Quality of tick values

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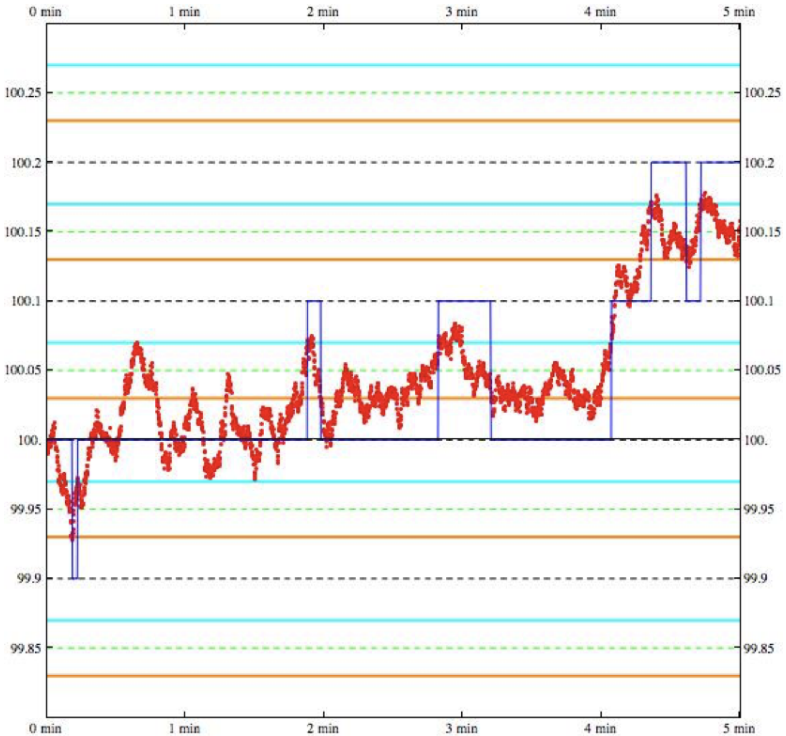
Contents

Counting moves

- Robert and Rosenbaum (2009)



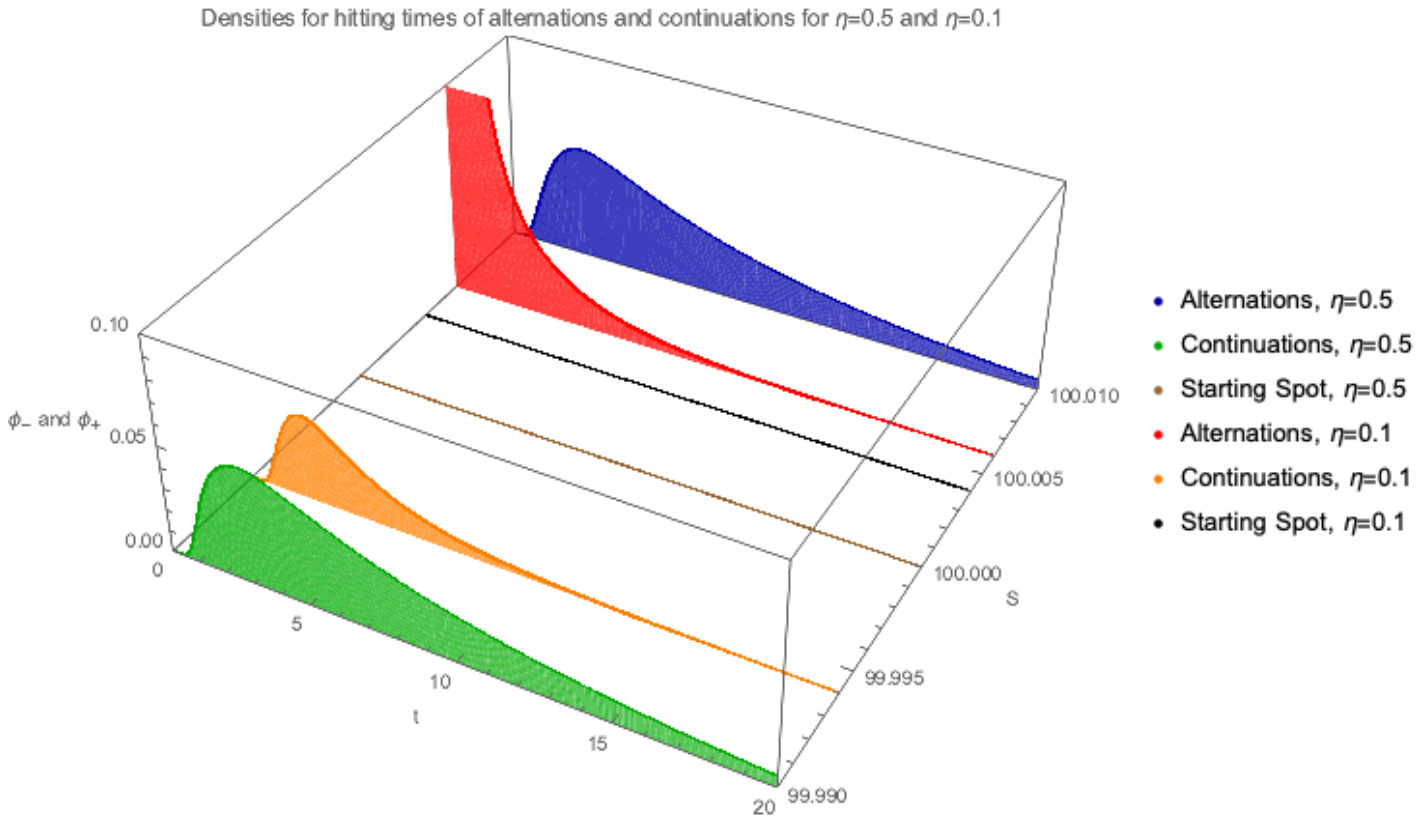
- Count continuations and alternations

$$\hat{\eta}_1 = \frac{1}{2}\frac{N_{C,k}}{N_{A,k}} \tag{1}$$

- $2 \cdot \eta \cdot \alpha$ is a natural spread

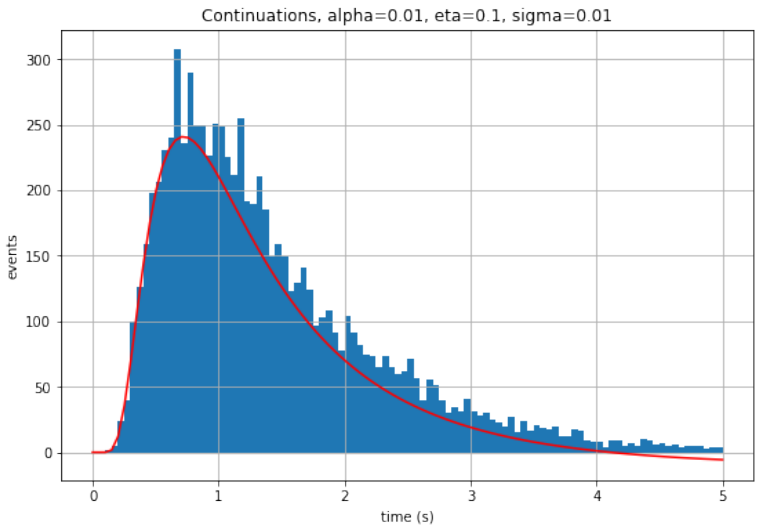
Two steps forward, one step back

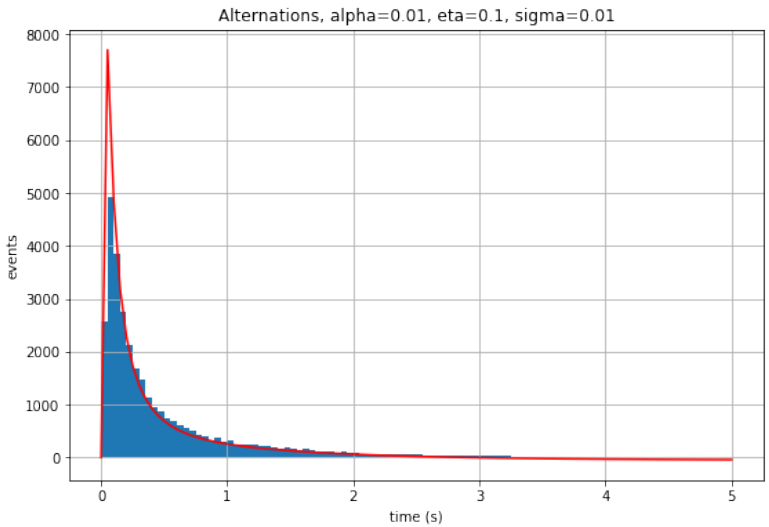
- Estimate time to reach frontiers of UZ
- UZ had size $2 \cdot \eta \cdot \alpha$ and is centered at mid-ticks $\left(P_i + \frac{\alpha}{2}\right)$



As time goes by

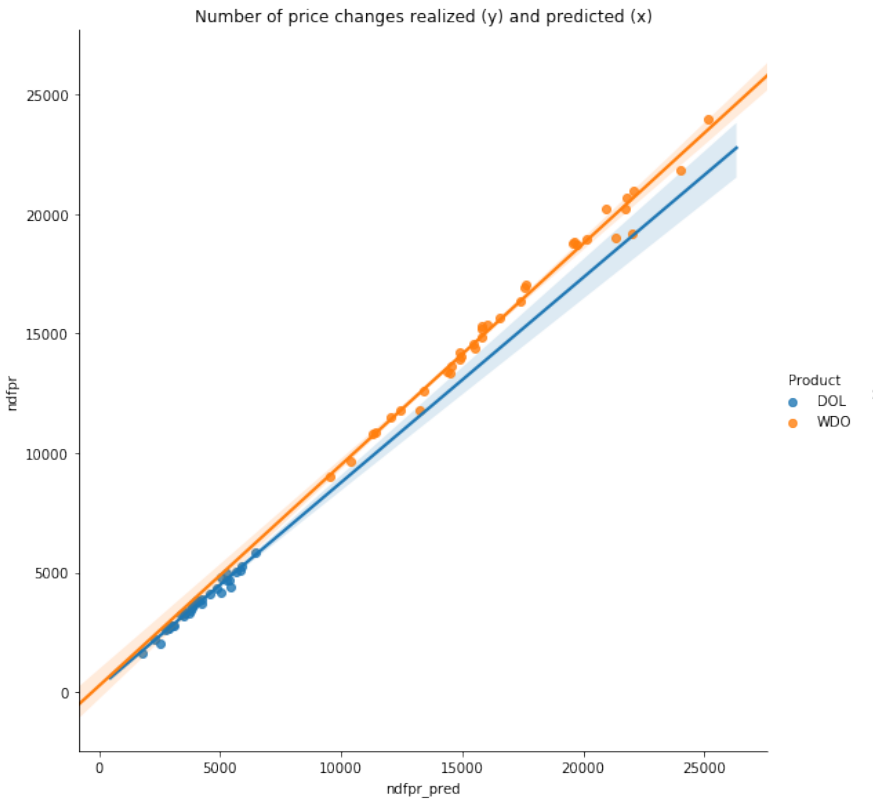
- Durations (Δt to next price change) are different
- But average durations can be estimated: $Dur \approx 2 \cdot \eta \cdot \left(\frac{\alpha}{\sigma \cdot S}\right)^2$
- Then number of price changes is inversely proportional to $2 \cdot \eta \cdot \left(\frac{\alpha}{\sigma \cdot S}\right)^2$

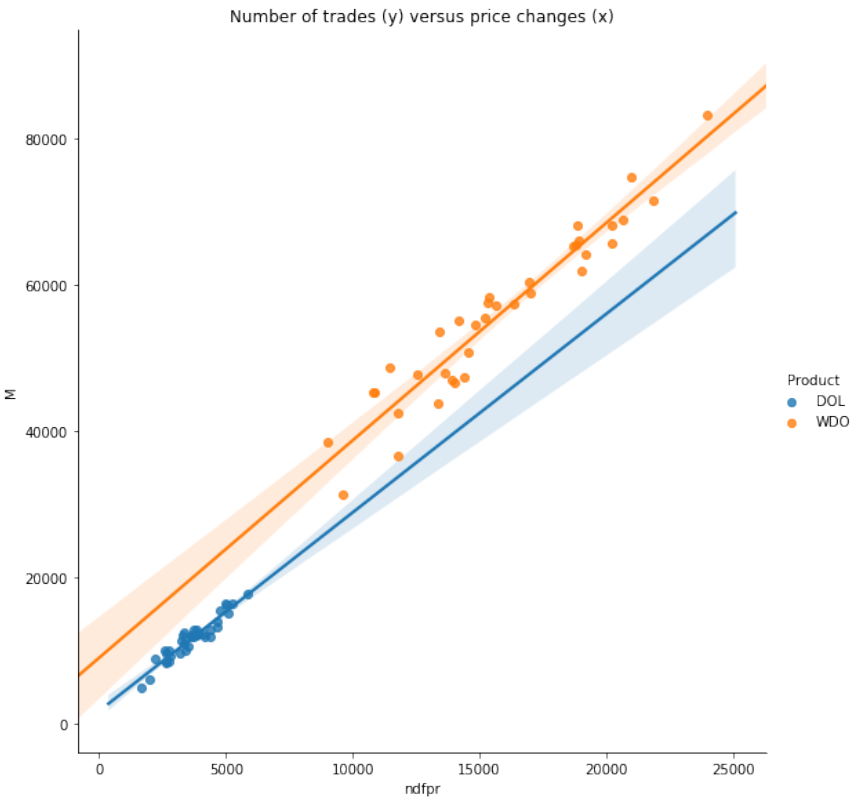




Informed trading

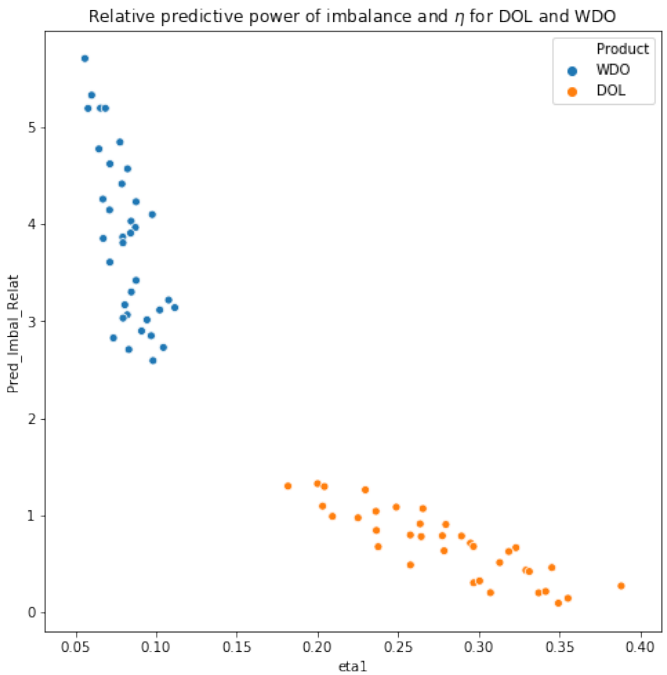
- Two FX contracts in Brazil, same tick size, underlying and settlement, but different size
- Open contracts / traded volume very different => informed traders
- Trades / Price changes: 2.71 DOL, 2.97 WDO





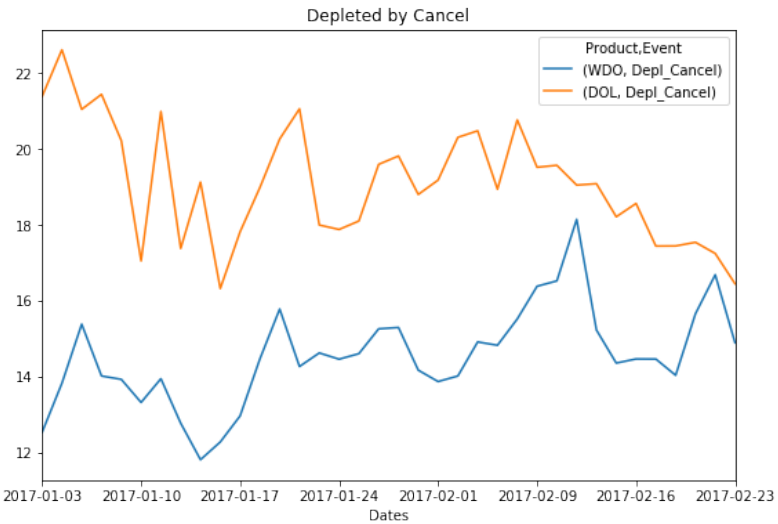
Imbalance

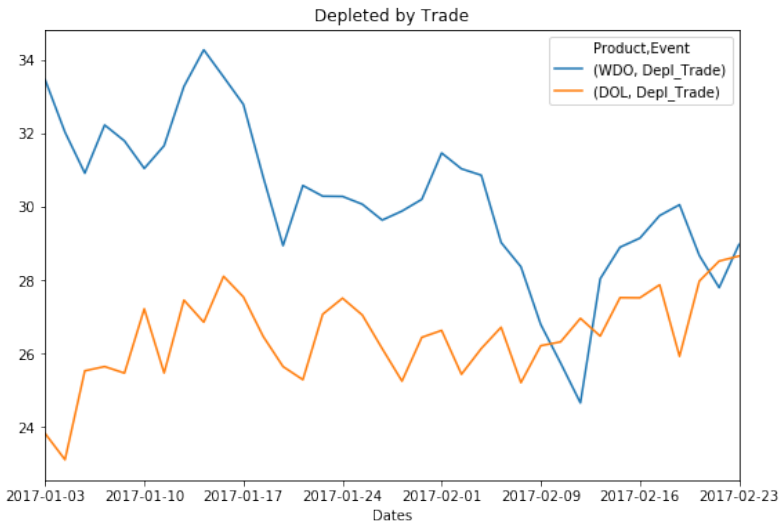
- Predictive power of imbalance (trade as expected - trade as not expected)
- Smaller η means imbalance is more predictive
- Equivalent to microprice leaving earlier a smaller UZ



Fight or flight

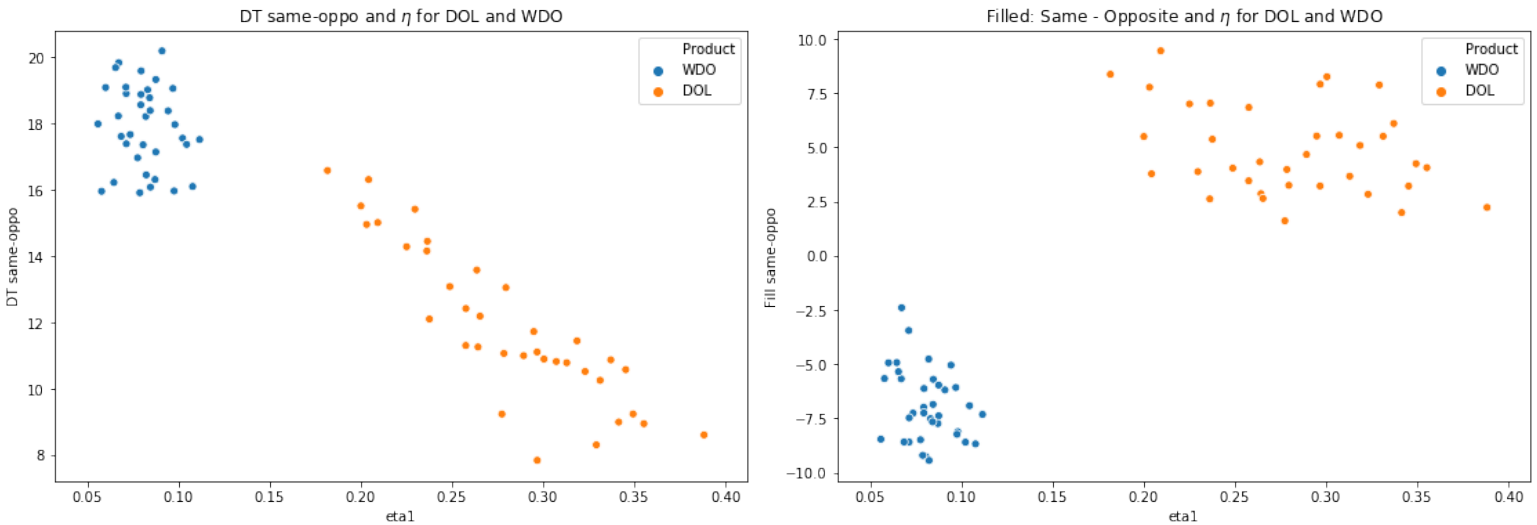
- Depletions by cancel or trade
- Smaller η means more depletions by trade, not by cancel





Regeneration

- Once depletions by trade happened, smaller η means more fills by the original side
- Once a fill happens, smaller η means more depletions on the opposite side



What is being measured?

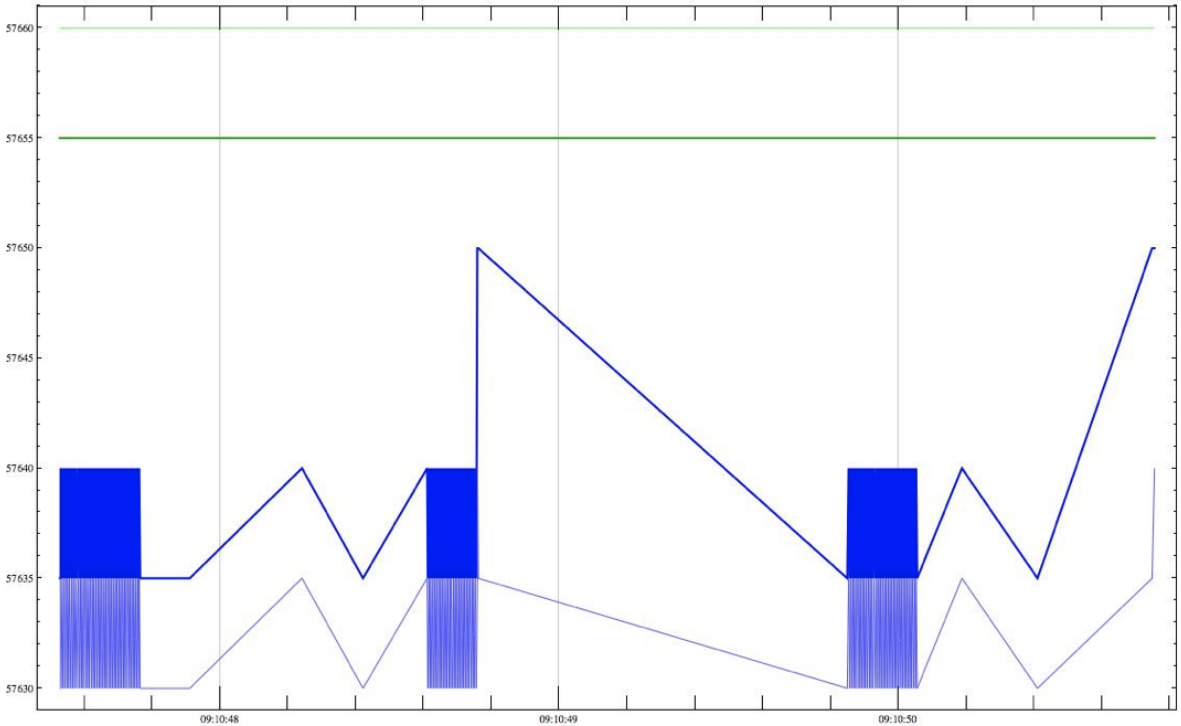
- Market makers hope to earn the spread but fear the informed trader
- Top of the book valuable but total size of best level important (buffer against informed trading)
- Summarize $VTB = 1 - 2 \cdot \eta$

Futures

- Availability of spot for price formation
- Leverage and liquidity might bring diverse ecology of traders
- Global futures exchanges - liquidity over a large period of the day
- But how to choose size of contract and tick size?

Shakespeare in 160 milliseconds

- Why choose large ticks?



- Hamlet $=>$ Macbeth
- Avoid excessive quotes with low amount of information

Factors to consider

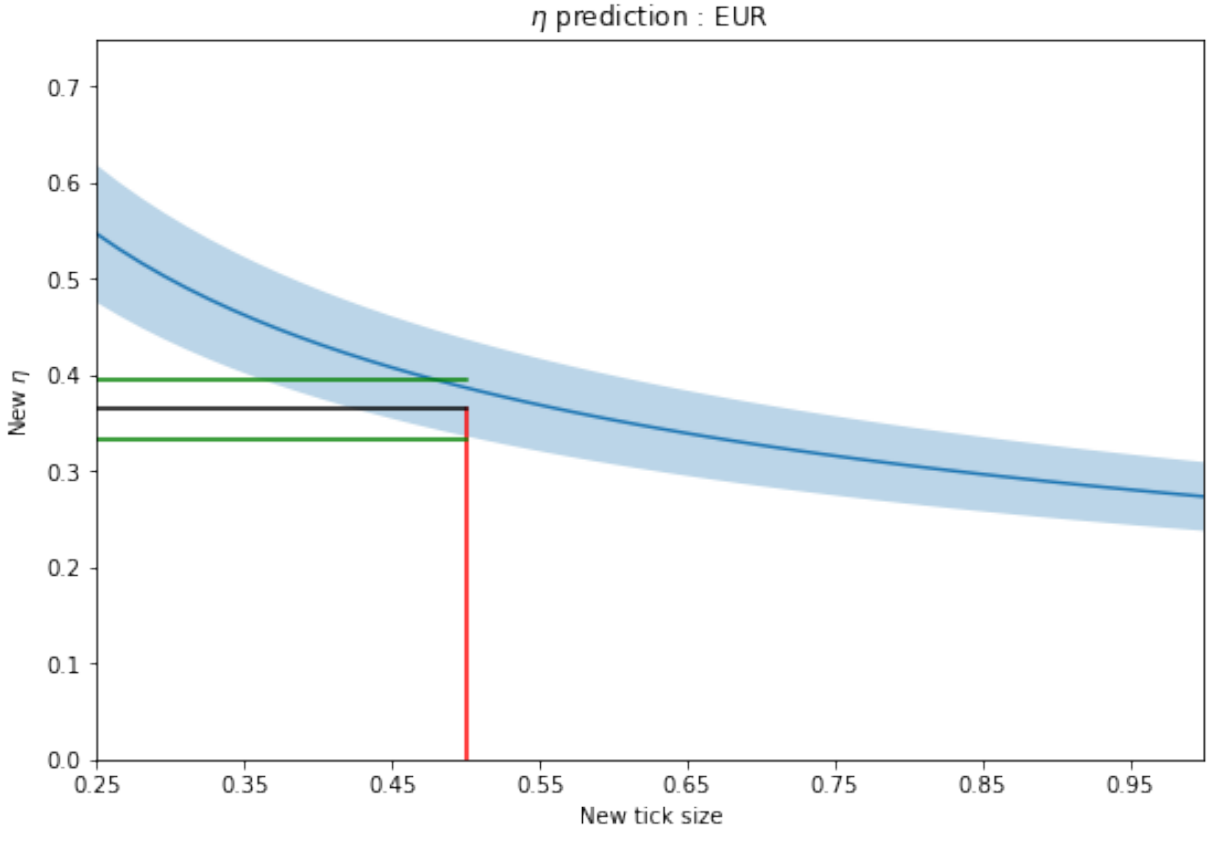
1. Spread of underlying
2. Time-weighted average spread
3. Average price change (related to λ_i)
4. η (assuming the factors above validate the assumption of a large tick asset)
5. Average cost curve
6. Duration (incorporates volatility and relative tick size)
7. Direct costs of trading (exchange fees)

Averages

Product	Tick	$\overline{\delta P}$	$\overline{S}$	Volume	M	# δP	Calc	η	# $S_=$	λ_1	σ_X
EUR	1.0	1.017	11060	100764	24142	4260	4655	0.274	0.984	0.986	0.438%
EUR	0.5	0.534	11189	85659	28417	8217	10570	0.364	0.940	0.940	0.375%
CAD	1.0	1.018	7538	41609	12129	1915	2049	0.338	0.984	0.983	0.486%
CAD	0.5	0.532	7578	37110	13319	3582	4471	0.386	0.914	0.943	0.376%
JPY	1.0	1.012	8330	62169	10936	1653	1790	0.235	0.990	0.991	0.338%
JPY	0.5	0.518	8205	58368	14735	3243	4781	0.335	0.964	0.974	0.304%
MXN	12.5	25.293	76526	17968	2321	216	225	0.196	0.991	0.991	0.298%
MXN	5.0	10.262	75181	26480	4760	765	836	0.327	0.986	0.980	0.305%

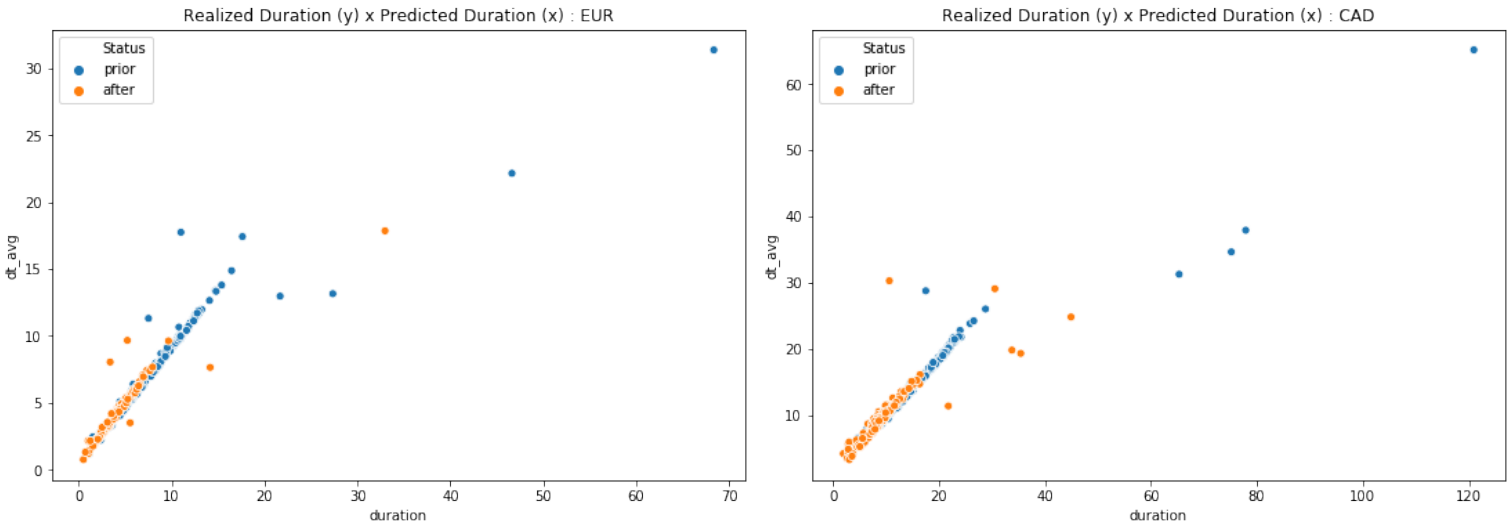
I've seen the future

- Predict next η



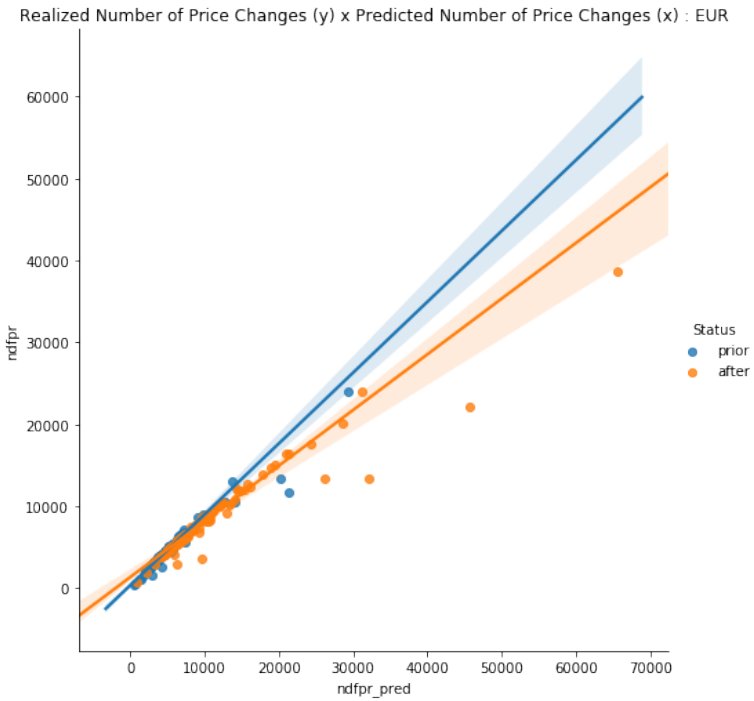
I've seen the future

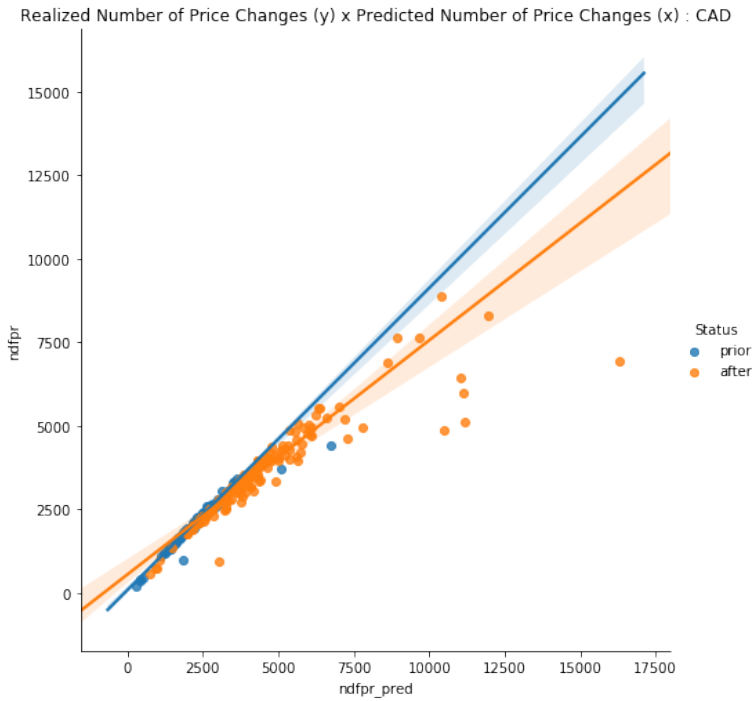
- Predict durations given tick value and spot, volatility, η



I've seen the future

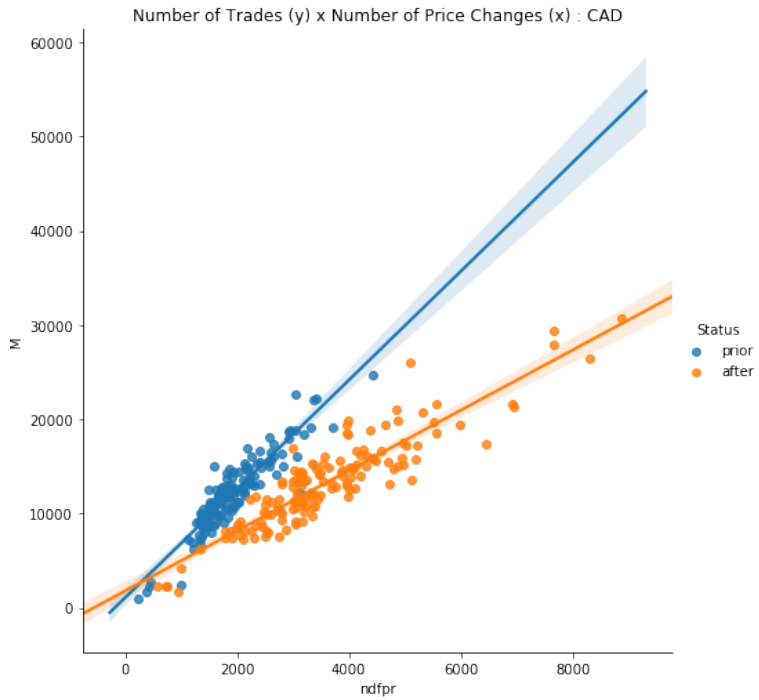
- Predict number of price changes given durations (tick value and spot, volatility, η)





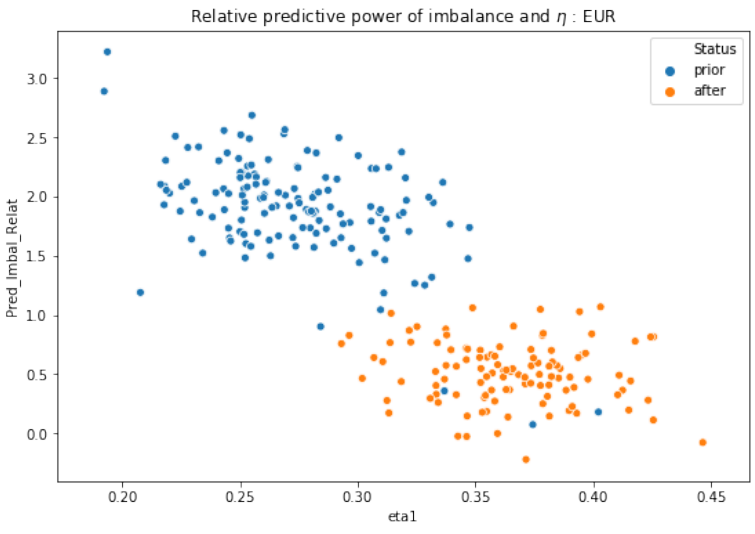
I've seen the future

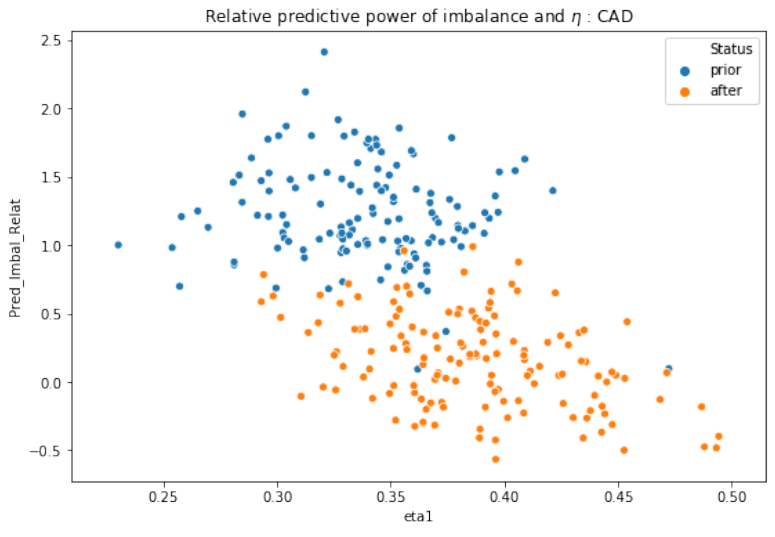
- Predict number of trades given number of price changes (ratio k)
- After: EUR 2.5, CAD 3.2



Looking behind the curtain

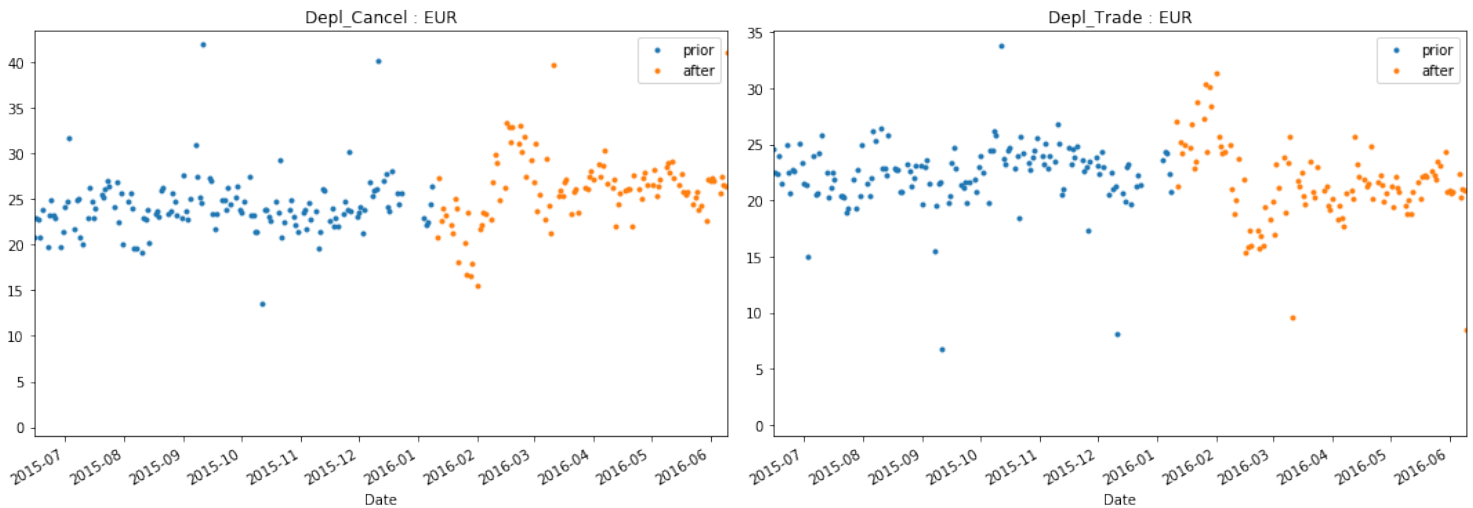
- Predictive power of imbalance





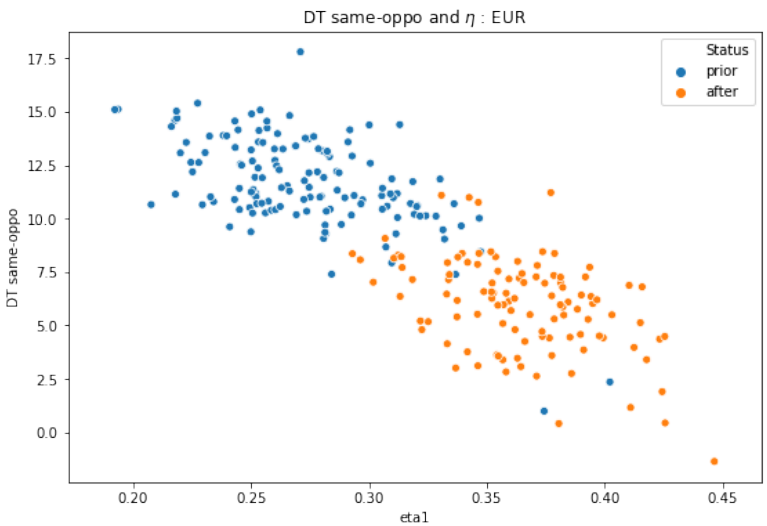
Looking behind the curtain

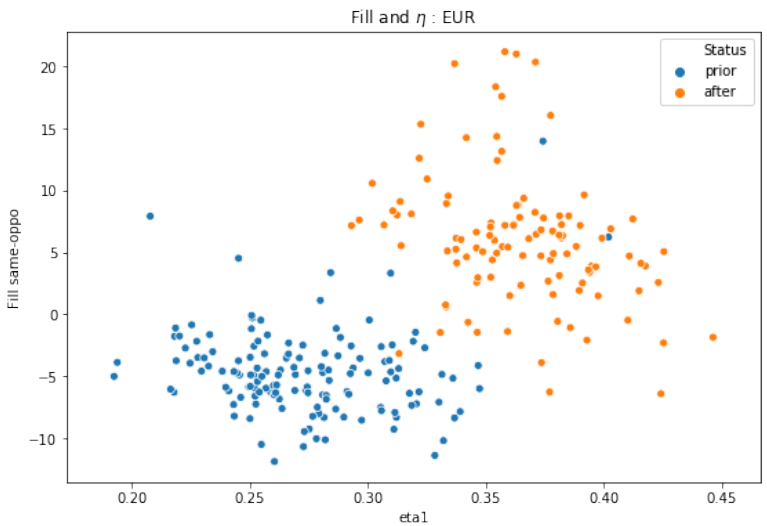
- Depletions



Looking behind the curtain

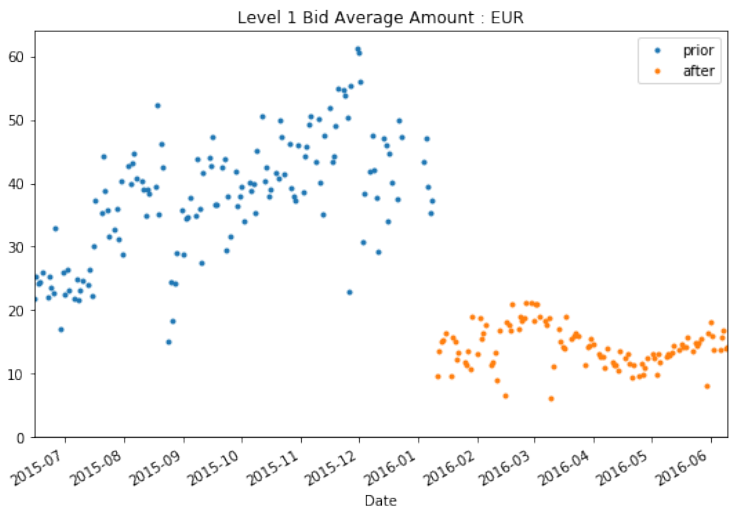
- Depletions and fills

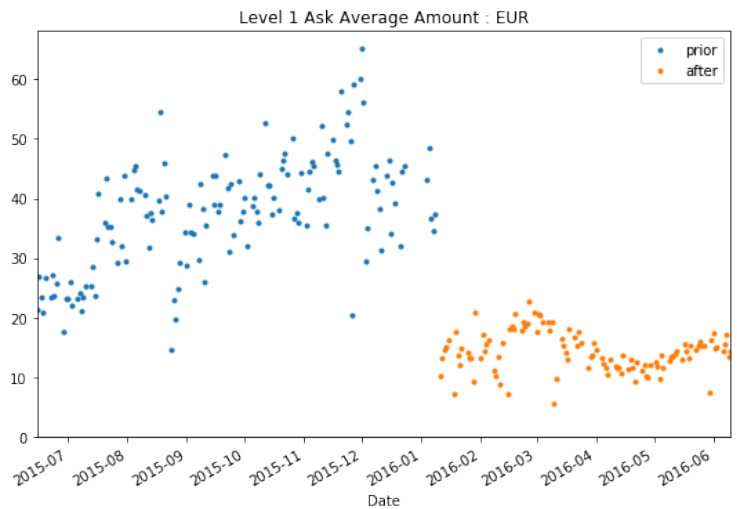




Posted liquidity

	$\frac{prior}{after}$		
		$\bar{Q}$	
Currency	Tick	Bid	Ask
EUR	2.0	2.64	2.62
CAD	2.0	2.15	2.14
JPY	2.0	2.04	2.08
MXN	2.5	3.12	3.38



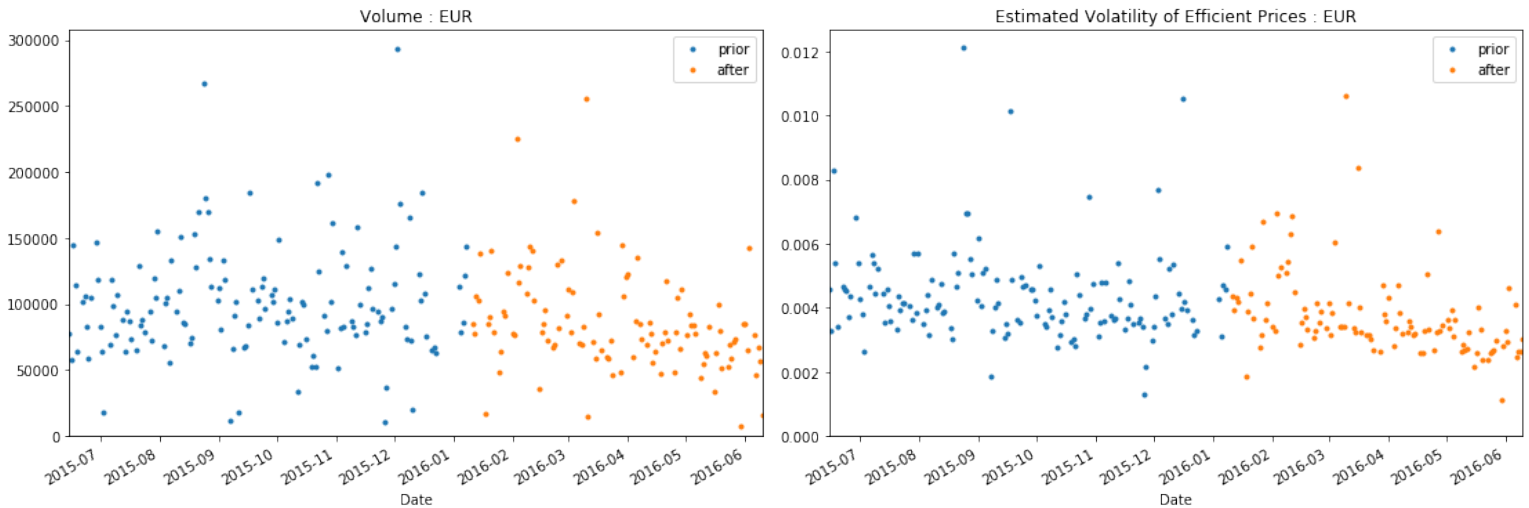


All together now

- $\frac{V_1}{V_0} = \frac{\beta_{V,M,1}}{\beta_{V,M,0}} \cdot \frac{M_1}{M_0} = \frac{\beta_{V,M,1}}{\beta_{V,M,0}} \cdot \frac{k_1}{k_0} \cdot \frac{\#\delta P_1}{\#\delta P_0}$
- $\frac{V_1}{V_0} = \frac{\beta_{V,M,1}}{\beta_{V,M,0}} \cdot \frac{k_1}{k_0} \cdot \frac{\eta_0}{\eta_1} \cdot \left(\frac{\alpha_0}{\alpha_1} \cdot \frac{S_1}{S_0} \cdot \frac{\sigma_1}{\sigma_0} \right)^2$
- Estimate ratio between volume and number of trades (β) using posted liquidity:
  - $\frac{\beta_{V,M,1}}{\beta_{V,M,0}} = \left(\frac{\alpha_1}{\alpha_0} \right)^\gamma$
- $\frac{V_1}{V_0} = \left(\frac{S_1}{S_0} \cdot \frac{\sigma_1}{\sigma_0} \right)^2 \cdot \frac{k_1}{k_0} \cdot \frac{\eta_0}{\eta_1} \cdot \left(\frac{\alpha_0}{\alpha_1} \right)^{2-\gamma}$

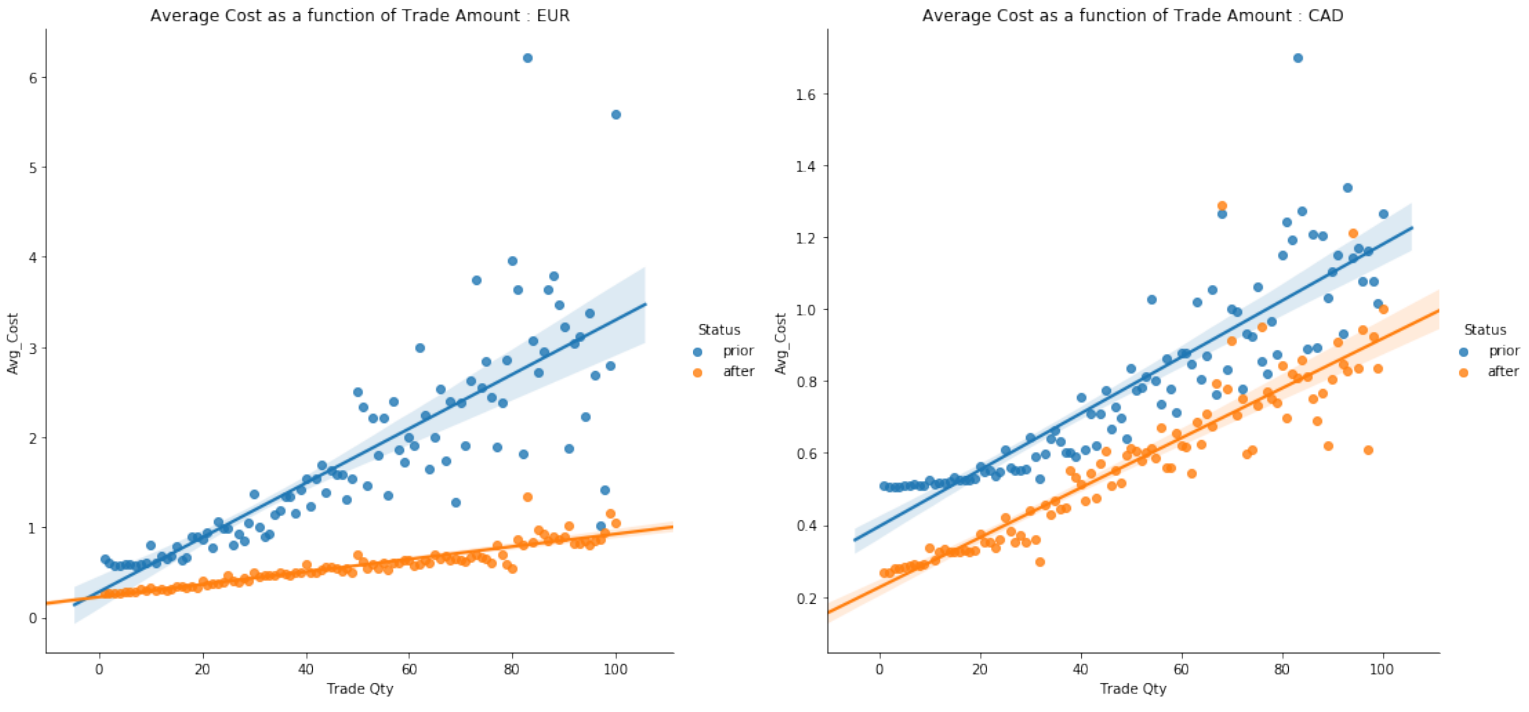
Volatile volume

- $\frac{V_1}{V_0} = \left(\frac{11189}{11059} \cdot \frac{0.00375}{0.00438}\right)^2 \cdot \frac{2.6}{3.6} \cdot \frac{0.27}{0.37} \cdot \left(\frac{1}{0.5}\right)^{2-\gamma}$
- $\frac{V_1}{V_0} = 0.75 * 0.527 \cdot (2)^{2-\gamma}$
- $\gamma = 1$
- $\frac{V_1}{V_0} = 0.80$ (realized 0.85)



Tale of the tape

- Average cost of each trade
- Group by amount traded and average
- Average results by amount over time



What this talk was about anyway?

Market design

- Exchanges need to keep all customers equally unhappy
- Tick value and η helps to determine spread, liquidity, cost/market impact
- Presence of informed traders increases η, spreads
- Dashboard of factors to measure and monitor

What η measures

- Not only mean reversion
- Predictive power of imbalance
- Relative proportion and sign of depletions by cancel and trade and refills
- $1 - 2 \cdot \eta$ as relative value of top of book (first place in queue)

What is next?

- Link to Queue Reactive model
- Expand model to other futures
- Even price level changes are a natural experiment

Books, papers, website

- Robert, C. Y. and Rosenbaum, M. (2009): "Volatility Estimation under Endogenous Microstructure Noise"
- Dayri, K. and Rosenbaum, M. (2015), "Large Tick Assets: Implicit Spread and Optimal Tick Size
- Huang, W., Lehalle, C.-A. and Rosenbaum, M. (2015), "Simulating and analyzing order book data: The queue-reactive model
- Huang, W., Rosenbaum, M. and Saliba, P. (2019), "From Glosten-Milgrom to the whole limit order book and applications to financial regulation"
- Chaboud, A., Dao, A. and Vega, C. (2019): "What makes HFTs tick?"
- https://quantreg.com/ : Analytics and Models for Regulation at CMAP – École Polytechnique