

“Is Equity Market Exchange Structure Anti-Competitive?”

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Abstract

One aspect of the structure of rebates and fees (“access fees”) of the three major stock exchange families are volume discounts (pricing tiers) that are intricately designed. We interpret the nature of the design of pricing tiers as well as the connection of pricing tiers to demand and cost considerations, the agency problem in brokerage and the disclosure setting. Rebate pricing tiers are intertwined with the structure of pricing for connectivity and proprietary data services for which an exchange is the unique supplier, highlighting the “fixed” pricing for connectivity and proprietary data, the incentive to cross subsidize exchange trading and differences from traditional price discrimination. We discuss the connection to such policy issues as required disclosures, banning pricing tiers and the underpinning of “best execution.”

Keywords: Exchanges; rebates and access fees; market data; price discrimination; anti-competitive; cross-subsidization; disclosure; best execution

1. Introduction

Our system of equity trading has evolved in a complex fashion in which fees are charged and rebates are provided for various orders when they are executed. This approach leads to a variety of trading distortions as a consequence of a fundamental agency problem because the fees and rebates are typically viewed as the responsibility of the broker rather than its buy-side customer, who receives the consequences of trade executions (e.g., Malinova and Park (2015), Battalio, Corwin and Jennings (2016), Angel, Harris and Spatt (2011, 2015) and Spatt (2018)). The equity market rebates received by particular brokers actually are based upon alternative published pricing schedules and the activity each month for each broker. Broad interest in the structure of our equity markets was heightened by the publication of *Flash Boys* by Michael Lewis (2014). Indeed, the SEC adopted (December 19, 2018) a pilot to facilitate the study of the impact of fees and rebates, including two treatment groups with tighter caps than present on the allowed fees (reducing the allowed fees from 30 mils per share to either 15 or 5 mils per share) and one treatment group in which rebates would be banned (the latter treatment would facilitate the study of the impact of such a change on the remaining fees and order routing).¹

This paper uses economic principles to identify a variety of ways in which the tiering of equity market rebates reflects profit-maximizing behavior and is potentially anti-competitive price discrimination in conjunction with cross-subsidization among the products sold by stock

¹The three major stock exchange families (New York Stock Exchange (NYSE), Nasdaq and BATS--Chicago Board Options Exchange (CBOE)) subsequently brought a court challenge to the access fee pilot, seeking an injunction from the District of Columbia Circuit Court of Appeals. The case was argued at the District of Columbia Circuit Court of Appeals on October 11, 2019 after an accelerated briefing schedule. The SEC has stayed the implementation of the main portion of the pilot, but not the six-month pre-implementation measurement period.

exchanges in the United States and market power in the provision of proprietary data and co-location (connectivity) services as the unique supplier of these services on particular exchanges.² Indeed, there is a long history of anti-competitive pricing by stock exchanges as illustrated by the tremendous market power of the New York Stock Exchange (NYSE) specialist and Nasdaq dealers in earlier eras.³ A critique of the role and potential power of stock exchanges was offered by (former) SEC Commissioner Robert Jackson (2018).

As illustrated below, there are a number of significant perspectives and conclusions that emerge from the structure of equity market rebates. Yet alternative designs for the rebates would help sustain competition to a greater degree.

- a) Three affiliate families own twelve stock exchanges with market share of more than 95% of exchange trading. Rather than twelve independent pricing decisions, there are just three independent decision makers, enhancing the market power of these affiliate families. Exchange trading is especially important in underlying securities price determination due to the transparency there.
- b) The prior merger of two affiliate families to reduce from four to three remaining affiliate families did not result in the consolidation of any exchanges and so didn't promote concentration of order activity.
- c) Maximum rebates offered by various exchange exceed the cap on fees under Regulation NMS (30 mils per share). Hence, cross-subsidization of trading is not uncommon.

² A recent introduction to the use of rebate price tiers is provided by Bishop (2019).

³ The specialist's market power on the New York Stock Exchange prior to the implementation of Regulation NMS more than a decade ago, resulted from his last mover (or "time and place") advantage. Market power on the Nasdaq until the mid-1990s resulted from the lack of order-handling rules (so the public could not access the orders of one another for trading to compete with dealers) and collusion among market makers to execute orders largely on even-eighths (making $\frac{1}{4}$ the effective tick size).

- d) Equity market rebate schedules have much in common with the tiered pricing schedules employed by airline frequent flyer programs (see discussion in Section 3).
- e) The rebate pricing schedules have the property that higher eligible liquidity directed by a broker to an exchange results in larger rebates per unit (volume discounts), thereby attracting greater trading activity at the margin in a cost-effective manner in that the marginal incentive exceeds the average cost of the rebate. This inducement of the rebates in general, including the additional marginal benefit of the volume discounts, will be greater when the rebates are paid to the broker rather than the customer (which is the heart of the agency problem).
- f) Enhancing the liquidity at an exchange in turn enhances the flow of orders seeking liquidity and the trading volume at that exchange.
- g) There are many rebate pricing tiers used by individual exchanges and in the aggregate. The pricing formulae often are intricate.⁴ These features are suggestive of an attempt to price discriminate, segment markets, extract surplus and offer “customized” pricing.
- h) The rebate pricing tiers are largely based upon relative volume rather than absolute volume in order to better price discriminate (by normalizing the measure of liquidity directed to an exchange) and serve effectively as an entry barrier, both among exchanges (who are competing with one another for liquidity) and their brokerage clients (by advantaging large vs. small brokers and incenting small brokers to direct orders through larger brokers to obtain the preferential pricing).⁵

⁴ For example, see RBC Capital Markets (2018) for a detailed discussion of the intricate nature of exchange pricing as well as the large number of pricing tiers and separate pricing variables. This is further summarized in Section 4 herein, which also offers several illustrative examples.

⁵ The Congressional letter of Budd, Mooney and Wagner (2020) criticizes the role of pricing tiers in disadvantaging small brokers.

- i) To the extent that the costs of an exchange depend upon the total number of trades, messages, share executed (but not the distribution) and relationships, then price tiering for individual customers reflects only demand discrimination and not costs.
- j) The direct incentive conflict of the broker-dealer focuses upon the difference between marginal rebates and fees.
- k) The rebates are computed based upon activity over the entire *current* month and so would not be known contemporaneously, even by the broker-dealer. In contrast, in the airline frequent traveler context the rewards are determined by activity in the *prior* year.
- l) While there is public disclosure in advance of the overall set of pricing tiers under the SEC's "fair access" requirements for exchanges, there is no disclosure of the specific pricing tier that a broker-dealer qualified for during a month or even afterwards. Analogously, there is no disclosure of the number of broker-dealers that utilized each pricing tier at an exchange during a month. It would be a modest step to enhance disclosure requirements, at least along the latter line. Building upon the discussion in Spatt (2019), the SEC Investor Advisory Committee (2020) recently recommended to the SEC enhanced disclosure of the pricing tiers.
- m) The potential conflict of interest between the broker-dealer and his buy-side clients is sustained and reinforced by the lack of disclosure and price tiering. This serves the interests of the exchange relative to efficient order routing (which cannot arise with unknown incentives) and hence competition among exchanges does not mitigate the conflict of interest. Furthermore, the potential conflict of interest serves the exchange's interests because the broker-dealer's incentive to route to it is maximized! The barrier to entry

results from the volume incentives created by the rebate pricing tiers and not the conflict of interest itself, however.

- n) The impact of equity market rebates in encouraging liquidity provision and therefore, trading on an exchange interacts with and reinforces the value and market pricing of proprietary market data and co-location (connectivity), for example, heightening the incentive for co-location and fast technology. Similarly, subsidizing trading by brokers and market makers enhances the overall value of proprietary market data and co-location.
- o) Because the pricing of data and co-location are not volume-dependent, the pricing tiers (with associated quantity discounts) for liquidity and overall pricing heighten the incentive to allocate marginal activity that adds liquidity to exchanges, which in turn leads to more volume. (In contrast, a conventional view about price discrimination would suggest that those who utilize market data and connectivity the most would pay more for it!⁶) The greater activity on an exchange enhances the value of its data and co-location services, pointing to the potential value of cross-subsidization between trading and both data and also co-location.
- p) Both the Nasdaq and CBOE have stated recently that five of its ten largest clients receive net payments (even after data and co-location charges) monthly, pointing to one of the forms of significant cross-subsidization of some customers. This implies that rebates exceed trading fees plus the cost of proprietary data and co-location for such clients. This “all-in” pricing finding suggests that (i) for those participants that the extent of activity

⁶ A classic example of this point is IBM monopolizing and charging high prices for punch cards in the 1950s (which were a key mechanism for computer input) as a way to price discriminate against more intensive users of its mainframe computers.

allocated to the exchange is very different for those orders offering liquidity and those consuming it and that (ii) smaller brokers face a significant relative burden.

- q) Arguably, data is the intellectual property of buy-side investors and their brokers (even if only in part), rather than solely that of the exchanges that aggregate the data.⁷ As the SEC has been reluctant historically to regulate the pricing of data,⁸ each exchange has monopoly control of its own proprietary data (as highlighted in the U. S. Treasury's (2017) Capital Markets report). In contrast, securities pricing does reflect regulated competition and explicit pricing constraints under Regulation NMS.
- r) Best Execution requirements serve to reinforce the monopoly power that exchanges possess with respect to selling their own (proprietary) data and co-location services. The Treasury's Capital Market Report (2017) argues for more flexibility for investors to meet Best Execution standards (and that the Standard Industry Processor (SIP) data should be sufficient for Best Execution).
- s) The overall institutional environment provides an explanation for the tiering of rebates as part of the profit-maximizing strategy of the exchanges.

Several important and subtle insights emerge from our analysis. For example, to the extent that exchange costs do not reflect the distribution of shares executed across brokers, but may reflect

⁷ This is analogous to asserting that the data that Facebook collects is not simply its intellectual property, but instead belongs (at least in part) to its participants. In light of the privacy concerns raised by critics of Facebook, it is no longer a simple matter to conclude that the data is Facebook's to handle (and license) as it chooses. In fact, Mark Zuckerberg (Facebook's founder and CEO) suggested in Congressional testimony in April 2018 that instead that the data in Facebook is owned by its participants (to forestall critics of Facebook's privacy practices), but without the above interpretation necessarily in mind.

⁸ One recent exception is SEC (2018b) in which the SEC required the exchanges to disclose how its pricing meets the economic requirements under the Exchange Act, including how it promotes competition. However, the District of Columbia Circuit Court of Appeals reversed this, indicating that the SEC lacked the authority to block the pricing after not making a determination to suspend the pricing within 60 days.

the number of shares executed, trades, messages and relationships, then price tiering for individual exchange clients (brokers and market makers) reflect demand and market power (creating potential scope for price discrimination) rather than cost considerations. Additionally, the use of price tiers also enhances the agency conflict compared to constant “make-take” prices. Furthermore, there are incentives to subsidize overall trading (both through marginal prices and absolute levels) in order to enhance the overall value of an exchange’s data and co-location (connectivity) services. Cross-subsidization between pricing and data (or co-location) leads to a more sophisticated approach of quantity discounting, compared to traditional price discrimination (where larger users are charged higher prices!). That many of the largest liquidity providers have negative all-in-pricing highlights the agency problem in brokerage.

We provide background on the structure of ownership of the principal exchanges in Section 2, highlighting that most of the exchanges are owned and operated by three affiliate families. In Section 3 we examine the characteristics of airline frequent flyer programs, which provide a useful benchmark and perspective for the structure of volume discounts in equity market rebates. We examine price discrimination through the structure of exchanges and equity market rebates in Section 4. Section 5 examines the interactions among equity market rebates, data revenues and co-location revenues. We offer some concluding comments in Section 6, addressing potential disclosure requirements and the possibility of regulatory restrictions on allowed pricing.

2. Affiliate Families and Ownership of Exchanges

Most of the public exchanges are organized into families of affiliated exchanges. This plays an important role in the routing of orders in addition to the use of fees and rebates. There are three

main exchange families, controlling 12 of the 13 existing exchanges, as well as an independent exchange operated by IEX (whose market share is below five percent of exchange trading).⁹ The main exchange families are operating affiliate exchanges based on distinct business models (such as rebates on orders that remove liquidity vs. rebates for orders that add liquidity). An exchange family can provide joint staffing and pricing coordination through the parent company. While many observers have criticized the proliferation of exchanges (and trading platforms more generally) because it diffuses liquidity and thereby undercuts the internalization of the liquidity externality by which orders desire to compete in as large a pool as possible, the standard benefit of proliferation-- enhanced competition among the exchanges-- is limited to the extent that an affiliate family can coordinate the pricing of its own products among its various exchanges, such as the setting of rebates and the pricing of data and co-location services. In effect, the traditional benefit of competition among exchanges associated with the presence of many exchanges is greatly diminished as there are just a few exchange families and each family can coordinate its setting of rebates and the pricing of data and co-location.

In summary, the three exchange families are each making a single pricing decision rather than an independent one for each of the twelve exchanges that they operate, suggesting that the extent of competitive behavior is very limited, despite the operation of twelve exchanges. Indeed, it is an interesting coincidence that the number of exchange families coincides with the number of major incumbent airlines (three!), which also offer tiered pricing programs (frequent traveler programs). The potential for joint decisions across these exchanges can support the exercise of considerable market power by these exchanges as the three exchange families have a combined market share of

⁹ The NYSE operates five exchanges, CBOE operates four and Nasdaq operates three.

more than 95% of exchange trading.¹⁰ Interestingly, the merger of BATS and Direct Edge in 2014, which reduced the number of affiliated exchange families from four to three, did not lead to the consolidation of any exchanges (BATS and Direct Edge each had operated two and the merged entity operates four). The merged entity would benefit both from potential cost synergies (but to a greater degree if there were consolidation) from the merger as well as enhanced ability to coordinate pricing with a range of trading designs.

The presence of twelve individual trading exchanges limits the benefit from internalizing the liquidity externality—yet the parameters, over which the exchanges themselves compete, such as the design of rebate programs and the cost of data and co-location services, now reflect just *three* competing exchange families.¹¹ The limited number of affiliate families greatly limits the competition among exchanges—without the standard benefit of internalizing the liquidity externality to the maximum degree feasible. This is a fundamental weakness in the current design of competition among stock exchanges. Of course, in earlier eras there was even more market power in exchange trading (e.g., see footnote 3).

Given the cost of operating an exchange, positive *trading* profits require that fees exceed rebates. Yet many contexts lead to rebates that actually exceed the maximum permitted fee under Regulation NMS (30 mils), providing clear-cut evidence of cross-subsidization. In effect, in some instances access fees and trading revenue is a loss leader. In a variety of situations the highest rebates being offered can exceed the maximum fee under Regulation NMS. For example, recently these levels were 30.5 mils per share for the Nasdaq (illustrated in Table 1), 32 mils for Direct

¹⁰ Trading executions also occur through a variety of non-exchange platforms as well, including dark pools. Of course, the nature of competition that is provided by dark pools is more modest due to their opacity.

¹¹ The exchanges point out that they are allowed by regulators to only run a single trading model on each exchange.

Edge, 32 mils for BATS, 31 mils for Arca (and 27.5 mils for the NYSE).¹² An extreme example is the case of the NYSE American with electronic designated market makers, for which there is a rebate of 45 mils to add displayed liquidity that executes (and charges just two mils to take liquidity).

3. Airline Frequent Flyer Programs

The features of airline frequent flyer programs, which are familiar to many economists and other professionals, and their potential anti-competitive nature, offer an instructive analogy for understanding how equity exchanges structure the determination of the rebates that they offer to brokers who route orders to them. The traditional and most prominent major airlines offer frequent flyer program with many similar features.¹³ American, United and Delta Airlines offer programs with a broad range of benefits including courtesy upgrades prioritized by airline status as well as secondary criteria such as check-in time, bonus miles for flights (which increase in the traveler's airline status), extra legroom complimentary seating, complimentary checked baggage privileges, early boarding time, etc. A simple interpretation of many of these benefits being an increasing function of the traveler's status is that the per-flight benefit is an increasing function of the *overall* business that the consumer allocates to that airline (within ranges), i.e., average reward increases with flight segments or mileage in the prior year. This prioritization applies across the airline's network, so that flights in one market (in which the airline otherwise offers mediocre service) offer

¹² These levels are as of May 2018.

¹³ Similar pricing does not necessarily imply that pricing is inherently anti-competitive. For example, in the simplest examples of competition and in the traditional competitive equilibrium all firms charge the same price as one another. Analogously, in the traditional oligopolistic equilibrium all firms again charge the same price as one another, though a higher price than the competitive price. In the conventional monopolistic equilibrium, of course, there is a single price prevailing (higher than the oligopolistic price).

benefits in all markets in which the airline operates. In effect, this leads to “tying” across different product markets and potentially serves as an entry barrier against smaller airlines.

There are many other features of these programs that are worth noting. For example, some of the specific benefits are opaque and difficult to quantify, especially the opportunity to obtain seats and upgrades for mileage (the airlines use many mileage price points for tickets within the same fare class and route). To a modest degree, the opacity even extends to qualifying for specific status since the airlines occasionally offer specials that provide for additional mileage benefits or offers to purchase a particular status. The presence of substantial amounts of existing miles can even create incentives for the airline issuer to increase the prices of awards (“inflation”) as there is a lack of commitment to award pricing and changes in award pricing from time to time (potentially both “expected” and “unexpected” inflation), somewhat analogous to monetary economics and the lack of commitment by a central bank with respect to inflation.

The nature of price discrimination that arises with frequent flyer programs is illustrated by the award programs of the three traditional carriers: American, United and Delta. Each uses four status levels and two main paths to obtain each status.¹⁴ All paths involve qualifying dollar spending (not including taxes) and either qualifying miles or segments. In this sense each airline uses eight basic pricing tiers (24 in total for the three airlines).¹⁵ The use of qualifying dollar

¹⁴ The description of the airline frequent flyer programs is based upon fall 2017.

¹⁵ There are additional ways to qualify for a particular status. For example, the programs will occasionally sell a bump-up in status or reclaiming one’s prior-year status (providing opportunities for customized pricing of status). The author, for example, declined several such offers in late 2017 from American Airlines at various times at \$895 and then \$695. If the airline prices such offers in an optimal price discriminating manner, then the consumer will reject most such offers. Airlines also have offered the opportunity to regain prior status by sufficient flight activity early in the subsequent year. These various types of offers are inherently opaque. The author also has declined an offer from United Airlines for 15,000 qualifying miles and 15 segments for approximately \$ 1,900 and rejected offers at \$1,895 and \$1,545 from American Airlines (rather expensive offers). Another example is to reward those individuals who have had substantial life-time flights; for example, American Airlines automatically provides for life its lowest tier

spending is a relatively new innovation by the airlines—but a way to ensure that a particular status is only being offered to sufficiently valuable customers. The airlines offer multiple paths to qualify for a particular status (qualifying miles or segments) in order to charge higher effective prices and obtain more surplus extraction than they could if they were pricing only in a single dimension. Of course, this is a central feature of economic models of price discrimination. Interestingly, American and United use identical thresholds for each of their four status levels and Delta also uses a similar scheme, except that it has made its top tier relatively harder to achieve.

For a concrete example consider the four tiers offered by American Airlines in 2017 and 2018. The lowest status level (“gold”)¹⁶ requires in a calendar year \$3,000 in airline spending plus either 25,000 qualifying miles (minimum of 500 miles per segment) or 30 segments. The remaining status levels have proportional requirements. For example, the second status level with American Airlines (“platinum”) requires \$6,000 in airline spending plus either 50,000 qualifying miles or 60 segments. The third status level (“platinum pro”) requires \$9,000 in airline spending plus either 75,000 in qualifying miles or 90 segments. Finally, the top status level (“executive platinum”) requires \$12,000 in airline spending plus either 100,000 qualifying miles or 120 segments. For United Airlines the structure is essentially identical (just using different labels) and for Delta it is similar, but more difficult to achieve at the highest levels (e.g., 140 segments instead of 120 segments are required for the top tier).

status to “million-mile” flyers. One can interpret these as creating additional pricing tiers. A final example is that under limited circumstances an airline may be willing to offer a one-time match of the status provided by one of its rivals, facilitating conversion by a consumer from his primary preferred airline.

¹⁶ One form of inflation is the names of the status level; in another era the lowest status level had been called “silver” rather than “gold.”

To summarize, notice that the presence of many paths facilitates price discrimination and surplus extraction—both because average (per flight) reward increases with overall flight activity (in the sense that the rewards apply to all trips and increase with higher status) and that several alternative variables can bind—airline spending, qualifying miles or qualifying segments. The latter facilitate the extent of discrimination and surplus extraction. Of course, American, Delta and United are not the only significant airlines in the United States. JetBlue and Southwest also have an important role and scale (in fact, Southwest has the largest market share of all the airlines) and indeed, they also operate frequent flyer programs. These programs are much simpler and do not possess the extent of non-linearity. One way to view these is as entrants whose rewards and benefits are essentially proportional. For example, the JetBlue program has just a single status level (“Mosaic”) and is not essential for obtaining upgrades at modest cost. In contrast, the design of the programs of the traditional airlines acts as an entry barrier due to the increasing marginal benefit and the cross-subsidization created by such programs across routes (the demand to fly on undesirable routes on which an airline offers few flights and uncomfortable planes is increased by the spillovers from the attractive routes). In the traditional programs the status is based upon cumulative performance; the marginal value of rewards is uncertain early in the relevant interval. The realized value is either very high or low late in the relevant interval.

The frequent flyer programs have been become more complex over time, leading to enhanced ability to price discriminate. Historically, programs of the major airlines previously had two or three status levels rather than four status levels and did not impose auxiliary airline spending requirements. It also is worth pointing out that the frequent flyer programs exploit an inherent conflict of interest—the benefits flow to the traveler who also typically makes the purchase

decision, but the costs of the air tickets are often paid by third parties, such as employers, so that in some instances the ticket purchasing decision is distorted.¹⁷

The presence of many thresholds (status levels), numerous alternative ways to qualify, increasing benefits to larger participants, the opaque nature of the programs and even qualification standards, how the programs serve as an entry barrier, and the inherent conflict of interest between the agent (who makes the decisions and receives the benefits) and principal (who bears the costs), largely point to potential anti-competitive features of frequent flyer programs and indeed, are highly relevant as well for the structure of equity market rebates.

4. Price Discrimination, Structure of Exchanges and Rebates

Building upon the analogy with frequent flyer award programs, the structure of equity market rebates for orders that add liquidity (such as the traditional limit order) on various exchanges illustrates the anti-competitive nature of the tiering of the rebates.¹⁸ The rebate schedules are set up so that additional activity by a broker results in larger (or at least not smaller) rebates on a per-share basis. This highlights that there is increasing marginal reward (as a step function) to broker-dealers who use orders that add liquidity through a particular stock exchange.

¹⁷ The extent of distortions in flight selection is likely to be modest compared to that in order routing, however. For example, I anticipate that the ethics of most travelers would imply little payment of fares that were more than necessary and that the self-interest of travelers would typically operate against using more circuitous routings to earn higher incentives.

¹⁸ The nature of the anti-competitive aspects of the structure of exchanges focuses upon the tiering of the rebates (not the rebates per se), cross-subsidization, and market power over both proprietary data and co-location services, and additionally the small number of affiliate families.

Conclusion 1 (Price Discrimination and Marginal Rewards):

The marginal reward (rebate) is typically greater than the average reward under tiered rebates.

Hence, there is relatively greater marginal incentive for the broker-dealers to route to a particular exchange compared to the direct out-of-pocket cost to the exchange for the order's rebate. We illustrate the presence of such volume discounts in the observed pricing tiers in situations in Nasdaq for adding displayed liquidity in Table 1. Achieving more challenging standards leads to larger rebates. These more challenging standards to earn higher rebates might reflect more difficult to achieve (tighter) conditions as well as additional or multiple conditions that need to be satisfied (illustrated by Table 2 for Nasdaq and Table 3 for the NYSE).

That there are alternative formulae to achieve a given per share rebate allows the exchanges to extract relatively more surplus, just as an array of pricing paths for frequent flyer programs allows more surplus to be extracted compared to the airlines being restricted to using a single pricing formula. In effect, a stock exchange or an airline is more aggressive by using multiple price paths and attempting to extract more of the surplus from the diverse paths than if the exchange or airline were restricted to a single formula. That there are many pricing paths employed in the case of equity market rebates allows considerable customization in the surplus extraction relative to barring customization. Table 4 for Nasdaq and Table 5 for NYSE Arca illustrate that there are a diverse (and at times somewhat idiosyncratic) set of ways of achieving the same rebates, pointing to the parallel with airline frequent flyer programs in which there are diverse alternatives for obtaining the same frequent flyer status. For example, the Royal Bank of Canada (RBC) indicated in 2016 that there were more than 800 pricing tiers when aggregating across exchanges (see Popper (2016)). More recently, RBC Capital Markets (2018) reported that "Our analysis identifies at least

1,023 pricing paths across the exchanges. Over one-third, or 381, of these paths consist of rebates. These 1,023 pricing paths are themselves determined by at least 3,762 pricing variables.” Some observers have suggested that many of the pricing paths are used by relatively few broker-dealers and in some instances may have been customized by a stock exchange for a particular broker-dealer. This reinforces the nature of the surplus extraction that is at work and may even reflect negotiation with a particular broker-dealer client.

Conclusion 2 (Customization):

The presence of many alternative pricing paths to achieve a particular rebate and the intricate (and even obscure) nature of the specific bases in the pricing formulae that are used suggest that customization plays an important role in defining the pricing.¹⁹

Even though in principle the same pricing opportunities are available to all brokers and the pricing tiers are publicly announced, the extent of customization in turn implicitly suggests that such pricing may not meet the requirements of the Exchange Act, which requires pricing that does not place an undue burden on competition. Evaluation of the extent of customization could be

¹⁹ For example, RBC Capital Markets (2018) states that “... in certain instances highly specific descriptions and tightly focused combinations of variables incorporated into pricing paths suggest that these paths may have come into being in connection with a few exchange clients – if not a single exchange client. While we cannot objectively validate this inference, we would emphasize that even the appearance of pricing tailored to specific exchange clients can itself undermine perceptions of marketplace fairness.”

facilitated by disclosure of the number of market participants who obtain the benefit of each pricing tier.

The pricing formulae used have shifted to focus upon proportions of volume rather than absolute volume (for example, this is reflected in most of the rebate tiers for adding displayed liquidity in the various tables). Given the exogenous fluctuations in trading volume (and cross-sectional correlation among brokers), this further reinforces the ability of the exchanges to extract surplus compared to when rebates were based upon absolute volume. The variation in market trading volume is not determined by an individual broker-dealer, so filtering out that variation and incenting the broker-dealer with respect to his routing decisions and using a suitable benchmark would enhance the effectiveness of the price discrimination and incentives created by the exchanges.

Conclusion 3 (Relative Volume):

Given random variation in market trading volume across months, it can be optimal to define pricing tiers and to price discriminate based upon the broker's relative volume.

To the extent that the broker-dealer needs to commit much of his volume to the major exchanges in order to obtain the maximal rebates feasible from them, the use of relative volumes in the rebate formulae reinforces how these rebates serve as an entry barrier. In contrast, if instead the formula were based upon a broker's specific absolute volume, then variation in the broader level of absolute volume would allow more flexibility for volume to be routed by brokers to entrants in high volume months. Note that the volume thresholds serve as an entry barrier vs. exchanges that don't use tiered pricing, because of the importance and value of a broker satisfying the threshold for higher

rebates on one's overall liquidity provision, offering an important advantage to exchanges using tiered pricing. Additionally, these serve as entry barriers to protect large brokers against small brokers because of the greater rebates intrinsically available to larger brokers given tiered pricing²⁰ (notice that the pricing formulae and tiers are not adjusted for the past level of activity of the particular broker). Along these lines, large brokers often intermediate trades of smaller brokers in order for the smaller brokers to gain access to the more favorable pricing. In effect, the pricing tiers are potentially a barrier to competition both among the exchanges as well as the broker-dealers, who are the clients of the exchanges. This raises the question as to whether the structure of the pricing tiers on rebates is compatible with the requirements of the Exchange Act. A simple remedy would be to require constant rebates and fees.

The traditional "maker-taker" exchanges offer rebates to attract desired orders, i.e., those that add liquidity, which in turn then helps the exchange to attract orders that consume liquidity (but on which they can charge fees), thereby enhancing trading volume at that exchange. Under Regulation NMS (adopted by the Securities and Exchange Commission (SEC) in 2005 and fully implemented by 2007), the fees are capped at 30 mils per share. The reason that fees on orders that take availability liquidity are capped is because under some conditions Regulation NMS directs the routing of orders that take available liquidity based upon gross rather than net pricing. Baseline rebates on orders that add liquidity are about 20 mils per share. However, the rebates provided by specific exchanges depend upon the activity directed to that exchange by the particular broker-dealer. There are often alternative pricing formulae or tiers to achieve a given rebate level and with incremental activity higher rebate levels. Here, the analogy with the frequent flyer programs is particularly apt in that the major airlines offer four status levels and alternative paths

²⁰ This is at the heart of the criticism in the Congressional letter by Budd, Mooney and Wagner (2020).

to achieve each (e.g., a minimum spending level for each status level and either a minimum qualifying mileage level or minimum number of segments for each). For example, recently the NASDAQ offered 27 pricing tiers on its principal exchange and RBC Capital Markets (2018) in its study identified 381 paths consisting of rebates being offered across exchanges. Given the very large number of pricing tiers compared to the exchanges and the intricate nature of their designs, there is considerable speculation that many are used by very small numbers of market participants (perhaps even zero or one) and that many of the pricing tiers were customized for particular brokers, while excluding others.

An important aspect of the nature of equity market rebates is that they are paid to the broker-dealers as the broker-dealer is the client of the exchange, rather than the underlying buy-side customer whose trading activity led to the rebate. Indeed, the exchange would not know which ultimate investor provided the order, so it is natural for the exchange to view the broker as its customer. This points to an important and widely recognized incentive conflict and agency problem regarding the payment of rebates (see, for example, Battalio, Corwin and Jennings (2016), Angel, Harris and Spatt (2011, 2015) and Spatt (2018)). The broker makes the routing decision and directly receives the benefit of the rebate. This can lead to a distortion in routing because of the differences in execution quality that result from routing to different platforms (see evidence provided by Battalio, Corwin and Jennings (2016)), as execution improvements accrue to the buy-side customer rather than his broker.

Not only are these rebates paid to the broker-dealer, but they depend upon the overall activity (across clients) of the broker-dealer during each specific month. Given the nature of the formulae used for computing rebates, the broker-dealers, as well as their buy-side clients, do not know the exact rebate level they will achieve for trades in a given month, until the conclusion of the month.

This avoids the parties having full contemporaneous knowledge of the rebate and prevents disclosure of the precise rebate level to the investment client, an observation which is broadly recognized in the investment community. In turn this makes it more difficult for the broker-dealer (if it were so inclined) to simply pass through the rebate to the client, which would provide one resolution of the agency problem. It also should be noted that regulators do not require disclosure of the rebate to the investment client even after it is finalized at the end of the month; indeed, such required regulatory disclosure (if contemporaneous) would impede the viability of rebates that are dependent upon overall trading activity within the month.

Furthermore, the exchanges do not disclose which broker-dealers, or even how many, receive rebates based upon the particular pricing formula (path). This is a simple, but important, weakness of the current disclosure regime with respect to equity market rebates. It also prevents direct evaluation by the regulator (as well as by the buy-side, their trade execution consultants and the academic community/public) of how routing is being influenced and potentially distorted by the presence of the equity rebates (e.g., how does order routing change late in the month depending upon how close is the broker-dealer to achieving an incremental pricing tier). One of the weaknesses of this type of narrow disclosure is that it limits the ability for disclosure to address the routing distortion. Stronger disclosure requirements would mitigate a portion of the conflict of interest and facilitate regulatory review of the conflict of interest and competitiveness of the rebate pricing structure (e.g., to what extent are the rebate pricing structures customized for particular broker-dealers?) among exchanges as well as the distortion in the trading process.

An interesting aspect of this is that the conflict of interest potentially serves the interests of the exchanges, i.e., it is more profitable for the exchanges to structure the rebates so that efficiency

would not obtain. This seems suggestive of why the exchanges have structured the rebates to make it difficult for their full benefit to flow through from their brokerage clients to the buy-side investor. One of the ways that the exchanges can compete with one another in such an environment is by strengthening the extent of conflict of interest; inducing greater conflict of interest can be a source of competitive advantage. In particular, the rebates cannot be observed contemporaneously or even attributed to particular clients.

Conclusion 4 (Agency):

The nonlinearity in the rebate formula (i.e., pricing tiers) helps sustain the agency conflict. More fundamentally, because the marginal incentives created by rebates flow back to the broker-dealer rather than the customer, the broker-dealer's routing incentive is maximized. Furthermore, the inability of the buy-side client to know the precise incentive received by the broker-dealer prevents the routing distortion from being fully neutralized, as it would be under an efficient contract. In this sense the pricing tiers and resulting price discrimination enhance the agency conflict.

Standard solutions to the agency problem include disclosure of the rebate paid on each transaction, sufficient disclosure of overall execution quality or the execution quality achieved on the particular order, a ban on rebates or a requirement that the rebate flows through to the investor (see Angel, Harris and Spatt (2011, 2015) and Spatt (2018)). The use of a monthly rebate calculation and tiering makes it problematic to isolate the rebate on an individual transaction. Disclosure of overall execution quality statistics is far from straightforward and leads to considerable noise; remedies requiring that we isolate the amount of the rebate (disclosure of the particular rebate or transferring

it to the relevant investors) are incompatible with a monthly formula with nonlinearity and lagged disclosure. It can be difficult for the investment client to receive the full benefit of the rebates or to be cognizant of it, facilitating distortion in trade routing. The use of pricing tiers serves the exchanges' interests by enhancing the agency conflict as well as inducing price discrimination.

5. Interactions Among Exchange Businesses

A very important source of revenue for exchanges in recent years has been the sale of proprietary data such as data about the order book of an exchange as well as co-location (connectivity) services near the market to facilitate speedy execution of orders (see Nagy and Gellach (2017)).²¹ The value of an exchange's data and the value of co-location services linked to the exchange depend upon the extent of activity on the trading platform. Incentive rebates that offer greater marginal amounts for additional liquidity provision encourage trading activity on an exchange, which in turn enhances the value of data and co-location services there.

Conclusion 5 (Price Interaction):

The use of pricing tiers increases the value (and pricing) of the data and co-location services sold by the exchanges on their own behalf. Similarly, subsidizing trading increases the value and pricing of data and co-location sold by the exchange.

The pricing of co-location and data by exchanges does not depend upon the specific realized intensity of use, though the pricing in some instances reflects the specific business models that

²¹ A broad range of market participants (especially brokers and buy-side investors) filed with the SEC a rule-making petition in December 2017, calling for much greater transparency with respect to data pricing. <https://www.sec.gov/rules/petitions/2017/petn4-716.pdf>

would use the data. In effect, this type of *fixed* pricing does not create direct disincentives to trading and receiving rebates, provided that the data or co-location services are being purchased.²² The value of the data and co-location to a market participant would depend upon the extent of activity by *others* on the exchange.²³ One of the striking aspects of overall exchange revenues in recent years is the increasing importance of data revenue (see Nagy and Gellasch (2017)). The incentives created by the structure of rebates enhances the ability of an exchange to profit from its broader product line; data and co-location revenues make it more valuable to each exchange to attract additional trading activity. The fixed pricing for data and co-location encourages brokers to reach higher tiers (greater discounts for providing more liquidity) and the additional trading does not result in greater data or co-location charges (despite greater potential exchange costs) for the individual broker, but enhancement in the overall data and co-location pricing that can be charged by the exchange. Subsidizing trading increases the value of the activity at an exchange and hence the value of its data and co-location services.

Conclusion 6 (Declining Costs of Liquidity Providers):

Because the data and co-location charges are fixed (independent of trading activity)²⁴ by assumption, the unit costs of providing additional units of liquidity are declining due to the increasing rebates per unit on larger volumes seeking liquidity, enhancing the marginal incentives for such orders.²⁵ In particular, the pricing for data and co-location to a participant does not directly

²² Arguably, there would have been a disincentive to trade if the pricing of data or co-location services increased in the extent of trading.

²³ The resulting prices specified by an exchange would reflect the total activity on it.

²⁴ In contrast, the traditional price discrimination view would suggest that brokers who have higher trading activity would pay higher fees for data and co-location rather than a constant fee (also see footnote 6).

²⁵ Both Nasdaq and CBOE have recently stated that five of their ten largest customers received net payments (so rebates must exceed the total of trading fees and data and co-location charges). This suggests that the agency problem underlying order routing leads to overall rebates for these customers substantially

depend upon his own activity (which is a small portion of the overall market), but depends upon the overall activity in the market.

Furthermore, greater activity on an exchange and longer queues (as induced by higher rebates and otherwise) implies that being at the front of the queue on that exchange is relatively more valuable. This increases the incentive to being at the front of the queue and the willingness to purchase fast technology and to use co-location to trade on that exchange as quickly as possible.²⁶ This provides an illustration of the overall anti-competitive nature of the design of equity market rebates in conjunction with the importance of data and co-location for rapid execution and the profitability of the exchange. It is interesting that the interactions operate simultaneously. These effects also are akin to the earlier dynamic between trading and data. The potential for cross-subsidization among trading, data and connectivity (co-location) services raises the question about whether the structure of pricing (including the presence and form of rebates) that emerges would be consistent with the requirements of the Exchange Act and avoid being unduly discriminatory.

While much of the emphasis on pricing in the context of exchange trading has traditionally focused upon the pricing of shares being acquired by investors and execution costs, there are important underlying questions about the pricing of data and the nature of data as a product. Exchanges offer a range of data products and co-location services. Of course, some potential purchasers of proprietary data would find the value much greater than others (e.g., most simply high volume vs.

exceeding trading fees. This implies that the allocation of activity by those customers is very different for orders that offer liquidity and those that seek it.

²⁶ Analogously, Srinivasan (2020) highlights the importance of speed and co-location in Google's advertising auctions. Google has a central role in both selling of advertising and the overall intermediation process.

low volume customers). There is a fundamental question about data and its final pricing. It is not at all obvious who “owns” the data (though control co-exists among the exchange, broker and client), but the exchanges sell various products derived from its aggregate data. After all, the data is arguably created by buy-side investors and their brokers. Should the resulting intellectual property be viewed as being transferred to the particular exchange through an attempt to execute an order on that exchange?²⁷ Indeed, while there is a fundamental focus on competition in the pricing of the shares of a particular firm, individual exchanges have little monopoly power for trading a particular firm’s shares. In contrast, each exchange has monopoly control over its aggregate data (e.g., as pointed out in the Treasury’s (2017) Capital Markets report), so while the SEC has been reluctant historically to regulate the pricing of data the monopoly control by an exchange over its data suggests that it is arguably at least as important to regulate data pricing compared to the price at which stocks trade under Regulation NMS. At the same time, Regulation NMS and Best Execution standards highlight, at least indirectly, the importance of data to both broker-dealers and buy-side investors. Glosten (2020) shows that monopoly power in proprietary data is reinforced through its complementarity with proprietary data of other exchanges.

At least some of the importance of data revenue may reflect the regulatory environment and regulatory constraints. Many market participants feel that they need to have the “best” data available in order to be in a position to meet their “Best Execution” responsibilities to their customers (not only to meet legal requirements, but also to meet customer needs). This has been

²⁷ In some respects the posture of an exchange with respect to ownership of the data created on its platform is not dissimilar from that of Google and Facebook with respect to the data emerging from them. Indeed, the lack of explicit pricing by Google and Facebook for many of its services reflects the consumer providing these firms data that they can sell in aggregate form.

a view that has been encouraged at least implicitly, by the U.S. securities regulator, the Securities and Exchange Commission (SEC). In its Capital Markets Report, the U.S. Treasury (2017) questions this perspective on the regulatory front and suggests that “best execution” should be satisfied by the use of the “utility” data available from the Securities Industry Processor (the “SIP”). The Treasury (2017) report implicitly calls into question whether the regulatory process around Best Execution is allowing Exchanges to obtain non-competitive pricing advantages in selling proprietary data (such as the limit order book dynamics) to allow broker-dealers and the buy-side to meet Best Execution requirements. While the SEC has not stated explicitly what data is required to satisfy Best Execution responsibilities, perhaps the appropriate data should depend upon the strategy of the investor (proprietary data describing the evolution of the limit order would appear more germane for a high frequency trader than a buy-and-hold investor due to the need of the former type to react quickly to information). One interesting aspect of the SEC not being explicit about the exact data needed to satisfy Best Execution responsibilities is that facilitates evolving standards that depend upon the strategies of customers and the evolving data, algorithms and the technological structure of trading. Regulation increases the incentive to use the structure of equity rebates to increase market share. While at first glance, this would not seem to lead to incentives for setting high marginal rebates, the value of marginal market share obtained by equity market rebates is enhanced by the regulatory (and market) demand for proprietary data.

A natural economic alternative to forcing the purchase of all relevant data for one’s customers to meet Best Execution standards or to require only the purchase of the SIP data, would be to require the purchase of such data as would be economically efficient in the absence of the agency problems with order routing. For example, a small broker would have different data imperatives than a

large broker and brokers executing retail orders (where timeliness is less crucial) would potentially have more limited data needs than those executing for institutional traders. However, not purchasing sufficient proprietary data limits the access of a broker to large institutional clients.²⁸ This suggests that the elasticity of the demand by brokers, even if not by their buy-side clients, is limited.

6. Concluding Comments

One of the central themes underlying this paper is that the design of pricing by stock exchanges in the United States regulatory environment reflects profit-maximizing conduct in a setting of regulatory constraints. As has been emphasized, there are a small number of affiliated families of exchanges and so at least the potential for price discrimination and the exercise of market power as part of a profit-maximizing strategy. The use of quantity discounts in rebates for those orders that add to liquidity, but fixed pricing of data and co-location services enhances the marginal incentives to provide orders that add liquidity to an exchange (due to overall quantity discounts) and enhance its volume and activity, thereby making its market data and co-location services more valuable to the other market participants.

It has long been recognized that investors naturally want to trade using platforms in which there is considerable concentration of trading. The nature of the rebate pricing tiers lead to incentives to further concentrate trading *beyond* the natural incentives of investors to trade in thick platforms.

²⁸At the SEC's Roundtable on Market Data (October 25-26, 2018) Mehmet Kinak (T. Rowe Price) commented that his firm would not consider hiring brokers who could not have access to all the market data (though it does not purchase all the available market data itself), because of the importance of the broker possessing proprietary data (e.g., on the order book) for fulfilling best execution for the firm's account.

At the same time tight connections among many exchanges (three affiliate families control twelve of the thirteen stock exchanges and more than 95% of exchange trading), limit the extent of competition among exchanges while simultaneously restricting the benefits of concentrated trading.

While this paper rests on an appeal to economic principles to address the anti-competitive nature of equity market rebate tiers, enhanced disclosures would be valuable (and more market oriented than restrictions on allowed pricing). Disclosure of the specific pricing tier that forms the basis of the payment provided each broker-dealer by the various exchanges would facilitate empirical evaluation of the extent of routing distortions and underlying conflict of interest as well as the competitiveness of exchange pricing. This also would enhance the ability of clients to evaluate their brokers and arguably offer a contracting solution to the conflict of interest. Even disclosure of the numbers of broker-dealers who are in specific pricing tiers would allow analysis of the extent to which the pricing tiers are customized and whether the exchanges are evading “fair access” requirements that mandate non-discriminatory pricing opportunities under the Exchange Act. Budd, Mooney and Wagner (2020) similarly raise whether the “customized pricing of rebates would run counter to the tenants of the Exchange Act.” Despite the disclosure of the rebate schedules, which are open to everyone, the design of many of the schedules could make them effectively customized.

An alternative approach would emphasize more directly restrictions on the allowed form of rebate pricing, such as requiring the use of proportionate (constant per share) rebates (see Spatt (2019)) or even zero rebates. This would reduce the barrier to entry associated with a tiered pricing approach and remove some of the potential scope for incentive conflict between the broker and customer because the pricing would be identifiable ex post (mitigating some of the conflict

underlying Best Execution). Indeed, pointing to many of the perspectives in an earlier version of this paper and its recommendation that the SEC require the use of constant per share pricing, Congressmen Budd, Mooney and Wagner (2020) requested that the SEC consider this reform seriously. More strongly, in the SEC's recently adopted transaction fee pilot (unanimously approved by the SEC in December 2018) one of the proposed treatment categories would bar rebates (which potentially could eliminate the conflict of interest underlying order routing).

Given the market power that exchanges possess (the lack of viable alternative suppliers, unlike for the traded securities) with respect to proprietary market data and co-location fees, it also would be natural to consider the possibility of greater regulation of pricing of proprietary data and co-location. Indeed, both the SEC's opinion in SEC (2018b), calling upon the exchanges to demonstrate that specific pricing proposals satisfy the requirements of the Exchange Act, as well as the discussion at the SEC's public roundtable (2018a), suggest the possibility of substantial changes in the pricing of exchange services (also see Jackson (2018)) and the broader regulatory environment for trading.

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Table 1: Rebate to Add Displayed Liquidity (Nasdaq)

Conditions: All US Equities (Executed at or above \$1.00 per share)	Rebate for Per Share Executed
Greater than 1.25% add ²⁹	\$0.00305
Greater than 0.60% added	\$0.0029
Greater than 0.30% added	\$0.0027
Greater than 0.10% added	\$0.0025
Minimum of 250,000 shares added per day in Tape A or Tape B securities (combined) ³⁰	\$0.0020
Minimum of 10,000 shares executed via QDRK ³¹	\$0.0020
All other firms	\$0.0020 for Tape A & B Securities \$0.0015 for Tape C Securities

Data source: Nasdaq Pricing:

<https://www.nasdaqtrader.com/Trader.aspx?id=PriceListTrading2#thrifty>

²⁹ Liquidity is calculated based on consolidated U.S. average daily share volume

³⁰ Tape A represents securities listed on NYSE, Tape B represents securities listed on exchanges other than Nasdaq and NYSE, and Tape C represents securities listed on Nasdaq. (Explanation source: NASDAQ Rule Book)

³¹ QDRK is a routing option under which orders check the System for available shares and simultaneously route the remaining shares to destinations on the System routing table that are not posting Protected Quotations within the meaning of Regulation NMS. If shares remain un-executed after routing, they are posted on the book. Once on the book, should the order subsequently be locked or crossed by another market center, the System will not route the order to the locking or crossing market center.

Table 2: Rebate to Add Displayed Liquidity (Nasdaq)

Conditions: All US Equities (Executed at or above \$1.00 per share)	Rebate for Per Share Executed
<ol style="list-style-type: none"> 1. Add greater than 0.60% TCV; and³² 2. Add NOM³³ Market Maker liquidity in Penny Pilot Options and/or Non- Penny Pilot Options of 0.10% or more of total industry ADV in the customer clearing range for Equity and ETF option contracts per day in a month on NOM; and 3. Add Customer, Professional, Firm, Non-NOM Market Maker and/or Broker-Dealer liquidity in Penny Pilot Options and/or Non- Penny Pilot Options of 1.50% or more of total industry ADV in the customer clearing range for Equity and ETF option contracts per day in a month on NOM 	\$0.00305
<ol style="list-style-type: none"> 1. Add greater than 0.12% TCV; and 2. Add Customer, Professional, Firm, Non-NOM Market Maker and/or Broker-Dealer liquidity in Penny Pilot Options and/or Non-Penny Pilot Options of 1.15% or more of total industry ADV in the customer clearing range for Equity and ETF option contracts per day in a month on NOM 	\$0.0030
<ol style="list-style-type: none"> 1. Add greater than 0.10% TCV; and 2. Add Customer, Professional, Firm, Non-NOM Market Maker and/or Broker-Dealer liquidity in Non- Penny Pilot Options of 0.40% or more of total industry ADV in the customer clearing range for Equity and ETF option contracts per day in a month on NOM 	\$0.0027

Data source: Nasdaq Pricing:

<https://www.nasdaqtrader.com/Trader.aspx?id=PriceListTrading2#thrifty>

³² Liquidity is calculated based on consolidated U.S. average daily share volume

³³ NOM: Nasdaq Options Market

Table 3: Rebate to Supplemental Liquidity Providers (“SLPs”)³⁴ (NYSE)

Tier Names	Condition ³⁵ (Executed at or above \$1.00 per share)	Rebate for Per Share Executed
SLP Tier 3	<ol style="list-style-type: none"> 1. Meets the 10% average or more quoting requirement in an assigned security pursuant to Rule 107B (quotes of an SLP-Prop and an SLMM³⁶ of the same member organization shall not be aggregated) and 2. Adds liquidity for all assigned SLP securities in the aggregate (including shares of both an SLP-Prop and an SLMM of the same or an affiliated member organization) of an ADV of more than 0.20% of NYSE CADV (for SLPs that are also DMM³⁷s and subject to Rule 107B(i)2)(A), more than 0.20% after a discount of the percentage for the prior quarter of NYSE CADV in DMM assigned securities as of the last business day of the prior month. 	\$0.0023
SLP Tier 2	<ol style="list-style-type: none"> 1. Meets the 10% average or more quoting requirement in an assigned security pursuant to Rule 107B (quotes of an SLP-Prop and an SLMM of the same member organization shall not be aggregated) and 2. Adds liquidity for all assigned SLP securities in the aggregate (including shares of both an SLP-Prop and an SLMM of the same or an affiliated member organization) of an ADV of more than 0.45% of NYSE CADV (for SLPs that are also DMMs and subject to Rule 107B(i)2)(A), more than 0.45% after a discount of the percentage for the prior quarter of NYSE CADV in DMM 	\$0.0026

³⁴ In order to add liquidity to our marketplace, NYSE established a new class of market participants called Supplemental Liquidity Providers (SLPs). SLPs are upstairs, electronic, high-volume members with financial incentive to add liquidity on the NYSE. They complement and compete with existing quote providers.

Also, 1) SLP must maintain a bid or offer at the National Best Bid or Offer (NBBO) in each assigned security at least 10 percent of the trading day; 2) SPL trade only for their proprietary accounts, not for public customers or on an agency basis; 3) SLPs that post liquidity in an assigned security that executes against incoming orders are awarded a financial rebate by the NYSE.

(Explanation source: https://www.nyse.com/publicdocs/nyse/listing/fact_sheet_slps.pdf)

³⁵ All credit above applied to: credit per Share - per transaction - for affiliated SLPs when adding liquidity to the NYSE with orders, other than MPL orders, in securities with a per share price of \$1.00 or more

³⁶ SLP-Prop and SLMM: Supplemental Liquidity Providing Firms

³⁷ DMM: Designed Market Maker

	assigned securities as of the last business day of the prior month	
SLP Tier 1A	<ol style="list-style-type: none"> 1. Meets the 10% average or more quoting requirement in an assigned security pursuant to Rule 107B (quotes of an SLP-Prop and an SLMM of the same member organization shall not be aggregated), and 2. Adds liquidity for all assigned SLP securities in the aggregate (including shares of both an SLP-Prop and an SLMM of the same or an affiliated member organization) of an ADV of more than 0.60% of NYSE CADV (for SLPs that are also DMMs and subject to Rule 107B(i)(2)(A), more than 0.60% after a discount of the percentage for the prior quarter of NYSE CADV in DMM assigned securities as of the last business day of the prior month 	\$0.00275
SLP Tier 1	<ol style="list-style-type: none"> 1. Meets the 10% average or more quoting requirement in an assigned security pursuant to Rule 107B (quotes of an SLP-Prop and an SLMM of the same member organization shall not be aggregated), and 2. Adds liquidity for all assigned SLP securities in the aggregate (including shares of both an SLP-Prop and an SLMM of the same or an affiliated member organization) of an ADV of more than 0.90% of NYSE CADV (for SLPs that are also DMMs and subject to Rule 107B(i)(2)(A), more than 0.90% after a discount of the percentage for the prior quarter of NYSE CADV in DMM assigned securities as of the last business day of the prior month 	\$0.0029

Data Source: New York Exchange Price List 2018

https://www.nyse.com/publicdocs/nyse/markets/nyse/NYSE_Price_List.pdf

Table 4: Rebate to Add Displayed Liquidity (Nasdaq)

Conditions: All US Equities (Executed at or above \$1.00 per share)	Rebate for Per Share Executed
Greater than 0.60% added ³⁸	\$0.0029
Greater than 0.40% added of which 0.10% are Tape B securities ³⁹	\$0.0029
Greater than 0.15% added and total contracts per day (added and removed) of 0.9% or more of total industry ADV in the customer clearing range for Equity and ETF option contracts per day in a month on NOM ⁴⁰	\$0.0029
Add greater than 0.50% TCV and Remove greater than 0.70% TCV	\$0.0029
Add Customer, Professional, Firm, Non-NOM Market Maker and/or Broker-Dealer liquidity in Penny Pilot Options and/or Non- Penny Pilot Options of 1.15% or more of total industry ADV in the customer clearing range for Equity and ETF option contracts per day in a month on NOM	\$0.0029

Data source: Nasdaq Pricing:

<https://www.nasdaqtrader.com/Trader.aspx?id=PriceListTrading2#thrifty>

³⁸ Liquidity is calculated based on consolidated U.S. average daily share volume

³⁹ Tape A represents securities listed on NYSE, Tape B represents securities listed on exchanges other than Nasdaq and NYSE, and Tape C represents securities listed on Nasdaq. (Explanation source: NASDAQ Rule Book)

⁴⁰ NOM: Nasdaq Options Market

Table 5: Rebate to Add Displayed Liquidity (NYSE Arca)

Tier Names	Conditions: (Round Lots and Odd Lots \$1.00 per share)	Rebate for Per Share Executed		
		Tape A ⁴¹	Tape B	Tape C
<u>Tier 1</u>	For ETP Holders and Market Makers that provide liquidity an average daily share volume per month of 0.70% or more of the US CADV ⁴²	\$0.0031	\$0.0023	\$0.0032
<u>Tier 2</u>	For ETP Holders and Market Makers that provide liquidity an average daily share volume per month of 0.30% or more, but less than 0.70% of the US CADV	\$0.0029	\$0.0022	\$0.0029
<u>Tier 2 (or)</u>	For ETP Holders and Market Makers that provide liquidity of 0.10% or more of the US CADV per month; And are affiliated with an OTP Holder or OTP Firm that provides an ADV of electronic posted Customer and Professional Customer executions in all issues on NYSE Arca Options (excluding mini options) of at least 1.50% of total Customer equity and ETF option ADV as reported by OCC	\$0.0029	\$0.0022	\$0.0029
<u>Tier 3</u>	For ETP Holders and Market Makers that provide liquidity an average daily share volume per month of 0.20% or more, but less than 0.30% of the US CADV	\$0.0025	\$0.0022	\$0.0025

Data source: NYSE Arca Marketplace: NYSE Arca Equities - FEES AND CHARGES⁴³
https://www.nyse.com/publicdocs/nyse/markets/nyse-arca/NYSE_Arca_Marketplace_Fees.pdf

⁴¹ Tape A represents securities listed on NYSE, Tape B represents securities listed on exchanges other than Nasdaq and NYSE, and Tape C represents securities listed on Nasdaq. (Explanation source: NASDAQ Rule Book)

⁴² US CADV means United States Consolidated Average Daily Volume for transactions reported to the Consolidated Tape, excluding odd lots through January 31, 2014 (except for purposes of Lead Market Maker pricing), and excludes volume on days when the market closes early and on the date of the annual reconstitution of the Russell Investments Indexes. Transactions that are not reported to the Consolidated Tape are not included in US CADV.

⁴³ Effective Date: Jun 11, 2018