

Risk Awards 2018

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Buy-side quant of the year
Jean-Philippe Bouchaud

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Only in the past decade have many traders considered how their own actions affect the market. Big trades can move a price up or down; trading too quickly will bump up costs.

Shrinking alpha due to low rates and high asset prices has brought more attention to the phenomenon, but while traders and portfolio managers may now be aware of price impact, they may not have thought much about cross-impact – the impact of trading on other assets' prices.

Jean-Philippe Bouchaud, head of research at Capital Fund Management (CFM) and an influential figure in price impact research, wins this year's buy-side quant of the year award for shining a light on cross-impact.

"Even if individual assets are only slightly affected, globally you are going to have a significant impact," says Bouchaud. "And the fact that it is small on a given pair means it is hard to measure. It's very noisy."

In *Trading lightly: cross impact and optimal portfolio execution*, published in *Risk* earlier this year, Bouchaud and his co-authors introduced the Eigenliquidity model, a means of incorporating cross-impact into optimal execution.

When trading futures on two nearby maturities, or options on two nearby strikes, cross-impact will cause the volatility surface to move and the impact of trading those contracts will therefore propagate to all other maturities or strikes. "It would be nonsensical to think you would move just one of these contracts and not their correlated counterparts," says Bouchaud.

A senior portfolio manager at a major hedge fund says: "People look at market impact for individual assets but not for multiple assets at the same time. They simply ignore the problem and say 'If I buy a lot of Amazon stocks and then try to buy Google stocks, it's not going to have an impact', but that's definitely not true."

"The Eigenliquidity model is simple and intuitive, and it fits with my own experience," says Robert Almgren, founder of Quantitative Brokers. "I think this paper's going to be interesting for a lot of people, and not just execution desks but portfolio managers too."

A big concern for market-neutral portfolio managers is retaining their market neutrality. This is difficult while executing a trade, as stocks do not behave independently of one another – their price movements correlate. Trading stocks as though they were independent will therefore result in higher exposure than expected, and to offset that effect, a portfolio manager will need to trade some of these same stocks in the other direction. As a result, they perform round-trip trades, accumulating higher trading costs.



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"If you want to be optimal, you better be careful about intraday exposure to the market," says Bouchaud. "Not because of risk but because of cost."

CFM's Eigenliquidity model groups the assets a manager wants to trade into sets of uncorrelated portfolios known as modes, the portfolios containing each asset in different proportions. The central assumption of the proposed Eigenliquidity model is that trading any one of these uncorrelated portfolios does not push the price of any other portfolio – an assumption supported approximately by empirical evidence. An execution desk can therefore trade these modes and not worry about how trades affect other modes.

Strategies can be expressed in terms of these modes. Most of the effects of cross-impact are contained in the so-called market mode. This reflects the overall average effect on the rest of the market of trading a stock at random. While the market mode dominates, sector modes – portfolios dominated by particular sectors – also have an important effect.

Once expressed in mode representation, a firm can optimise the strategy

as it would previously. An optimal solution will involve reducing the weight of the market mode, compared with a scenario with zero cross-impact, by trading more of the other modes. The cost of the strategy is then proportional to the amounts of each mode multiplied by its self-impact.

Ultimately, the paper shows spreading orders across correlated assets is not as cost-effective as traders may have thought, due to the effect of cross-impact.

Empirical studies of cross-impact were completed by Michael Benzaquen, a post-doc at the firm. The team working on the project also included Iacopo Mastromatteo, a former CFM post-doc, Zoltan Eisler, co-head of the execution team, and Bouchaud.

Most research on market impact has so far focused on the impact on the traded asset's own price. Bouchaud believes there is much more to be done on cross-impact to catch up with the self-impact literature.

Cross-impact, and the ways assets are webbed together, leads naturally to the topic of contagion and instability – an area the CFM researchers are keen to look at from a microstructural point of view.

“Financial markets seem to be following a dynamic of their own and unfortunately it seems to be pretty unstable, producing micro-crashes and macro-crashes,” says Bouchaud. “The dynamics of contagion, the way the flash crash took place in 2010 – I think this is all related to cross-impact.”

Another paper authored by CFM this year and published in *Risk* is *Optimal trading with linear and (small) non-linear costs*. In this highly technical paper, Bouchaud's team consider trade scenarios involving linear and quadratic transaction costs. These are due to the costs of fees or the bid-ask spread, and the costs due to market impact respectively. For the latter, the amount by which an asset price rises is assumed proportional to the volume of the asset being traded.

While optimal trades have been constructed in the presence of each type of cost – linear and quadratic – independently, this is the first paper to find the optimal trades in which both types of cost are present at the same time.

“This was probably one of the most difficult technical problems we have solved in the 25 years of CFM's existence,” says Bouchaud.

Adam Rej, a researcher at CFM, was initially tasked with the research, supervised by Raphael Benichou, but they soon realised the difficulty of the problem. The other authors, Bouchaud, Gilles Zerah and Joachim de Lataillade, CFM's head of execution strategies, were brought in due to their experience in the field.

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The breakthrough came in realising how to generalise an assumption made in the earlier linear cost paper Mean reversion pays, but costs, authored by Richard Martin and Torsten Schöneborn.

Similar to the solution for linear costs, the paper shows that if transaction fees are too high, a portfolio manager should wait until their alpha signal is stronger. As the signal strengthens, they should start trading gradually, in proportion to the strength of the signal, and then if the signal



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is sufficiently strong they should trade in proportion to the square of the signal strength.

Prior to a trade, the model is calibrated and the position sizes are set within which trades should not be executed, traded linearly or traded proportionally to the square of the signal. The model then becomes an easy reference for a trading algorithm to decide how quickly to trade for a particular signal strength.

CFM is known for attracting and developing young talents, easing them into the world of quantitative finance. “We see ourselves as a lot like a lab,” says Bouchaud. A key part of this is the publication of new research. By providing intellectual as well as financial incentives, CFM seeks to hire the best talent from academia. Bouchaud says investors appreciate the effort too, saying it shows the firm is actively trying to stay ahead of the competition.

“I think in the last 20 years or so we have gained much more by publishing papers than we have lost, from the point of view of hiring, the quality of the work inside the company and the spirit. I recognise myself more in a company like ours than in other, less open firms.”

The optimal trading solution in the presence of quadratic costs was published in 2013, but Bouchaud claims he solved it prior to this. “We had a solution back in 2007 but we didn't publish it, stupidly enough. So the authors credited for this are Gârleanu and Pedersen, and that's now a classic paper.”

He adds: “I now regret not publishing our solution because this is a good way to enhance the firm's brand.”

One area of future research Bouchaud sees as increasingly important involves agent-based modelling of macroeconomic issues. CFM's recent paper on central bank inflation targeting is the first in a drive towards macro-modelling.

“Agent-based modelling has been used a lot on traffic jams, for example, or epidemics, but not enough in macroeconomics. So we have been trying to put our toe in the water since 2012, and this is probably going to continue in the coming months.” ■