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Souleles, Daniel

Document Version
Final published version

Published in:
Economy and Society

DOI:
[10.1080/03085147.2019.1678263](https://doi.org/10.1080/03085147.2019.1678263)

Publication date:
2019

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Citation for published version (APA):
Souleles, D. (2019). The Distribution of Ignorance on Financial Markets. *Economy and Society*, 48(4), 510-531.
<https://doi.org/10.1080/03085147.2019.1678263>

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Download date: 20. May. 2024



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To cite this article: Daniel Souleles (2019) The distribution of ignorance on financial markets, *Economy and Society*, 48:4, 510-531, DOI: [10.1080/03085147.2019.1678263](https://doi.org/10.1080/03085147.2019.1678263)

To link to this article: <https://doi.org/10.1080/03085147.2019.1678263>



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Published online: 03 Dec 2019.



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The distribution of ignorance on financial markets

Daniel Souleles

Abstract

In the economists' old conception of a market, perfection would arrive when all participants had complete knowledge. However, economists and psychologists have lately realized that ignorance and bias more accurately describe the state of human knowledge even around those hallowed moments of transactional decision making. In these new academic stories, these models of irrationality and bias often take the form of basic cognitive features or evolutionary mal-adaptations. However, it's just, as is often the case, that there is also a historically specific story about local culture to be told about ignorance. This paper will report back from field-work conducted with contemporary, computerized stock traders, develop a typology of the things they say they don't know, and then suggest what this has to do with some of the more durable features and behaviours of contemporary financial markets.

Keywords: Finance; markets; traders; trading; ignorance.

There aren't many secrets in finance. So, anybody who tells you differently is lying to you. (Horace Banning (D029), Algorithmic Trading Lead)

On interviewing futures traders: I'll talk, but I gotta bring my lawyer ...

Technological sophistication has been a descriptive leitmotif in the study of financial markets over the past few decades. Not only has a new class of often

Daniel Souleles, Department of Management, Politics, and Philosophy, Copenhagen Business School, Porcelenshaven 18A, 2000 Frederiksberg, Denmark. E-mail: ds.mpp@cbs.dk

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PhD-educated hard scientists and mathematicians steadily replaced less formally educated traders drawn from local networks (e.g. Derman, 2007; Zaloom, 2006), but the infrastructural baseline of much reporting on finance has emphasized the fact that financiers, in their communicative race against each other and the speed of light, have invested astronomical amounts of money in data and the computers to process it (e.g. MacKenzie *et al.*, 2012), leading to ever more sophisticated, fine-grained analyses of how markets function, which trades will make money, and when to execute a given strategy. But, despite all that, when I sat down with six people, traders, data scientists and a lawyer, at a technologically sophisticated, high-speed market-making firm, Firehose Trading in Chicago, in a generic conference room (industrial carpet, fluorescent lighting, white walls, tables, chairs, a projector, a speaker phone, etc.) at 4pm on a Friday in the Fall of 2017, the people in the room told me over and over and over again that there was a lot that they didn't know about the markets they traded on.

Again, Firehose is a futures market-making firm, that needs to execute their trades at high speeds via an elaborate, proprietary technological architecture. Futures are a contract to deliver some asset at a set price at a specified future date. For example, if some people were interested in guaranteeing the price of oil 90 days from now, they might buy one 'lot' (1,000 barrels, or the smallest unit you can trade) of Light Sweet Crude Oil Futures on the New York Mercantile Exchange at the price of \$66.81 per barrel. There are a number of reasons people might want to buy a futures contract – they might need to guarantee a supply of oil at a price they can afford. They also might be using it in a larger investment portfolio, perhaps assuming that oil prices have some uncorrelated relationship to the other things you invest in and could therefore offer them the opportunity to hedge some other risk. Or they might have an investment strategy based on their analysis of the electronic trading architecture, and have some proprietary knowledge that when one type of trade shows up on an exchange, another will follow. Or they could be market-makers like Firehose, and not really care about any of that. They may just want to make lots of bids and offers, making money by allowing for a functional marketplace (see also MacKenzie, 2018a). In thumbnail sketch, this gets at some of the variety of market participants – fundamental traders, hedging investors and market makers.

Market makers are a class of traders that often, though not always, have a special relationship to the exchanges that they trade on. In exchange for incentives (say, trade rebates [bonuses for making particular kinds of trades], or more favourable margin requirements [margins are the amount of money you have to have set aside at the exchange to cover the risk of your trades]), market-makers ensure that there will be a market, there will always be someone selling and buying, in whatever it is they are trading. The vast majority of public, lit markets are constructed around a limit order book in which there is an aggregation of anonymous, electronically submitted bids to buy and offers to sell whatever the market is trading. The 'spread' is the space in between the highest buy

price and quantity or ‘bid’ and the lowest sell price and quantity, or ‘offer/ask’. This is how Firehose makes their money. They make a lot of markets in a lot of different futures on exchanges all over the world.

When the day arrived for the interview, I was prepared for evasion around sensitive, competitive and proprietary information regarding the firm’s trading strategies (remember, there was a lawyer monitoring the conversation). True to form, my contact Solomon, his colleagues and their lawyer redirected the conversation numerous times. Again, I expected this (see also: Souleles, 2018). What I did not anticipate, though, was what they *could not* tell me. Nine times in the course of an hour and a half interview they explicitly said and elaborated, that despite being exceptionally successful market makers, they did not know basic things about their competitors or customers.

What I will suggest is that what I heard at Firehose exemplifies contemporary financial market conditions more broadly – namely there are certain structural, repetitive gaps in knowledge that market participants have that in turn informs the way they behave on markets, and perhaps how financial markets more generally act. While many of these gaps in knowledge reflect long-standing and long-observed traits of financiers – say, the difficulty of predicting future market moves or a company’s behaviour – a number of the expressions of ignorance I noted are due to changes that have happened in financial markets over the last 20 or so years as they have become electronic, fragmented, and, in many cases, anonymous. I’ll illustrate all this using a corpus of interview data from a cross-section of market participants, anthropological theories of knowledge as well as more widely dispersed theories of ignorance.

I will suggest that ignorance varies depending on structural market location, and market function. Put another way, a regulator will experience market ignorance differently than the market makers at Firehouse, who both will not see things differently than someone managing an investment fund, running a brokerage software platform, or managing a hedge fund. All of these players have different priorities in, on, and around financial markets, despite all being alienated by a market structure designed to isolate them. I will suggest, too, that all this adds up to a fairly consistent, alienated and isolated ignorance on the part of market participants. First, though, before we go too much further, an example from my meeting with Firehose to set the stage:

At one point we were talking about confusing market behaviour, and we got to talking about how exchange rates, currency futures and treasury bond interest rates interacted in unpredictable ways after the financial crisis. Specifically, they got confused when the interest rate for Eurodollar deposits (US dollars deposited outside of the United States) was lower than the interest rate on long-term US treasury notes (what is supposed to be the safest, most boring investment to buy, and priced low accordingly); something is up with financial markets.

Firehose Trader #1: At the time everybody was going what? What's going on? What is going on? When the Eurodollar rates are below treasury rates, what? What? Fed government rates are higher than bank rates?

And it certainly was not because anybody thought the United States was literally gonna default on their debt. So, that was a big puzzle. And there were still disagreements about what that meant and why it happened. But it certainly hampered a lot of people's trading. I know tens of traders just took it on the chin for a long time after the crisis. So, yeah, definitely, there are things you don't know what the hell's going on ...

Some people think, oh, it's all the PhDs at Goldman. Well you can talk to the PhDs at Goldman. I remember talking to their risk guy when we were switching to Goldman for Eurodollars ... so yeah, you know this idea there's true cause. 'Cause we know some of the smartest financial mathematicians and we know that nobody truly understands all the weirdness that's going on, and how suddenly the lemmings can wind up and move one way or the other or whatever. There's too much going on. It's too much of a complex process. (D020)

There is a lot going on here. What I'd like to highlight, though, is that Solomon's colleague articulated a number of ways he doesn't know markets that I'll be returning to over the course of this paper.

First, from a macro perspective, he doesn't know why Eurodollar rates would go lower than treasury rates given that no one (he knows) thinks that the U.S. is going to default on its Treasury bond payments. The aggregated market is behaving in a way that he thinks is weird. Second, he doesn't know who is doing it. He suggests that often people explain weird market stuff by means of invoking 'the PhDs at Goldman' – the PhD physicists, financial mathematicians and economists that the investment bank and financial services firm Goldman Sachs employs as quantitative traders. Surely there is something to their mystical expertise and arcane ways that would explain such a move? They must have figured something out about the markets that we haven't, and, therefore we're all left to react.

Solomon's colleague deflates this idea as quickly as he says it. Firehose talked to the PhDs at Goldman. The PhDs at Goldman were perplexed too. As a final surrender to the inexplicable market movement, Solomon's colleague decides market participants must be lemmings. A second trader punctuates the exchange:

Firehose Trader #2: I'd like to further [Trader #1's] point. We've seen a lot of very violent moves recently happening at a much higher frequency than normal. How is the [order] book still so thick as it is? Like, all these people are out there, are they not getting run over¹? And, if so, how is that possible? So, there's this confusion, is it that they are getting run over and they're just being very rational about it and are just holding on? Just taking the loss on the chin and continuing to stay in the market. [It's] very confusing. [It] didn't used to happen.

Very basically, the traders at Firehose don't really know who are on the other end of their trades. Their markets and their orderbooks are electronic and often anonymous. As a consequence of this, they're at a bit of a loss to both explain and perhaps plan for what current market participants are doing.

Trader #2 is correct. Though the time frame he's referring to in his quote is ambiguous, for a variety of reasons, this didn't use to happen. As recently as in the early 2010s, futures and options were traded in person, physically, in trading pits at exchanges.² In this context, traders had access to a tremendous amount of information, both formally and informally, about who was making what trades and why, that could then inform their own participation in markets (Baker, 1984; Zaloom, 2006). This information was essential. However, over those last two decades markets have electrified, automated and anonymized in ways that have changed many of the mechanics of trading (MacKenzie, 2015, 2018b), as well as leading to abnormal market behaviours such as flash crashes (Borch, 2016). Humans rarely, if ever, trade directly,³ and the algorithms that do their trading for them are built on information and assumptions that developers can glean from these electronic order books.

While there is a large literature parsing what this sort of electrification, anonymization, automation, and lack of physical co-presence means for markets and traders (some of which I will review below), I'd like to anchor my inquiry about ignorance to questions about market design and knowledge researchers raised in two ethnographic studies of futures traders, released a decade apart.

In the late 1990s, Caitlin Zaloom (2006) did ethnographic field-work on futures traders, first as a runner for futures pit-traders at the Chicago Board of Trade, then as a click trader at a London based trading firm. Over the arc of her field work she saw the shift from in-person trading to anonymous participation in electronic markets (though, the trades she saw were still manually 'clicked' in and not yet automated). She observes on the process of anonymization embedded in electrifying markets, 'Creating an autonomous market space depends on a commitment to separating the trader from the ties of family, friendship, place and work; it is, therefore, a political as well as an economic process' (pp. 163–164). She goes on to note, 'such work is never quite finished: there is no end to the process of producing the conditions of formal rationality' (p. 165). Zaloom observes that rationalism, as an ideal, is never quite achievable in the here and now in market design. Given this, markets' shape, form and regulation are constantly in flux.

One question, then, for the researcher is in what ways does market design affect the relations of traders to each other, and the assumptions they can build into their automated trading strategies. Zaloom observed that in the era of open outcry, '[A trader] with ears open ... can glean a certain amount of 'feel' and the important information that the pit has to offer: who, exactly is buying and selling' (p. 161). And even when markets are electronic but still manual/non-algorithmic, traders are able to make up a certain amount of narrative and ethics as to what is going on. What do traders and algorithmic developers know now that they're out of the pits and anonymous to each other?

Ann-Christina Lange (2016), has provided an answer in her paper, 'Organizational ignorance: An ethnographic study of high-frequency trading'. In her paper, drawing on work at a 'proprietary high-frequency' trading firm,⁴ as well as a number of interviews with related professionals, she suggests that, due to the basic task of creating automated algorithms to function in markets in lieu of human click traders, the traders she saw were isolated intellectually both from each other and the wider market. Because of a hyper-partitioned workflow that prevented individual programmers from seeing the totality of a trading strategy they were working on, workers at her firm didn't know the strategies their colleagues were employing, and they certainly did not know what people outside of their firm were doing on markets (p. 237). Lange suggests that this internal ignorance is due to the protection of trade secrets – so narrow is the profit margin of many high-speed traders.

Moreover, she suggests that this is evidence of a larger, thorough-going 'black-boxing' effect across high-frequency trading – no one knows what anyone else is doing due to the protection of trade secrets and the nature of algorithmic trading and development. There are larger ramifications of this sort of professional secret-keeping: traders by definition can't know what other market actors, like them, are up to.

Lange's paper made excellent use of data in and around a particular type of actor – a proprietary high-frequency trading firm. What I would like to do is broaden the sample to investigate how ignorance manifests across the current variety of market participants. I suggest that it's not so much a product of algorithmic black boxing in development and then in trading that leads to ignorance, but rather a basic feature of how contemporary electronic markets operate – a function of market design as Zaloom might have it – that everyone is kept anonymous from each other. MacKenzie and Pardo-Guerra (2014), in fact, convincingly argue that this isolation and anonymity was a deliberate regulatory imposition on markets, designed to prevent collusion by, among others, broker-dealers.

Moreover, I would like to show how this feature of market design – the anonymous, electric, limit order book – leads to predictable, structured patterns of ignorance among various types of market participants. I'll highlight market-makers, brokers, investment firms, hedge funds and regulators, and will show that if something is presumed to be unknowable, it will affect the way in which people structure their trading strategies, their interactions with markets, and in turn how markets behave.

To help this effort, I will conjure some wisdom from the anthropology of knowledge and wider studies of ignorance. Then, I'll explain where my data came from and to what use I can put it, showing examples of ignorance that structures market actors' identities as well as ignorance that structures their market behaviour. Finally, I'll suggest how paying attention to not knowing is useful for understanding how financial markets operate, hoping to, if not answer, at least explain a little bit of why things are so confusing for Solomon's colleagues at Firehose.

Theories of knowledge: knowing and not-knowing are social

Before we can understand more about the traders at Firehose, I need to explain what exactly I mean by knowing or being ignorant of something. My starting point is that knowledge is not an individual possession, floating free of context, but rather that knowledge is inextricably social, and cycles dialectically between individuals and their larger social scene (e.g. Barth, 1987; Murphy, 1971). Given that, a definition of knowledge need not be terribly elaborate. In his essay, 'An anthropology of knowledge', Fredrik Barth (2002) defines knowledge simply as 'what a person employs to interpret and act on the world' (p. 1).

Though this isn't breaking new ground for anthropologists or sociologists, it should be noted that this is different from theories of rationality and cognition that centre, psychologically, the individual brain and its modes of cognition (e.g. Kahneman, 2011), and starts to find some common ground with the theories of rationality that, while still focusing on individual decision making processes offer some concession to context (as in the case of Organization Studies' 'bounded rationality' [Simon, 1991], 'behavioral economists' ultimatum game experiments [Nowak *et al.*, 2000], or the work of economists that are finally starting to realize that humans don't have perfect information and that theories should reflect that [Stiglitz, 2002]).

What becomes interesting, though, is how knowledge functions. Barth offers a suggestion:

By our acceptance of valid inference, we all extend the reach and scope of our knowledge immensely, relying on judgments based on whatever criteria of validity we embrace – above all, what others whom we trust tell us they believe. As a consequence, much of our knowledge we have accumulated by learning from others – including, indeed, the criteria for judging validity that we have learned to use. Though it is experience-based, most knowledge thus does not become private in any individual sense. (Barth, 2002, p. 2; Lave & Wenger, 1991; Lave, 2011)

Knowledge, again, cycles between the individual and the individual's social context (see also, Crick, 1982; Cohen, 2010). In this way, any study of knowledge or ignorance is a study of the accumulated ways a group of people make sense of the world, novel interpretations of that world included.

Knowledge-as-social, again, is likely basic to most social scientists. Moreover, more broadly still, the question of knowledge, epistemology, how we know things, takes up a staggeringly large portion of a variety of intellectual disciplines. What is more recent, though, is a focus on ignorance. What happens when people don't know something? Proctor and colleagues (2008) felt that the field was so new that it merited a neologism, 'agnotology', a seminar and a volume. Routledge has published a handbook on ignorance studies (Gross & McGoey, 2015). And a philosopher has suggested that, 'knowledge and

insight accumulate fastest in the minds of those who hold an ignorance-based worldview' (Vitek & Jaskson, 2008, p. 5).

What emerges from this relatively new interest in ignorance is that, far from being a residual category, or a simple absence, ignorance is every bit as socially determined and mappable as knowledge. And, while there are a number of other ways to understand ignorance – Gershon and Raj (2000; see also Arndt, 2016) illustrate the way knowledge and ignorance structure social identities; Rancière (1991; see also Scroggins, 2017; Varenne, 2009) demonstrates the emancipatory, generative power in ignorance, particularly among students – for the analysis of financial markets and their participants, I'll focus on how we might understand larger geographies of ignorance as part and parcel of large social and technological systems as Lange alluded to above.

According to that which came before, the ignorance of large social organizations is either (1) an a-moral byproduct of their size and structure; (2) a necessary byproduct of utopic bureaucratic desire to treat all who come equally; or (3) a deliberate strategy used to shield an organization and the people within it from the consequences of actions they or the organization take (in order: Tett, 2016; Graeber, 2015; McGoe, 2007). McGoe (2007), in her analysis of the governmental regulation of SSRI antidepressants related to their potential suicidality, fuses these modes of ignorance on the part of powerful social entities suggesting that there is a larger, 'strategic will to ignorance' (p. 216).

Today, even the admission that one harbours a secret, risks a measure of public censure for the unwillingness to disclose it. Thus, the feigning of ignorance – whether deliberately or unconsciously, collectively or individually – answers the twin demands of appearing transparent while wielding control over the very information one has an interest in concealing. (McGoe, 2007, pp. 216–217)

I'll suggest that we might see something similar in financial markets. Ignorance is a deliberate component of market design; because ideal market actors should not know what others do, both to stave off collusion and to find 'true' prices, markets are designed to create such lack of knowledge on the part of other actors (see also Callon, 1998, on the intentional structuring of classical economic rationality in a market). Moreover, the lack of knowledge and the inability to collude shields individual market participants from accepting any guilt due to the havoc of, say, being responsible for trashing others retirement savings in a volatile stock market. There is no possibility of collusion – there are only individual trading agents that add up to a market. It's politically expedient; it's by design; and, in a neo-classical way, it's utopic.

Eclectic methods

Since September 2017, I've been a member of AlgoFinance, a group research project at the Copenhagen Business School, studying changes in markets due

to many of the shifts I enumerated at the top of the paper. Specifically, we're doing ethnographic research to support the development of an agent-based modelling simulation of financial markets. It turns out that there is no real way to observe algorithms interacting with each other in a limit order book in the same way that one might have as a runner at the CME trading pits. Nor is there a central repository of algorithms – they're proprietary. Even retrieving agent resolved data from exchanges – that is, data that identifies market participants, is exceedingly difficult. So, insofar as we want to see how algorithms interact, that is, 'algorithmic sociality' perhaps, we would need to build a plausible simulation, run experiments, and then validate our findings against actual market events, and by way of industry experts. The ambition of this project has called for an interdisciplinary approach.

The project is headed by Christian Borch, a sociologist by training. I, an anthropologist, work with two other sociologists, Bo Hee Min and Kristian Bondo Hansen. The four of us are conducting fieldwork in Chicago, New York, Washington DC, London and Amsterdam with various market participants seeking to understand the make-up and distribution of current market actors and their strategies as well as the minutiae of daily life revealed in the course of ethnography. In turn, our findings inform the decisions we collectively make about the structure of our financial market simulation. Our agent-based modelling platform is being constructed by Nikolas Skar-Gislinge, a physicist; Pankaj Kumar, a data scientist; and Zachary David, a trader and finance software developer. I enumerate all of this to give some sense of what is behind the field work I'm reporting on. In addition to what any of us do individually, we have the context of a larger, collaborative project, replete with working groups and visiting experts, that allows us to check the validity of our findings in ways not easily legible in a simple reporting on rolls of informants or months logged wandering around financial districts of some metropolis or other (Hoffart, 1991 on 'member checks').

For this specific paper, though, from a larger archive of interviews and field notes I took a corpus of 31 interviews that we in the project have conducted with a variety of market participants – brokers, market-makers, hedge fund investors, proprietary traders, ETF makers, regulators, at a variety of levels of seniority. We might call this a maximum variation sample. The interviews were open-ended and ethnographic in nature, designed to elicit structures and frames of thought (Spradley 1979), though they did have a preliminary section which collected life and career history as well. I chose 30 interviews because there seems to be evidence that novel themes in cultural data slow to a trickle after thirty or so interviews (Guest *et al.*, 2006, p. 67⁵).

To analyse the transcribed interviews for instances of ignorance, I first listened to all the interviews and noted moments when people explicitly acknowledge that they or someone else did not know something, regardless of how it was framed syntactically. Then I went through each interview and did a full text search for 't know' (for 'don't know') or any phrase that puts 'not' before 'know'. I realize this is a fairly limited range of the expression of ignorance,

and that, again, sticking to semantics, we could easily multiple the range of expression I've suggested by tens ('don't really know', 'not sure', 'couldn't say', 'haven't the faintest', etc.). My gambit in restricting my analysis the way I did was that there would likely be plenty of varied data to make an analysis, and everything else would occur far less frequently than 't know'. Moreover, I was not persuaded that different, more difficult to locate or idiosyncratic linguistic tags would necessarily reveal a radically different structure of known and acknowledged ignorance. In any event, it seems that I was validated in this assumption as I turned up 279 examples of 'not knowing' across the 31 interviews, coming to an average of around nine 'don't knows' per interview. From this, I came up with 13 categories of ignorance, with one residual pile of 16 one-offs I couldn't fit anywhere. I list the categories below.

I was gratified too, that the distribution of instances in categories seemed to roughly follow that of the sort of cultural data that is enumerated in free-lists, that is a few frequently occurring categories then a long taper off, as in the case of a scree chart (Weller & Romney, 1988; Weller, 2014). Moreover, the categories were confirmed as sensible by members of my team as well as the informants who took up the offer to read, review, and correct a draft version of this paper (again, Hoffart, 1991). Some of these categories could arguably be collapsed (number 5, might be a subsection of number 2 for instance), but at the end of the day this sort of analysis is both an empirical *and* an interpretive act.

1. Don't know who is on the other side of a transaction/why they are in the market. Both inside the same firm and in the markets more broadly 94/279.
2. Establishing the difference between finance and non-finance people by what the finance people know and the non-finance people don't know 37/279.
3. The future effect of contemporary events on markets is unknowable 29/279.
4. Ambivalent about how to frame a fact/don't have an interpretive frame to contextualize a fact 22/279.
5. Sceptical of how the researcher frames something/dubious of the researcher's premise 20/279.
6. Trading model is so complicated you don't know what it will do/what it does 19/279.
7. The world of finance is big and I am small therefore I only know my little part of it 16/279.
8. I don't know the thing because it happened before my time/after my time 14/279.
9. Unsure if knowledge exists 5/279.
10. Something unexamined about one's past/don't know how to interpret or place an experience 4/279.
11. Don't know something about family 4/279.
12. Speech act to introduce a hypothetical 3/279.

13. Don't know the word in English 3/279.
14. Residual, don't know how to categorize 16/279.

This, then, is the empirical grounding of what will follow. In turn, I'll explain what various market participants do not know about the markets they are on or the people they trade against. Taken together this will illustrate how ignorance is a pervasive structural reality and constraint in contemporary financial markets, differently distributed than even a few decades ago.

Illustrating the varieties of ignorance: the truth isn't out there

Firehose's traders didn't know why the markets they traded on, made their livelihoods from, and in many ways identified with, behaved the way they did. This was typical of a larger phenomenon, that in response to electrification and anonymization of trading, market participants have new, durable ignorance about what other market actors are doing, and that this ignorance constrains the market actions people make. To develop this claim further, I'll show what this ignorance practically looks like for four further types of market actors, bringing us to five in total: market-makers (already treated above), brokers, sophisticated investors (like, say, a quantitative hedge fund), general investment corporations (like say an endowment, a pension fund, or, in this case, a family office), and market regulators. However, a note of caution: While, I believe my sample, our larger data-set, and the subsequent analysis suggest that ignorance of other market participants is a thoroughgoing feature of electronic, anonymous, algorithmically-mediated markets, I'm not sure whether we've reached saturation with all the various sub-types of market participants. As such, what I'll offer is a first attempt at granularity, at explaining specific actors and their relationships to markets. As our and others' research proceeds, we'll elaborate and hopefully corroborate what is below.

As to the types of market participants I've enumerated, I picked them to give a sense of general market dynamics and what different actors want from markets. As noted above, market-makers share a special relationship with various exchanges ensuring liquidity exists around the spread. Brokers offer access to the market for people who are not directly connected to exchanges. Hedge funds serve no formal market function like market-makers and brokers. Rather, they simply make use of the markets to invest, as a reliable place to buy and sell often with some sort of preferred asset class that has known correlational relations to others. Investment corporations manage money for other people and usually fund some larger societal function – sending resources to a university, ensuring pension payouts, or maintaining the elite social status of a dynasty or some such. Regulators ensure that markets are functional and that no one cheats. They have enforcement as well as policy making responsibilities. Altogether, these different sorts of players make up what we gloss as markets. All are ignorant in their own ways.

Hedge fund investors

Jathniel is a slender American man in his mid-50s. He's had a long career as a technologically sophisticated market participant, spending much of it designing ways to beat other investors to market and take advantage of having faster trading technology. He is currently working in a hedge fund that is trying to integrate his high-speed capabilities into their longer-term trading strategies (weeks, months). Key to the work that Jathniel does is using machine-learning algorithms to cluster and organize market data for further analysis. He might take a month's worth of trade data on a particular security and use a clustering algorithm to see what patterns in trades emerge, and if there are predictable activities that he can anticipate and profit from. While the minutiae of how this works is beyond the scope of his paper, Jathniel's sense of who his competition is, is not. I asked him if the techniques he used were standard. He said:

I don't know that people use it a lot. I mean, to be honest, it's hard for me to say this is standard or this is not standard because I don't know what other people do because we don't talk about it.

In my industry, no one ever talks about stuff ... You know, everyone has buddies from other firms and we talk and we talk about stuff in big terms like what we're working [on], but we don't necessarily say I'm using this technique because it really works and this time I can get it to work.

Like, I know one of my friends uses recursive neural nets or says he does. Once again, who knows? But, he knows.

You know, they generally don't work, and he says he's got them working. I don't know if that's true or not, but it's also none of my business so I guess that's why. (D012)

Even in the days of the pits, there would be a certain inscrutability to why someone made some trade or another. You'd have ideas about why trades were happening based on the brokers they went through and the patterns you could gather in the pit. But still, there would be an inscrutability to the big why with some trades. Someone knows something you don't. We might see Jathniel's complaint in a similar light.

I think though, there may be something else at work here. Absent person to person data and in the presence of the anonymous order book, again and again, Jathniel expressed his ignorance. He didn't know if people were looking at the same units of time he cared about. He didn't know if people registered the same market signals that he did. On a basic level, he doesn't even know if what other people are doing is more or less complicated than what he is doing. To my mind, this adds up to a cumulative deficit of information that would be, at least mitigated in the context of person to person trading, at least in the person of the broker, the person that controls access to the market.

Brokers

Not just anyone can trade on an exchange. Typically, you have to have some sort of membership or affiliation, traditionally a seat. That broker would have someone in the firm execute the trade (or a bundle of similar trades combined for lot size). The way brokerage manifests with contemporary trading is via market access. Large banks and financial services firms offer brokerage services to their clients – some do trades of their own, others simply function as brokers. What these services look like can vary widely, but often add up to some sort of market interface in which a would-be investor can enter the parameters of the type of trade that they would like to execute (measure of price, market impact, limits, and so on), and then automated algorithms, with or without human supervision, will visit the various exchanges, dark pools,⁶ and so on, and (try to) make the trade as specified.

Whereas in the past we could imagine some sort of relationship between a broker and their clients, wherein the broker might know what exactly their client had in mind, with the rise of this sort of platform, that kind of knowledge has fallen away. At least, this was the sense I got from Ephraim and two members of his team.

Ephraim works at a large financial services firm, and, among their products, is a brokerage platform that allows you as a client to trade various strategies across a variety of markets (say, I would like the time-weighted average price (TWAP), or the volume-weighted average price (VWAP) for Apple on NASDAQ over the following hour). Or perhaps I want to buy 10,000 shares of Apple, only if it's dropped 20 per cent from where I've seen it. Or maybe I wanted to 'ping' a dark pool to see if there is a better price. Or so on. Different exchanges allow for a variety of different order types, and Ephraim and his colleagues see it as their obligation to make them available in an easily navigable format for their customers. That said, because they don't really know their customers, and because they are deploying so many algorithms, they often won't know what effect their trading algorithms will have on their clients:

Mathematically, you could think of [order combining] as an optimization problem. But, the thing is, it's not as simple right? I mean, you can optimize all you want, but then you have some things that have to be governed by heuristics. Also, sometimes, you don't know right? If you introduce a particular action into an algo, you actually don't know whether it is beneficial or not ... the change that you make [could] have snowball repercussions. (D007)

Our users have themselves big compliance departments. They are looking for execution quality and also staying in front of the clients. You know, it's like your internet provider, you don't know anything about it until it goes down right? (D007)

There's a way in which these brokers are set aside both from the clients they service and the trades their algorithms make that introduces an amount of

uncertainty into their work. They try to keep up with changes in markets, changes in the macro environment, changes in their clients' demands. But ultimately, they don't really know what effect their algorithms will have.

Ephraim and his colleagues had it relatively easy, though. They didn't trade. Abiasaph, however, worked at a brokerage firm that also invested and traded, and observed the difficulty of figuring out what anyone else was doing.

A: I mean, once you have a money-making strategy, would you change it unless it stopped working?

We did some things to put up wide moats, to prevent people from even figuring out what we were doing. So, it was a lot of clever things that you can do ... I think a lot of high frequency trading groups that are successful end up being like that. But, it's never like that to the people that are there because there's a little bit of like paranoia. It's like people figure out what we're doing or some are father an us.

Daniel: Was the paranoia founded?

A: It's hard to say. The thing with paranoia is you think it's gonna happen overnight, and usually it happens over the first months. But, yeah, we found that it made us feel better about what we were doing if we could ... (D025)

Abiasaph is describing both a trading strategy and something that seems to adhere to being a market-maker. The trading strategy is creating moats, or deliberately misleading trades to throw people off your strategic trail. Perhaps you don't execute quite as fast as you are able to, but as fast as you need to. Or perhaps you take a dive on a few trades but your overall profit and loss is still within acceptable parameters. Regardless of how you do it, you're intentionally muddying the market, making it even more difficult for other participants to figure out what you're doing. And for Abiasaph, this emerges from a healthy dose of paranoia about what other people are doing. Are they on to us? Have we been scooped and we don't know it? Or, are we misreading someone else's moat and interpreting it all wrong all together?

Cumulatively, this leads to paranoia. And as Lange noted for ignorance of other algorithmic strategies, it's not just outside the firm that matters. Often traders don't know what other people inside the firm are doing. This seems true, too, for Abiasaph's paranoia:

When I left, there was a healthy amount of paranoia within the group.

When you start making money, and as you make more money, you start to fight over the money, and then fight over the credit. And then, you start to try to get suspicious of like what are they doing over there that's making money, that we're not doing, that they're not sharing with us, that they're planning on jumping ship with and going and starting their own thing with. Especially if the group gets bigger too, that happens, because you have people that are working on stuff that aren't getting paid that much 'cause they haven't contributed to like what

generates money currently. If they figure something out, why would they share it with you? They just leave to do their own thing in a certain group. So, that I think, it's just not a great environment. We had some conflicts that arose as a result of it too that led to people leaving or being forced to leave. (D025)

It seems, that for traders like Abiasaph, a certain paranoia comes from anonymous markets which both changes how they interact with the markets (they make intentionally non-maximally profitable orders) and makes them suspicious of each other. If one goal of market design is to create atomized, competitive individuals, we may say that electrification and anonymization seem to have succeeded.

Investment firms

Admittedly, 'investment firms' is a catch-all category. What I mean by it, though, is institutions that are set up to manage large amounts of other people's money, places that have a broad mandate to simply make money. They tend to be sophisticated, though not technological specialists, and have a wide portfolio of investments, of which algorithmic or high-frequency hedge funds would make up a small portion. They're of interest to us, because they represent a large portion of market volume, and are often investing over a longer time horizon (months to years), than more specialized shops like Jathniel's. They are active across multiple electrified markets, and must reckon with how markets function now that automation has occurred. The upshot seems to be that this sort of investor has trouble figuring out whether or not changes in prices or shifts in volatility are fundamental – that is, tied to the performance of a company – or noise that comes from algorithmic trading agents bouncing off of each other. They can't know whether shifts from algorithmic trading agents are due to investing fundamentals or noisy 'wars' between various algorithms.

Larry, one such investor, the manager of an American-based family office, gave some sense of the change that has come to his investing practice. I will quote him at length because he both walks through his theory of what has changed on financial markets and how he and his fellow investors deal with these market shifts. What it all comes down to is an uncertainty about the cause of market movements caused by anonymous trading algorithms:

Larry: I'm definitely not a person that thinks that algorithmic trading is bad. It's just the evolution of the marketplace is such now that I think the biggest change has been post Dodd Frank this strange outcome where natural buyers that used to take advantage of fear, they're just not there. Qualitative buyers, they're just not there.

You can't get a mutual fund manager to be like well at 2:00 I'm going to start buying. They're not going to do that. They're tracked to an index and so, they're methodical. If a huge organization has a buy order in say JP Morgan

or Apple stock they do it via dollar cost averaging over a long period of time. The broker doesn't want to take the risk of being wrong 50 basis points.

D: In 20 minutes.

L: Exactly. So who's left? It's only the quant guys. They're the market makers and the market takers ...

D: So given these dynamics that are emerging as these natural buyers have gone away, how has it changed the way you guys invest?

L: We don't look at the markets as much anymore.

D: Could you explain that a little more?

L: Like on a day to day basis. So like, I would say like a decade ago, we have systems that track our financial reporting or portfolio management reporting ... I could run through a lot of engineering based statistics to showcase even if that market moves one standard dev, two standard dev, three standard dev, based on historical or implied volatility, I'd be like fine, OK, maybe this is an opportunity to buy or sell. OK.

Now, the printing of that number as well as the signals it generates, it's just become another level, meaning if we're academics, we could say a three standard deviation should occur in once maybe three years. I think it occurs now, don't quote me on this, but it feels as a human, six times a year.

D: So, from a human point of view, that's just crazy?

L: Right.

D: So, we used to in the past, when we saw a move based on historical vol[atility] or implied vol, and we had a buy over the quarter, of course that'd be like calling the broker, dating myself, saying yeah, go ahead, work this limit order at that price. Then the second deviation gets in, OK work some more, third deviation hits, works some more, because this is probably only going to happen once this year. But now, since it's happening six times per year we just don't look at it ...

D: Could you explain it a little more?

L: So like in the past to de-risk a portfolio we would have regimented stop losses.

D: Ah. Based on your historical whatevers⁷?

L: Sure. Say Apple if it goes down five per cent we have to take some profit off. Or if it goes down 10 per cent we have to take some profit off. We've decided to in essence put that under review. Does that make sense?

D: So you intervene with a human?

L: Mhmm. Simply say, we pause to ask if the sell-off is 'genuine.' It's almost like, does this sell off make sense or does it make no sense. Because the quant people will want us to think our numbers are numbers, track your P&L in real time so we're giving you liquidity to trade, sell out of your position and trade so you have some profit. And so many times it's wrong now because the stock or index snaps right back. (D047)

Larry manages and invests millions of dollars. He is uncertain when markets become chaotic or when they lose and gain value, whether or not trading agents are moving things around due to investing fundamentals or due to algorithmic competition and churn for churn's sake. He suspects, given how often things revert, a lot of what he sees is noise inherent to this new market environment. But, he can't be sure. So, he and his colleagues trade less often, and do so over a longer time horizon. They deal with anonymous markets by trading less.

Regulators

Standing above and at some remove from day to day trading are regulators. In the United States financial markets are heavily regulated. This means that there are government agencies, such as the Securities and Exchange Commission (SEC) for equities and Commodity Futures Trading Commission (CFTC) for futures and some derivatives, that are given the task of ensuring orderly, functional public markets. They do so by both establishing regulatory law, and bringing legal enforcement actions for violation of those laws. Often, given that they lag technologically and strategically behind the financiers that they regulate, a lot goes on in markets that they don't know. Given, too, that their enforcement tends to be reactive and can be motivated by referrals and tips, they generally start from a position of ignorance.

There are two forms of this sort of ignorance that I'd like to highlight: the first has to do with an outlook that is at some remove from trading; the second has to do with the mechanics of reconstructing what traders do. Both seem to come about from regulators' structural relationship to markets as well as the amount of technological change that has come to markets:

50 years ago, Sam, a physicist by training, would not have been leading a division of a regulatory agency. But 50 years ago, no one really thought you would need a physicist to understand financial markets. In the course of an interview, I asked Sam a question about what was causing contemporary low volumes of trade and relatively small amounts of price fluctuations or low volatility – things that seemed to be concerning a number of other traders I was talking with. In answering me, he suggested that he didn't really accept the frame of my question, and demonstrated that his new type of financier is bringing a novel set of interpretive and metaphoric knowledge to bear on the world of finance:

I don't know. I mean, we're most certainly in a low volatility regime, and we most certainly have seen prices steadily increase for a while. Why is that again? We have low interest rates. With very low volatility. You expect prices to be higher because risk is lower. Plus, the global economy seems to be rebounding from the huge disaster of the global financial crisis. Have we gone too far? I don't know. Maybe we have. Maybe we're in for a correction. A lot of people say that probably, so that's your speculation?

I mean, if you say that prices are accurate, then what you would say is we have a multitude of future states and each one of them has a certain probability of occurring. And, if you take the probability, multiply it times the price of the securities across those it should equal what the current price is. So, even if we have a correction maybe that's because in that state we ended up in a state of the world where, you know, quantum fluctuations pushed us to that state. Whereas, it could have been that we kept steadily going and that prices are accurate now. So, even if we have a correction, that doesn't mean to me that prices were inaccurate. Now, I don't know. I mean, and again that just goes back to the whole idea, is a bubble really a bubble or not?

I think that there is evidence that bubbles, because they are mean reverting, that you can show mean reversion of them, that potentially they are really bubbles. But, otherwise, there's all you know the other argument is well, prices are a random walk. I mean, the economy, what happens to it, is a random walk. So, yes, we would, should expect, then, in certain cases, prices go down, certain cases prices go up. And, if you have quantum fluctuations which change things in one way versus the other you could avoid ... You know, in fact, if you believe in multiple universes, there is a universe at which we were in the good state and prices remained high and the economy remained good. (D017)

Setting aside how remarkable it would be if there were universes born every time markets went into recession, it's unclear to me how widely spread Sam's speculation about why markets behave the way they do is. I am certain though, that finance is shifting towards people like him, people who have a radically different frame of reference from more conventional traders (Zaloom, 2006, pp. 83ff).

Sticking to this universe, Sheryl Lange and Bobby Bee work at another US regulatory agency, in an enforcement division. They sat comfortably in a small white office with a window overlooking a construction site. They both had economics backgrounds. Sheryl explained that even if they had all the data in the world, contemporary, electronic markets produce an 'endless number of it,' in terms of, 'breadth, width and endless sophistication'. 'You can correlate and cross correlate markets, and there are endless rows and observations ... Moreover, there is the issue of timing; it's ultra-high frequency, not just multiple rows but multiple milliseconds'. In sum, 'It's as complicated as you want it to be ... an endless puzzle ... you understand a tiny bit of it. After 30 years, maybe you understand your own market ... By the time you understand it all, the ground would have shifted under you and it all would have evolved away'.

This isn't as drastic as it sounds, though. Yes, there are any number of structural and practical and velocity-based reasons that regulation can't keep up with markets and why regulators don't know what is going on when it happens. But Sheryl pointed out that, 'They have years. Finding something at the exact time of occurrence eludes us. But, we have years'.

Market structure, intentional ignorance and economic man

Bureaucracies public and private appear – for whatever historical reasons – to be organized in such a way as to guarantee that a significant proportion of actors will not be able to perform their tasks as expected. (Graeber, 2006, p. 2)

A number of social scientists have made important contributions to the study of stock trading, documenting the changes that have happened over the last 20 years or so. Many of them have striven to show that when traders left the pits and plopped in front of screens, it wasn't so much that they lost knowledge of markets, but that they found knowledge of markets in different ways, via computer mediated forms of sociality and cognition (Beunza & Stark, 2004, 2012; Knorr Cetina & Bruegger, 2002; Preda, 2009). One thread uniting these studies is an attention to the way that cognition still functions and knowledge is still available.

What I hope the above demonstrates is that this computer mediated cognition and the knowledge of the electronic interaction order is only part of the story of the electrification and anonymization of financial markets. The other side of this is the creation and spread of particular patterns of ignorance.

Ignorance systematically affects the trading strategies of various market actors. High frequency operators have no idea what exactly their colleagues are doing and if they're paying attention to the same things they are. Brokers don't really know what their clients will do with their algorithms and how changes in code will affect their services. Traditional investors are increasingly sceptical of financial markets and trade less. Regulators, due to their remove from markets and the amount of data that markets generate always start in the dark, perhaps in a different universe. Finally, market-makers are paranoid that they're going to get run over by high speed predators and throw up smoke screens to mask their exact strategies. Taken together a picture emerges of specialized, atomized and often paranoid market actors, unsure of their competitors, and wary of losing their evanescent edge.

Perhaps the social sciences have finely found *homo economicus*.

Acknowledgements

Thanks are due to Christian Borch, Zachary David, Megan Laws, Teo Zidaru-Barbulescu and the participants in the LSE '(Mis)trust, Money, and Debt' workshop who all tolerated, read and commented on earlier versions of this paper.

Disclosure statement

No potential conflict of interest was reported by the author.

Funding

This project has received funding from the European Research Council (ERC) under the European Union's Horizon 2020 research and innovation programme (grant agreement No 725706).

Notes

- 1 Getting 'run-over' is one way of saying that the market is moving away from a market maker. If a market maker has bids and offers around a certain spread and price, and the market quickly moves away from them leaving them with useless orders, they've been runover.
- 2 Some pits are still open. The largest that I've seen is the S&P 500 options (SPX) pit at the Chicago Board Options Exchange, or CBOE, which has around 150 traders, down from around 500 a decade ago.
- 3 This is most true for equities. A lot of options are negotiated directly, over the phone, as are many futures contracts. Even with equities, though, large blocks can still be traded over the counter.
- 4 'Proprietary' means that the firm trades only its partner's money. 'High-frequency' is a loose term, generally referring to people who make use of their technological ability to get to markets faster than their competitors to make trades – in practice most trades are 'high frequency' at this point, going as they do through brokers algorithms meant to mitigate the effects of proprietary high-frequency trading.
- 5 Things really drop off after about 18 interviews in their study.
- 6 Dark pools are exclusive exchanges, often run by large banks or other financial service funds, that do not show their order book and take their pricing from some measure of prices shown on lit, public exchanges. Moreover, they often do not have first in first out order book dynamics, so it can be difficult to impossible to know what is listed on a dark pool until after a trade occurs, and is reported. The idea with all of this is to keep your trade from changing prices in lit markets.
- 7 I assure the reader that this is a term of interview art ...

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Daniel Souleles is an anthropologist and an Associate Professor at the Copenhagen Business School. He is currently studying financial markets and algorithmic trading. He has previously published in *The Journal of Cultural Economy*, *Economic Anthropology*, *Economy and Society*, *Field Methods*, and *Political and Legal Anthropology Review*. He has also written an ethnography of private equity investing, *Songs of profit, songs of loss: Private equity, wealth, and inequality*, published by the University of Nebraska Press in their series on the ethnography of contemporary North America.