

Executive Summary

The present landscape of securities markets and exchanges is fragmented. On a national or even regional scale, there is a degree of competition between exchanges as value propositions – whether in the commercial or regulatory dimensions. Internationally, we see ‘horizontal’ fragmentation of securities markets across different exchanges, while ‘vertical’ fragmentation occurs when alternative trading venues compete with conventional exchanges in trading equities and its derivatives.

It is obvious from the above that a monopolistic model of our exchanges dominates such a fragmented landscape. The result for the attendant price formation process is a non-coherence and inaccuracy in the prices formed (thus taking a toll on the social utility of the process) and the chance for opportunistic exploitation. In order to address this outmoded monopolistic approach, we should reconceive price formation in an absolutist manner.

This may be achieved by reconceptualising the landscape around “true global markets” for each individual security: where the “true global market” serves as the central focus of trading of its security. In other words, market-nodes would be isolated from each other, wherein each market-node will be supported by the use of decentralised ledgers (to record and represent ownership of assets) and cloud computing (to hold up the network infrastructure). This also allows for the benefits of both (spatial) fragmentation and (virtual) consolidation to be harnessed simultaneously.

As a result, exchange rules relating internally to the marketplace will have to be standardised, while those relating externally to the participants can be varied to differentiate the exchanges. National authorities can even be replaced by codes and algorithms in the enforcement of securities regulations.

Hopefully, investors and exchanges will, in the future, tap into each market-node for the trading of the respective securities, regardless of borders and boundaries – all playing their part in the collective absolute process of price formation.

300 Words

Introduction

A tap on the “submit” button below the ticker, a notification that the order had been filled, and a peek at the Yahoo Finance price chart showing the bid price reflected as the latest price for the ticker. This was all it took for me to complete my first limit order, and equity purchase – and all it took for me to play an infinitesimal yet constructive role in the enormous collective process of price formation on the New York Stock Exchange. The price formation process is this exercise writ large: replicated *ad nauseum* on a national or even global scale, by a range of stakeholders across the securities landscape (from retail investors, and funds to traders), all in the service of the moving right tip of a chart which moves at its own whim and yet dictates the fates of all these players.

But the price formation mechanism has not always taken this form. If anything, the technological forces at the fore of today’s economy have shaped it as such. And in light of new evolving technological realities, it is unlikely to persist in this form. In this essay, I envision a future for the price formation and discovery construct (in the context of securities markets and exchanges) which integrates the potentialities of today’s technologies - so that the interests of its stakeholders may be better served. In this future, a “true global market” will take root for each individual security, supported by a decentralised, isolated and nodal infrastructure. Indeed, “our work on [securities] market structure is never finished... instead, we must always be focused on what in our market structure can be improved for the benefit of investors and companies”¹.

¹ Mary Jo White, “Intermediation in the Modern Securities Markets: Putting Technology and Competition to Work for Investors” (Speech at the Economic Club of New York, 20 June 2014) <<https://www.sec.gov/news/speech/2014-spch062014mjw>> accessed 9 July 2020

The Present Construct of Price Formation

A Positive Look at Price Formation

It is apposite at this juncture to consider the present construct of price formation. Only by understanding the current structure can we base the future theoretical contours on normative grounds. We may understand price formation as an information-gathering process that ultimately allows market participants to sufficiently know the prices of the assets being traded so as to make well-informed decisions². There is added significance of the price formation process in securities market because the assets being traded are not for immediate consumption, but rather represent prospective earnings in the future³. However, this prospective cash flow is wrought with risks and uncertainties. The price formation process can aid by not only internalising the sum total of all objective externalities and subjective factors (being the knowledge and information of all market participants), but also doing so singularly with a numerical and concrete output.

This process is supported by a multitude of services and mechanisms provided by exchanges, which make up their regulatory and commercial roles. Firstly, exchanges provide trade execution (often together with market data as joint products)⁴, primarily through the technical matching of orders on the 'buy' and 'sell' sides. For example, the auction mechanism sees market participants engaging in the matching of bid-ask orders such that the highest bidding price is matched with the lowest asking price. Secondly, exchanges play other commercial roles such as the provision of liquidity

² Jonathan Haynes, "Price Formation and Market Data" (Speech at FESE Convention, Dublin, 5 June 2019) <<https://www.oxera.com/price-formation-and-market-data/>> accessed 9 July 2020

³ *Ibid*

⁴ *Ibid*

through market making, and the facilitation of initial listing of securities. Thirdly, it fulfils its regulatory role by implementing and enforcing rules which govern the trading of securities. It is through these various offerings that exchanges differentiate themselves as distinct value propositions.

This differentiation of exchanges as distinct value proposition is closely related to two phenomena relevant to the present price formation process and landscape. On the national or even regional level (for example, in the U.S. and E.U.), there is a certain degree of competition between exchanges as (commercial) value propositions – assuming the notional boundary of the respective financial markets is large enough to support such competition. A study in the U.S. has found that exchanges are able to capture and maintain economic rents from the sale of speed technology (e.g. co-location, proprietary data feeds), even if there is a single synthesized exchange across the fragmented market with trading activities split across various exchanges⁵. In fact, it has been posited that introducing and increasing competition to a (national) stock market (between exchanges and/or trading platforms) has the benefit of reducing trading and post-trading fees, while potentially fracturing price information as well as introducing incremental costs to regulators and brokers⁶. Hence, exchanges continue to present itself in a commercial dimension, leading to inter-exchange competition of varying degrees (depending on the country and region they are situated in). Going

⁵ Eric Budish, Robin S Lee and John J Shim, “A Theory of Stock Exchange Competition and Innovation: Will the Market Fix the Market?” (31 December 2019) University of Chicago, Becker Friedman Institute for Economics Working Paper No. 2019-72. Available at: <http://dx.doi.org/10.2139/ssrn.3391461>

⁶ Oxera, “Introducing Competition Between Stock Exchanges: The Costs and Benefits” (November 2012) Agenda. Available at: <https://www.oxera.com/wp-content/uploads/2018/03/Introducing-competition-between-stock-exchanges.pdf>

further, exchanges can even compete more broadly when one takes into account the regulatory role they play, and the variation of rules and standards they implement.

On an international scale, there is a global fragmentation across (rather than consolidation within) the landscape of securities markets and exchanges. This is clearest in observing the alternative listing and trading of securities, whereby the assets with substantively the same rights are listed and traded in different markets and, importantly, exchanges. A 2016 empirical study has found that there is a persistent price leader-follower relationship when a stock is traded on multiple venues, both during intraday auctions and subsequent continuous trading⁷. This has also been observed on the Singapore Exchange in relation to the trading of index futures; another study found that it is possible for the price discovery process to occur on a foreign country's exchange, insofar as one market leads while the other lags⁸. In this sense, fragmentation occurs 'horizontally' within the notional market for individual securities when more than one exchange is used to trade it and trading activities can occur in parallel – but usually in a price leader-follower manner. Fragmentation may also occur 'vertically' when new trading venues, such as electronic platforms and the futures and options markets, are added to compete with exchanges in trading an underlying equity⁹. Studies have found that such a 'vertical' fragmentation across alternative trading venues (beyond conventional exchanges) and the migration of

⁷ Benjamin Clapham and Kai Zimmermann, "Price discovery and Convergence in Fragmented Securities Markets" (July 2016) *International Journal of Managerial Finance*, Vol. 12 No. 4, pp. 381-407. Available at: <https://doi.org/10.1108/IJMF-02-2015-0037>

⁸ Jerry X Cao, Xiaoming Wang, Nelson Yap and Sili Zhou, "Price Discovery of Index Futures Across Markets" (2016) Research Collection Lee Kong Chian School of Business. Available at: https://ink.library.smu.edu.sg/lkcsb_research/5222

⁹ Mao Ye, "Price Discovery and Liquidity in a Fragmented Stock Market" (January 2011) *Cornell Theses and Dissertations*. Available at: <https://ecommons.cornell.edu/bitstream/handle/1813/33587/my87.pdf?sequence=1&isAllowed=y>

trading volumes result in lower transaction costs and faster execution speeds¹⁰, but may cause a primary exchange to lose its dominance in the price discovery process¹¹. Therefore, the fragmentation of particular securities markets and between exchanges which host their respective trading is an existing phenomenon of the present price formation construct.

A Normative Look at Price Formation

The significance of these two phenomena lays in both positing a framework through which to view the present construct and network of price formation, as well as understanding how it may evolve in the future.

What is consistent between the two phenomena is the monopolistic fabric and model which dominates the present landscape of securities markets and exchanges. After all, exchanges began as natural monopolies. Even as technology allows for exchanges and markets to network beyond geographical boundaries, the institutions which took root before the information technological age continue to be the reference point through which we conceive of securities trading. This has implications for the attendant price formation process because prices are necessarily determined at the market level (which we have observed is fragmented). And yet there is nothing inherent about price formation which entails that it should be fragmented in such a manner. Indeed, this allows for the aforementioned price leader-follower relationship to take place between primary and alternative trading venues. This takes a toll on the

¹⁰ Ye (n 9)

¹¹ Joachim Grammig and Franziska J Peter, "Tumbling Titans? The Changing Patterns of Price Discovery in the U.S. Equity Market" (18 April 2018). Available at: <https://ssrn.com/abstract=3194484>.

social utility of the price formation process because it emasculates the cohesiveness and accuracy of the prices formed. In fact, price information and price discovery are the most important products of a security market for they have many characteristics of a public good¹². The practical consequence is that it creates the chance for opportunistic exploitation and arbitrage. Even if the price leader-follower relationships mean that prices eventually stabilise, this is not a result of design and is inefficient (especially from the perspective of the price follower¹³).

To that end, the case for a “true global market” for each individual security may be better understood. If a monopolistic approach to price formation is to be treated as outmoded, a natural progression would be to dismantle this framework and conceive of price formation in an absolutist fashion. In order to achieve an absolutist and pure version of price formation, one may imagine a true market, which spans globally and without regard for conventional boundaries, dedicated to each particular security. This conception of committed and unfragmented securities markets will conduce to a singular process of price formation, and thus to coherence and accuracy in the resultant prices.

A Decentralised, Isolated and Nodal Infrastructure

It is suggested that the necessary improvements to the present construct of price formation capitalise on the recent developments in technology to overcome the present limitations faced. In solving the issue of a fragmented landscape of markets

¹² Joel Hasbrouck, “One Security, Many Markets: Determining the Contributions to Price Discovery” (1995) *The Journal of Finance*, Vol. 50 No. 4, pp. 1175-1199. Available at: www.jstor.org/stable/2329348

¹³ Cao, Wang, Yap and Zhou (n 8)

and exchanges, technology should be used to decentralise and democratize the price formation process, so that the end result will be a “true global market” for each individual security. The technological infrastructure will be one comprising of isolated markets as nodes, relying on decentralised ledgers (i.e. Blockchain technology) and cloud computing. In putting forward this vision, its regulatory impact will also be discussed.

Technological Developments

A major theme in recent developments of data and information technology is the “decentralisation” of existing infrastructures. This first entered the public discourse due to the explosion in popularity and concomitant trading of Bitcoin and its offshoot cryptocurrencies. The use of the underlying Blockchain technology also saw life in various commercial realms (e.g. supply chain management, corporate compliance)¹⁴. The attractiveness of a decentralised, cryptographically secure ledger, which records changes on every copy on the network, is clear. The immutability of the ledger allows it to be used as a tamper-free secure database to store data, and the simplicity of the idea allows for varied iterations across unlikely realms. For example, it has seen use in the budding decentralised internet; rather than have a single location and server for the hosting of data and information – and thus trust the host with the entire wealth of data – a network of computers stores encrypted data which can only be decrypted by the intended user¹⁵.

¹⁴ Klint Finley and Gregory Barber, “The WIRED Guide to the Blockchain” (9 July 2019) <<https://www.wired.com/story/guide-blockchain/>> accessed 13 July 2020

¹⁵ Tom Simonite, “The Decentralized Internet is Here, With Some Glitches” (5 March 2018) <<https://www.wired.com/story/the-decentralized-internet-is-here-with-some-glitches/>> accessed 12 July 2020

Another relevant development in technology (in the area of hardware) is the emergence of cloud computing. This may be broadly understood to refer to the outsourced use of a server for performing certain computing functions. In other words, computing functions such as processing and rendering (in the case of cloud gaming) will be carried out by an off-site dedicated server, often on a subscription-based model, thus alleviating the need for personal devices to require the latest, most expensive hardware¹⁶.

Schematics

In order to achieve a “true global market”, technology has to support the creation of a singular marketplace which can extend beyond conventional boundaries (e.g. geographical, linguistics, regulatory). The major existing constraints for such a conception arise from the existing monopolistic model of trading on exchanges, and include the reliance on exchanges for the basic execution of trade, variation in ways to transfer ownership of securities and the resulting general non-interoperability between exchanges. This can be overcome with the use of Blockchain technology, adapted for such a purpose. By relying on a trust-less and immutable ledger to record and even represent ownership of securities, we will be able to move away from reliance on a central authority (such as the clearing house or central depository) for executing trades and transferring ownership.

¹⁶ Steve Ranger, “What is Cloud Computing? Everything You Need to Know About the Cloud Explained” (13 December 2018) < <https://www.zdnet.com/article/what-is-cloud-computing-everything-you-need-to-know-about-the-cloud/>> accessed 15 July 2020

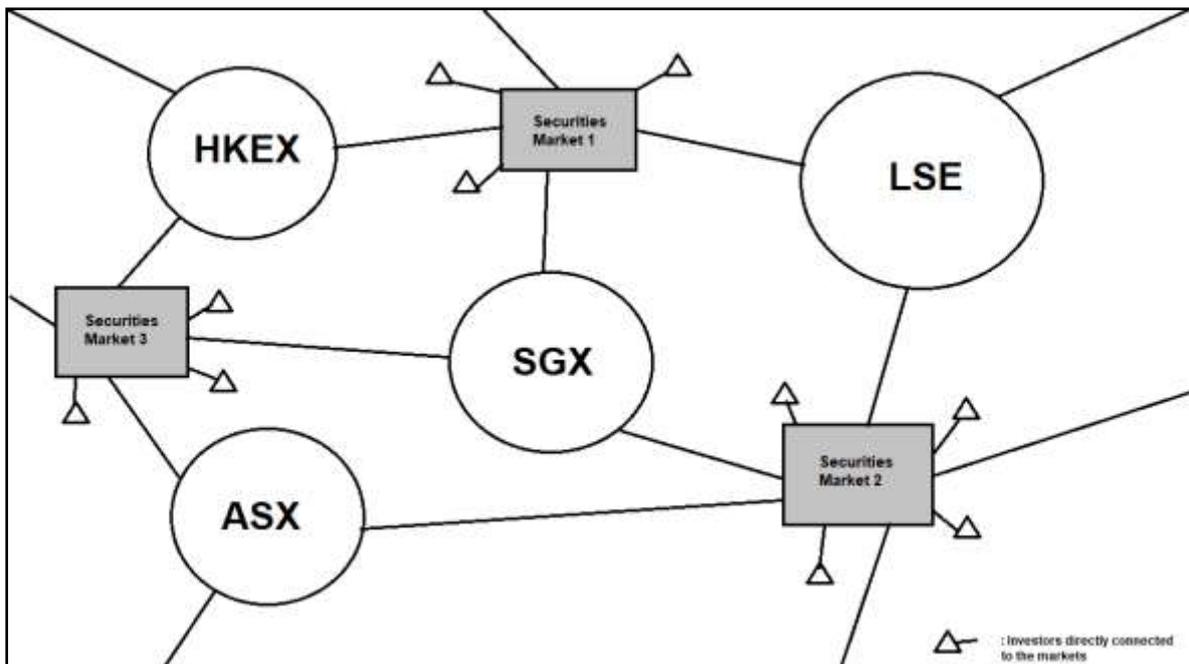


Figure 1: Simplified Schematic Diagram of Landscape of "True Global Markets"

Imagine a world where individual investors and traders employ the use of their personal devices to execute trades and transfer ownership of assets, while connected to a singular global market for that particular asset. In this landscape, exchanges step away from being the marketplace, and towards operating as processing powerhouses whereby the heavy computing work of running the network and processing the trades are carried out by the exchanges via cloud computing technologies. Multiple exchanges will be connected to the singular global market to provide computing prowess, and thus support the network infrastructure, while fulfilling its regulatory duties in overseeing market activities. Even if the technical matching of orders may conventionally require a central locale, this may be carried out on a parallel network from the execution of trades and transference of ownership, within individual exchanges chosen by cycling through a roster of the connected exchanges. Markets

would thus become nodes isolated from other market-nodes for other securities, but nevertheless serving as the central focus of trading for its own security.

That is not to say that exchanges are relegated to being mere processing powerhouses. They may continue to compete as value propositions by offering different commercial products (such as market data and sale of speed technology). They may even compete by offering different regulatory rules and standards vis-à-vis investors such that investors are aligned to a particular exchange for the purposes of investor oversight – all the while standardising the rules which apply to trading activities (see below). Hence, and as mentioned above, competition between exchanges can continue to exist within each market-node, but – and this is the crux – not at the expense of fragmenting the securities markets.

Benefits

The general non-interoperability of exchanges is hence replaced by the universality of the true market and the use of a single immutable ledger to represent ownership of the traded asset. There would thus only be one singular market, with multiple points of access for both investors and exchanges. This benefits the price formation process by improving the social utility, cohesiveness and accuracy of the prices formed. It achieves this by aggregating all trading into one marketplace, thus eliminating alternative prices, as well as increasing liquidity and volume of participants and trades (due to an increased accessibility) so that positive network effects of consolidation may be reaped (see below).

Furthermore, this is not unlike the present phenomenon of the “synthesized” exchange in the U.S. The regulatory features of the U.S. equities market (in particular, the Regulation National Market System and Unlisted Trading Privileges¹⁷) support an environment where market participants can in fact ‘stitch’ together multiple exchanges into a single “synthesized” exchange¹⁸. This virtual consolidation of the market (notwithstanding fragmentation persisting on a physical and spatial level) arguably allows for the benefits of fragmentation to be reaped without the negative effects of a loss of consolidation¹⁹. Fragmentation of trading allows for greater competition within the market, on top of the aforesaid benefits of lower transaction costs and faster execution speeds, whilst maintaining positive network externality effects often associated with consolidated trading²⁰. In other words, a virtual market with multiple points of access has the best of both worlds: from (spatial) fragmentation and (virtual) consolidation. This will be the case for a “true global market” for securities, which is the single “synthesized” exchange of the U.S. equities market writ large. While the consolidation of all trading for a particular security into a singular market produces, for example, positive network effects, it still allows for fragmentation to occur beneficially in that there is greater volume of trading (thus competition within the marketplace) and lower transaction costs (from the competition between exchanges).

¹⁷ Budish, Lee and Shim (n 5): Regulation National Market System (Reg NMS) requires information about trading opportunities (i.e. quotes) to be automatically disseminated across the entire market, thus directing trades to the most attractive prices. On the other hand, Unlisted Trading Privileges (UTP) enables all stocks to trade on all exchanges independently of its technical listing. Taken together, a “synthesized” exchange is formed because the UTP allows for stocks to be perfectly fungible across exchanges while Reg NMS ensures that accessing (i.e. searching among and transacting across) exchanges is frictionless.

¹⁸ Budish, Lee and Shim (n 5)

¹⁹ Ye (n 9)

²⁰ Ye (n 9)

Regulatory Impact

The implications of such a landscape on regulation and rule-setting will also be profound. Firstly, given the diversity of exchanges which would be tapped into any single securities market-node, there will be a need for standardisation of rules. In particular, rules which apply internally within the marketplace and to trading activities, including but not limited to requirements on disclosure, public float and minimum trading prices, have to be coherent. On the other hand, rules externally relating to investor oversight (such as the oversight of individual accounts to combat money laundering and terrorism financing) and initial listing of securities can tolerably be varied across exchanges to appeal to different needs of investors.

Secondly, in order to smoothen out the matching of orders, and to prevent favouring investors geographically proximate to the exchange-of-the-day, batch auction may be employed to aggregate orders and to produce a price valid for a short period of time.

Lastly, there will be a general de-emphasis on securities laws and regulations being implemented and enforced at the national level by governmental authorities. Given the reframing of the market into a virtual, digital entity without borders, and the adoption of technological developments in the process, time may be ripe to reconsider using technology to implement regulations. For example, hard rules which relate to numerical thresholds and quanta may be imbued into the underlying code used to execute trades, in a manner not unlike the present use of smart contracts to execute certain commercial activities. Conversely, the enforcement of soft rules which require human judgement (e.g. grant of licences, directors' duties) may be undertaken by

exchanges. In that sense, exchanges remain as the primary regulators in this future landscape.

Conclusion

As observed above, there is indubitably room for improvement in the present construct of price formation, especially looking at the global landscape of securities markets and exchanges *in toto*. The fragmented construct and prevalent emphasis on a monopolistic approach lends itself to a non-cohesive and inaccurate price formation process. To do better, a “true global market” for each security has to be conceived, relying on an infrastructure based on immutable decentralised ledgers and cloud computing processing. By reframing the price formation process in an absolutist fashion, and around a singular market-node (isolated from other similar market-nodes), we can improve upon the social utility of the price formation process on top of harnessing the benefits of (spatial) fragmentation and (virtual) consolidation. Indeed, we have to “fully understand the role of technology and competition in today’s markets and... help these powerful forces work for investors in every securities market... to support a strong, growing global economy”²¹. Perhaps one day, tapping the “submit” button will allow me to partake in an even larger and more absolute price formation process.

2985 Words

²¹ White (n 1)

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