

Towards an Automated Trading Ecosystem

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- 1 The need for Automated Trading
 - Suppliers
 - Users
 - More technically...
- 2 Implied Changes
 - New practices
 - New (infrastructure) risks?

- The last years (since 1980) have seen an electronization of markets.
 - Market-wide pressure (from regulation and market participants):
 - to obtain a more transparent Price Formation Process;
 - in conjunction of an increase of technological capabilities (Moore's Law, big data, etc);
 - with an increasing competition between platforms (Reg ATS/NMS –US, 1999/2005– and MiFID –Europe, 2007–).
 - Last years (after the crisis), investment banks focussed on more linear products (ETFs, smart-beta, etc), for which trading costs are near from negligible.
- ⇒ Need for “optimal” trading schemes.

Platforms provide access to their matching engines, matching services (internalization, “tactics”, order routing, etc) and data feeds.

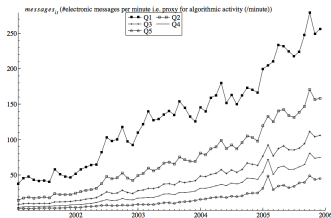
+ Colocation, execution (quality) analysis, software, testing (“life” or “sandboxes”), storage.

Brokers / sell side Direct Market Access (DMA), data feeds, order routing, execution algorithms (portfolio or single line), Transaction Costs Analysis (TCA), execution services, research (small to medium scale).

+ Broker Crossing Networks (BCN) and Dark Pools.

Technology Vendors data feeds, storage capabilities, back testing, development frameworks, toolkits. (networks, datacenters, hardware, etc).

+ common protocols/standards agencies (FIX). And providers of information (calendars, news, corporate events, etc).



Source: *Does Algorithmic Trading Improve Liquidity?*,
JoF 2011 (Hendershott, Jones, Menkveld).

- Retail investors use smart routing and BCN,
- Institutional Investors can use care orders delegated (by brokers) to algorithms, order routing, direct algo trading users.

Dealing desks of large investors have to cut a portfolio to use the adequate route on each subset.

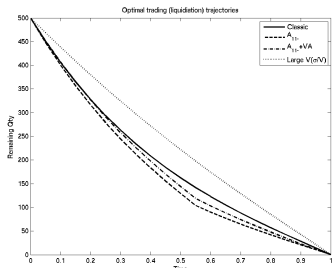
It is a matter of market timing, order routing and TCA.



- Brokers use trading algorithms to execute orders in behalf of their clients;
- Liquidity facilitation and principal trading use automated tools;
- Market makers (of many kinds) need to automate their practices to fulfill their quoting obligations.

BCN and Dark Pools can be seen as facilities in between intermediation (liquidity provision) and platforms (matching). High Frequency Trading positioning can be discussed, nevertheless they are massive users of automated trading.

The faster you trade, the more trading impacts the price a unfavourable way. The slower you trade, the more exposed to the risk of the price diverging from your decision price. A **mean-variance** criterion can be used (*Optimal execution of portfolio transactions*, Journal of Risk, Almgren, Chriss; 2000).



Source: [Lehalle et al., 2013]

Extensions to different cost functions have been proposed [Bouchard et al., 2011].

Then it is similar to Markowitz allocation on “time slots”:

- on the expectation side, you put your “market impact” (the way your trading impacts the price);
- on the risk side, you put autocorrelations of the price.

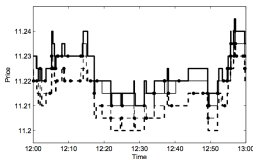


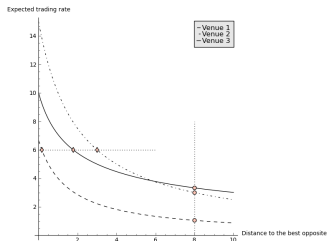
Fig. 13 Details for the quotes and trades when the strategy is used on France Telecom (15/03/2012). Thin lines represent the market while bold lines represent the quotes of the market maker. Dotted lines are associated to the bid side while plain lines are associated to the ask side. Black points represent trades in which the market maker is involved.

Source: [Guéant et al., 2013]

Seen from a trader controlling its inventory using the ask and bid prices, the largest inventory the more exposed to market risk (especially “adverse selection”). With a tiny inventory you never have the occasion to “gain the spread”.

Stochastic control allows to solve this problem: the value function $v(t, X)$ is transported to $v(t + dt, X + dX(c))$ depending on the control c . Since the terminal values can be computed as a function of X , it is possible to solve backward and find the best control as a function of t and X (state space).

In practice the trading process takes place in an uncertain environment. The trader explores the market conditions while he is trading.



Source: [Lehalle et al., 2013]

Dedicated optimizing schemes can be used under such conditions. Typical applications:

- trading in several liquidity pools with uncertainty [Pagès et al., 2011];
- when market reaction to trading cannot be properly modelled [Laruelle et al., 2013].

Exploration-exploitation approaches can thus be formalized.

Different techniques for different goals

Up to now, different heuristics have been developed by practitioners, later formalized by academics.

Approach	Cost function	Control	Used for
Trade scheduling	mean-variance	trading rate	Agency algo trading <i>medium term</i>
Stochastic control	almost “any”	trading rate or price (any)	Market making Market timing <i>explorations</i>
Learning	asymptotic “at infinity”	rate or price	Liquidity seeking <i>short term</i>

Agency brokers and high frequency market makers are typically using such approaches, fine tuned thanks to empirical additions.

A standard optimization paradox

- The more parameters you add to a situation, the **better the optimum**.
- But the **more complex** to find.



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Order: 0BNPPFA

BNPPop_Chi	Type	BNP	PARIBAS	FR0000131104	INS /102	EUR	OAFPROB	11:07
Last	Net Chng				Buy	Vol	Sell	Vol
68.5000	-0.0050	50			200	68.4950 / 68.5450	200	
68.5000	Pct.Chng	Volume			400	68.4800 / 68.5300	400	
68.5000	-1.3%	60008			200	68.4850 / 68.5450	198	
68.5000	Buy-Sell ID	Value			200	68.4800 / 68.5500	200	
68.5000		4312007.25			800	68.4700 / 68.5500	500	
	Moves				380	68.4650 / 68.5900	200	
5231	226	15			200	68.4550 / 68.5650	340	
Open	Hign	52.Mk.Hi:			400	68.4350 / 68.5700	200	
68.8700	69.1700				1011	68.0800 / 68.5750	380	
69.4050	68.2900	52.Mk.Lo:			1000	68.0500 / 68.5800	380	

Order: 0BNPPFA

BNPPop_Fa	Type	BNP	PARIBAS	FR0000131104	BNP	PAR	EUR	OAFPROB	10:08
Last	TrdVol	Pct.Chng			Order	Bid Size	Ask	Ask Size	Order
68.5450	Net Chng	-1.18			11	68.5800	68.5450	199	2
68.5450	VolWgt	744392			2	1074	68.4950 / 68.5500	396	3
68.4850	Turnover	News			1	200	68.4800 / 68.5550	344	1
68.4800	Turnover	News			1	200	68.4600 / 68.5650	200	1
MAAP 22.24	S1157744	09:03			1	202	68.4500 / 68.5700	200	1
Mp/LoLWt: 72.3650 / 65.4750					PHP	50000	68.4950 / 68.6450	50000	PHP

A standard optimization paradox

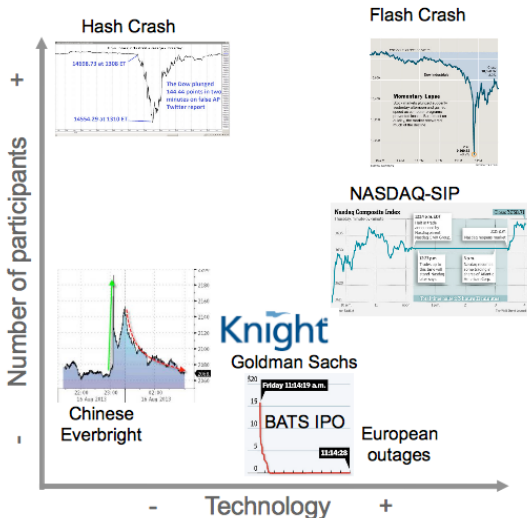
- The more parameters you add to a situation, the **better the optimum**.
- But the **more complex** to find.
- a large academic literature emerged to formalize the **optimization of the trading process** (see [Lehalle, 2013] in the *Handbook on systemic risk*, 2013 for a review and *Market Microstructure in Practice*, 201 for examples of use).
- For instance, as a result, a large trader can now liquidate a position using a majority of limit (liquidity adding) orders.

The notion of liquidity changed. A dynamical and probabilistic approach is now needed.

As consequences:

- the split between market and limit orders is no more the one between investors and market makers;
- less delegation to intermediaries (institutional investors dealing desks are more in charge):
 - better alignment with buy side needs,
 - more competition pressure on intermediaries.
- markets are far more multilateral than bilateral (what is multilateral market making?).

Classification of outages



This transformation leads to different potential issues:

- competition pressure on intermediaries and market operators leads them to share the same resources: emergence of few crucial nodes. **Risk is concentrated** in these few points.
⇒ need for **norms and certifications** (reco. 1,2,6,8,9 of [Abergel et al., 2013]) + Need of **comprehensive and efficient circuit breakers** (reco. 3).

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- **Operational risk** has more consequence since all goes faster.
⇒ need for **development cycle standards and risk assessment** (reco. 9).
- **More complexity** in the trading process if analysed with old tools / methods.
⇒ need for **education** (reco. 7, 12, 18).



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