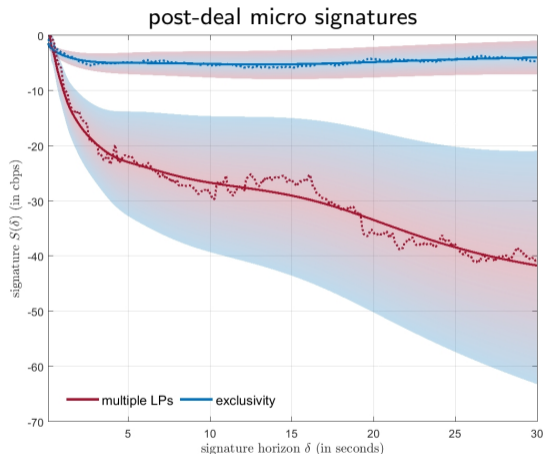
They are open to a radical change or experiment to improve matters.

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



- 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!



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

Note: figures are for illustrative purposes only.



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

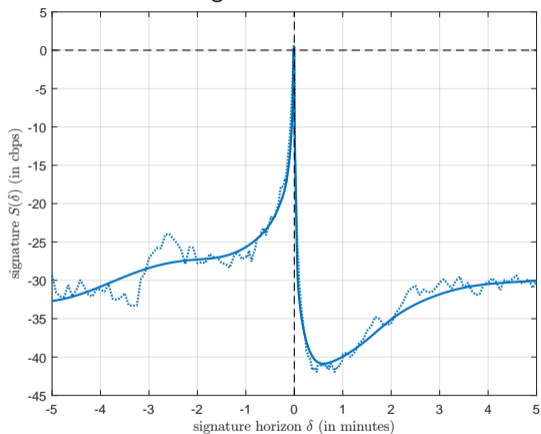
- mixed experience on selected execution (impact, reject rates)
- regularly speaks with LPs' sales representatives about the liquidity offering, but can't quite identify (whether there is) an issue

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

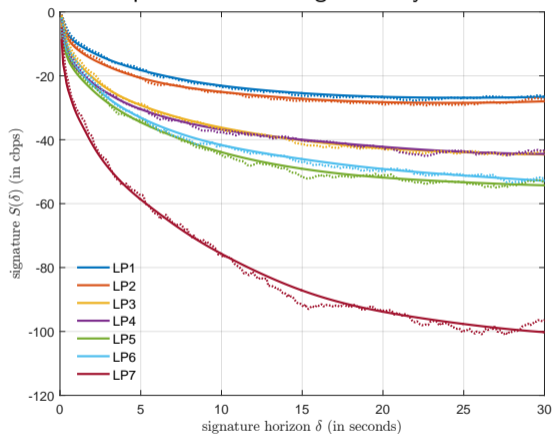
Case-study II : Consistency of LP risk management style



macro signature across all trades



post-deal micro signature by LP



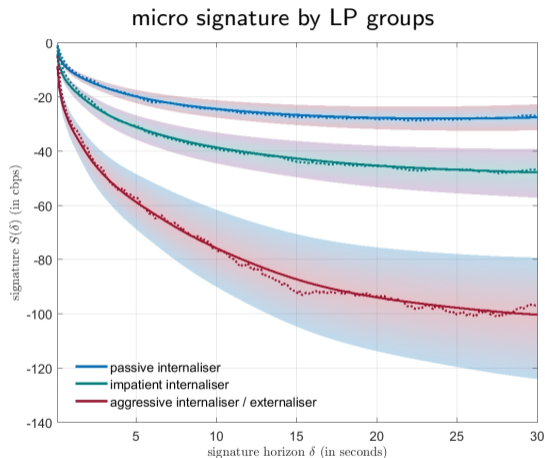
Case-study II : Consistency of LP risk management style



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

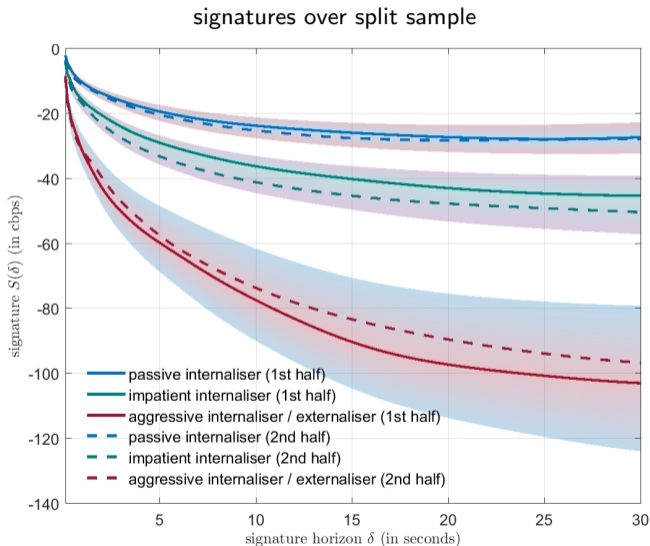


Natural classification into:

- passive internalisers,
- impatient internalisers,
- aggressive internalisers or externalisers

(as discussed in [Butz and Oomen, 2018](#))

Case-study II : Consistency of LP risk management style





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



- 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.