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Neo-brokers and Payment for Order Flow – A Literature Review



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Abstract

This work examines the emergence of neo-brokers and their implications on the retail trading landscape. Neo-brokers are characterized by user-friendly interfaces, minimal account requirements, and low to zero commissions. Often utilizing smartphone apps, these platforms provide cost-effective and convenient access to trading services. The recent retail trading hype has brought neo-brokers and their primary revenue source, Payment for Order Flow (PFOF), under media scrutiny and criticism. A key point of contention is the potential conflict of interest arising from brokers being paid for routing customer orders and whether they fulfill their obligation to provide the best possible execution for their customers consistently. The thesis analyzes the current state of scientific research on this topic. Furthermore, it evaluates the average performance of retail investors on online trading platforms and how investor behavior and performance are influenced by the use of Digital Engagement Practices.

Studies suggest that PFOF can benefit retail orders depending on transaction size and liquidity factors. Digital Engagement Practices may encourage users to trade more frequently and take on higher risks. Retail investors often exhibit behavioral patterns, such as overconfidence and overtrading, which can harm their returns. Additional research is required to conclusively determine PFOF's overall advantages or disadvantages, particularly for options markets. Potential recommendations include establishing fixed thresholds (based on transaction size, liquidity, and other factors) to determine when off-exchange execution and PFOF should be allowed, refining the definition of best execution, establishing uniform benchmarks for order execution quality, and educating investors about common investment mistakes and behavioral patterns.

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1 Introduction

Investing has undergone significant changes in the past few decades, with the United States (US) serving as a prominent example due to its status as the largest equities market. The U.S. Securities and Exchange Commission's (SEC) abolishment of fixed commissions in 1975, followed by the opening of the first discount brokerage by Charles Schwab a few months later, led to the emergence of over 600 discount brokers by the mid-1980s (Zweig, 2015; Mihm, 2020). In the 1980s, direct dial-up connections were still prevalent; however, the 1990s marked the beginning of internet-based trading. By 1999, 25% of individual investors' trades were conducted online (Levitt, 1999). Discount brokerages, especially online, have significantly contributed to the democratization of the financial and investment world, as they allowed a broad range of investors access to financial markets.

In recent years, the emergence of new-age digital brokerage platforms, commonly referred to as neo-brokers, has transformed the financial landscape again. These innovative platforms offer low-cost, technology-driven solutions to retail investors, enabling them to access financial markets with even more reduced barriers to entry. The advent of neo-brokers has coincided with a retail trading boom, as an increasing number of individuals have begun participating in the stock markets. Today about 20-25% of the stock market in the US is comprised of retail trading, up from around 10% in 2019 (Bloomberg, 2020; Saul, 2023). The retail trading surge has been observed not only in the United States but also in countries such as Germany, where the number of individuals investing in stocks, funds, or ETFs rose from approximately 9.7 million in 2019 to 12.9 million by the end of 2022 (Balonier et al., 2021, 2022; Fey & Stämmeler, 2023).

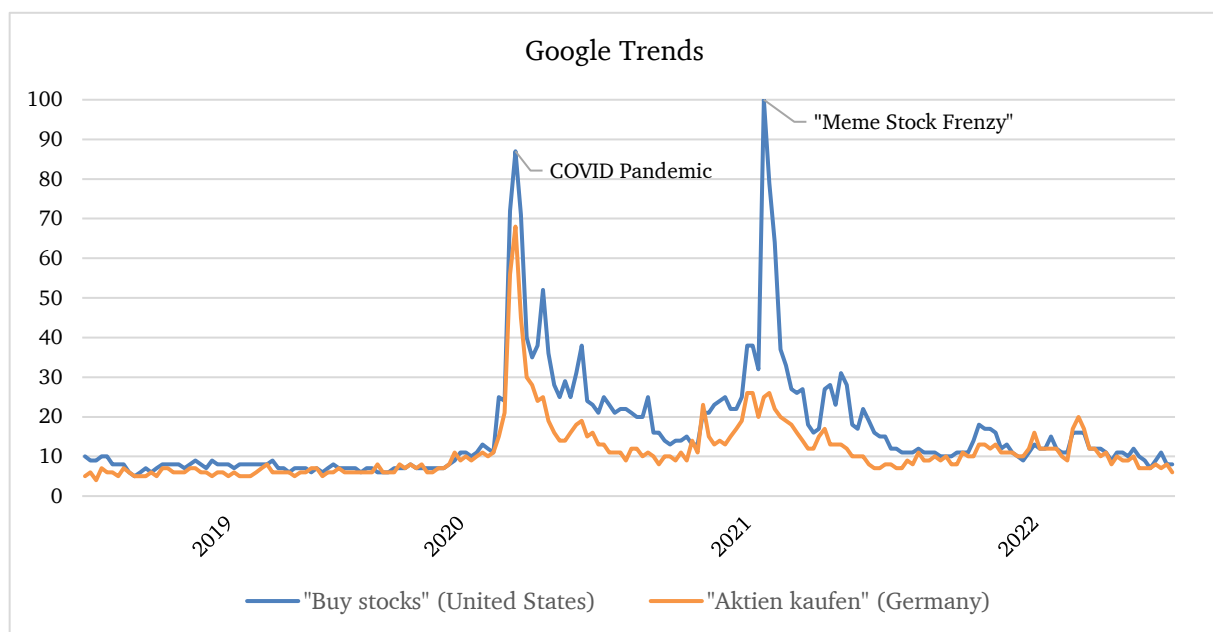


Figure 1: Google Searches for “Buy Stocks” in the US and “Aktien kaufen” in Germany¹

¹ Data from: <https://trends.google.com/home>.

Several factors have contributed to the growth of retail trading in recent years. Most notably, the COVID-19 pandemic has prompted people to stay at home, with many turning to the stock market as a means of income or investment. Quantitative easing measures implemented worldwide to support economies, like the stimulus checks in the US, have further fueled the retail trading boom. Additionally, years of low interest rates have left investors with limited alternative investment options, driving them toward the stock market. The shift in work patterns and entertainment opportunities, doubled by heightened volatility and “fear of missing out”, whetted the risk appetite of work-from-home traders. Figure 1 illustrates the increasing interest in trading, as evidenced by the spikes in Google searches for “Aktien kaufen” (buy stocks) in Germany (red) and “Buy stocks” in the United States (blue) during the onset of the COVID pandemic and the meme stock frenzy in early 2021.

The rapid growth of neo-brokers, such as Robinhood Markets, Inc. (Robinhood) in the United States and Trade Republic in the European Union - sometimes referred to as the “European Robinhood” (Browne, 2021) - can be attributed to their attractive offerings. These platforms provide low to zero fees, minimal account minimums, and easy-to-use interfaces, making them highly appealing to retail investors. Consequently, numerous traditional brokerages cut their trading fees for retail customers to remain competitive, as witnessed by the big four US brokerages at the end of 2019 (DeCambre, 2019; Talbot, 2019).

Neo-brokers primarily generate revenue through a practice known as payment for order flow (PFOF), in which they receive compensation for routing their customers’ orders to specific execution venues. PFOF has been present in the US since the 1980s and has always been a subject of critical debate. Opponents contend that PFOF creates inherent conflicts of interest for brokers, as they prioritize maximizing revenue rather than ensuring optimal execution for their clients. Furthermore, concerns have been expressed regarding the consequences of redirecting orders away from public markets on liquidity and the effectiveness of price information.

The issue of PFOF has garnered significant attention, particularly following the meme stock frenzy in 2021. Regulators have closely examined the practice, questioning whether PFOF and neo-brokers are a net positive for retail investors and the overall market. As a result, debates have arisen in both the European Union and the United States over whether PFOF should be banned outright or more strictly regulated. This paper seeks to provide a comprehensive overview of the PFOF phenomenon, examining its mechanics, advantages, disadvantages, and current regulatory frameworks in the European Union and the United States. Furthermore, it will delve into the existing body of research on the topic, focusing on whether brokers engaging in PFOF arrangements achieve the best execution for their clients and the effects of neo-brokers, PFOF, and internalization on overall market quality.

Another critique of neo-brokers involves using “Digital Engagement Practices” (DEPs) to motivate users to trade, such as gamifying the user experience, sending regular notifications, or offering reward

programs. This work will also address these tactics and present relevant studies. Lastly, the financial performance of retail investors, specifically on online platforms, will be examined.

Given the greater availability of research and data from the United States and considering that the PFOF concept originated in the country, this paper will place a strong emphasis on the US market. Nevertheless, due to the similarities between the financial systems and regulations of the United States and the European Union, the findings presented should essentially be transferable to the European Market. In the discussion of neo-brokers, Robinhood frequently emerges as a prominent example, as it pioneered the concept of zero-commission and gamification of trading. Moreover, the availability of extensive public data further solidifies Robinhood's position as a key reference point in exploring neo-brokers and their impact on the financial landscape.

2 Methods

Upon investigating the subject of neo-brokers and PFOF, it became apparent that knowledge and research in this area are somewhat fragmented and could be more cohesive. This is further exacerbated by rapid changes in financial markets and the evolving business landscape. In order to synthesize the current state of research, I am conducting a literature review based on the framework proposed by Baumeister & Leary (1997).

The initial section aim to establish a foundational understanding of neo-brokers and the practice of PFOF (section 3 and 4), which will serve as the basis for subsequent sections. First, neo-brokers are defined, and the different investment vehicles on these platforms are explained. This is followed by an examination of neo-brokers' revenue generation methods and a detailed presentation of PFOF. The section on PFOF also covers its history and the contemporary market. Literature for these foundational section was identified using electronic databases and search engines such as Google Scholar, the Social Science Research Network (SSRN), and Journal Storage (JSTOR). Various keyword combinations, including "Neo Broker", "Payment for Order Flow", "PFOF", and relevant modifiers like "Process", "Revenue", "History", "Studies", and more, were employed. The snowballing method was utilized to discover pertinent studies and literature by searching reference lists and citations in identified papers (Wohlin, 2014). A sufficient number of publications on the topic were found.

The subsequent section explores the advantages and disadvantages of neo-brokers and PFOF. A significant part delves into a detailed analysis of PFOF's impact on retail order execution quality and the overall market (section 5.1). This analysis aims to collate evidence and summarize the current scientific understanding on this subject (Baumeister & Leary, 1997). Relevant studies were sourced through a thorough search of the aforementioned databases, primarily using the following search string: ("Payment for Order Flow" OR "PFOF") AND ("Cost" OR "Execution" OR "Study" OR "Price" OR "Quality"). Additional keywords such as "Fees", "Retail", "Implicit", or "Commission" were also used. The snowballing method was once again used to identify supplementary literature. The regulatory section, in particular, drew from legal texts and reports by legal institutions such as the European Securities Markets Authority (ESMA), Bundesanstalt für Finanzdienstleistungsaufsicht (BaFin), SEC, and Financial Industry Regulatory Authority (FINRA). Only studies published in English or German were considered, with care taken to ensure they were published by reputable scholars, journals, universities, or institutions. Reviewing the abstract and conclusion sections determined which studies were suitable for the scope of this work. To ensure relevance, especially given the recent surge in retail trading, studies published from 2021 onwards were included.

The focus is on studies examining equity markets, as the higher density of knowledge in this area allows for comparisons between US and EU markets. Tables 1 and 2 present the studies that form the foundation for evaluating PFOF's impact on order execution quality. The literature on PFOF's and

internalization’s impact on options markets is less well-established. Selected studies, some predating 2021 (as shown in Table 8 in the Appendix), are presented to highlight any differences between options and equity markets. These findings will be utilized to assess whether PFOF in its current form is beneficial or detrimental to retail customers, whether neo-brokers fulfill their best execution obligations, and the overall effect on market quality. Moreover, this analysis aims to identify areas requiring further research due to weaknesses or contradictions (Baumeister & Leary, 1997).

Study	Author(s)	Year
Private Investors and the Emergence of Neo-Brokers: Does Payment for Order Flow harm Private Investors?	Meyer et al.	2021
Assessing the quality of execution on trading venues	Dutch Authority for the Financial Markets	2022
PFOF: An analysis of the Quality of Execution on a zero commission broker on Spanish Stocks	Comisión Nacional del Mercado de Valores	2022
Study into execution quality on selected German trading platforms	BaFin	2022
Payment for Order Flow and Market Quality: A Field Experiment	Elsas et al.	2022

Table 1: Studies – Equity Markets in the European Union

Study	Author(s)	Year
Retail Order Execution Quality under Zero Commissions	Adams & Kasten	2021
Do Investors save when Market Makers Pay? Retail Execution Costs Under Payment for Order Flow Models	Adams et al.	2021
The Good, The Bad and The UGLY of PFOF	Mittal & Berkow	2021
Trading Volume Shares and Market Quality: Pre- and Post- Zero Commissions	Jain et al.	2021
Commission Savings and Execution Quality for Retail Trades	Kothari et al.	2021
Payment for Order Flow and Asset Choice	Ernst & Spatt	2022
Price Improvement and Payment for Order Flow: Evidence from A Randomized Controlled Trial	Levy	2022
The “Actual Retail Price” of Equity Trades	Schwarz et al.	2022
Competition for Retail Order Flow and Market Quality	Hu & Murphy	2022

Table 2: Studies – Equity Markets in the United States

The following section (section 5.2) will examine the influence of DEPs on neo-broker users and the underlying performance of retail investors. To ensure a comprehensive analysis, the criteria will be expanded to include older studies for the chapter on investor performance. For this purpose, the

previously mentioned databases were again searched using keywords such as “Digital Engagement Practices”, “impact”, “behavior”, “gamification”, “performance” and “returns” in conjunction with “broker”, “neo-broker”, “apps”, “retail investor” and “individual investor”. Tables 9 and 10 in the Appendix list the identified, relevant studies. These sections aim to provide a comprehensive understanding of the relationship between DEPs and the behaviors of investors as well as the performance of retail investors. By incorporating findings from both newer and older studies, we will be better equipped to draw meaningful conclusions about the effects of DEPs on investor outcomes and to identify potential areas for future research. This approach ensures that the analysis is up-to-date and grounded in a solid understanding of the existing literature.

Overall, this literature review seeks to provide an organized and cohesive synthesis of the current knowledge surrounding neo-brokers and PFOF, as well as their advantages, disadvantages, and impacts on retail investors and market quality. By drawing from various reputable sources, we aim to offer valuable insights and identify potential areas for further investigation. This comprehensive analysis will serve as a sound foundation for understanding the complex and evolving landscape of neo-brokers and PFOF. The main findings of the examined studies are also presented in tabular form in the Appendix.

3 Neo-brokers

Generally, a broker is an independent individual that serves as an intermediary between two parties, typically a buyer and a seller. Brokers often collect fees or commissions while facilitating transactions. In the financial domain, brokers traditionally connect investors with securities exchanges, allowing brokerage firms or banks to execute transactions on their client's behalf. There are two main types of brokers: full-service brokers, who offer additional services such as market research and comprehensive investment advice at higher fees, and discount brokers, who primarily focus on providing brokerage services at lower costs. The latter gained popularity due to the internet, which enabled a more comprehensive range of investors to access financial markets. Today, brokers are predominantly used online, particularly by retail investors. Brokerages whose products are mainly aimed at private investors with smaller portfolios and transaction sizes are referred to as retail brokers.

Neo-brokers are a subcategory of retail brokers characterized by (near)-zero-fee trading and low account minimums. Compared to traditional online brokers, they typically offer a more limited range of securities, trading venues, and services. Customers can access their services through user-friendly websites or smartphone apps, facilitating convenient and straightforward operations. A notable distinction is that many neo-brokers frequently employ promotional tactics to attract new customers (SEC, 2021a). Customer orders are often not processed via a securities exchange but instead routed to an off-exchange market maker for execution (SEC, 2021a). Additionally, some neo-brokers do not provide all order types or restrict certain order types for specific assets (e.g., no limit or stop loss orders) (Frölich & Lembach, 2021).

Numerous (neo-)brokers employ advanced technologies, such as artificial intelligence (AI) and machine learning algorithms, within their platform. These technologies serve several purposes: They can be utilized in customer service chatbots, user data analysis and also support order routing processes. AI-powered smart order routing processes analyze multiple trading venues to determine the execution for a given order, considering factors like liquidity, price and trading costs (Ende et al., 2009). Adaptive algorithms dynamically adjust order routing strategies in real-time based on market conditions, including fluctuations in volatility and liquidity. By continuously learning from the evolving market environment, these algorithms can enhance order execution and reduce transaction costs (Hendershott et al., 2011). An emerging application area for these technologies is robo-advisory, which offers users personalized investment advice and portfolio management services.

As mentioned before, neo-brokers primarily focus on retail customers and trades. Although there is no specific legislation that explicitly defines a retail trader in the US, it generally refers to individuals who don't trade for a professional purpose. Retail-sized trades are typically characterized by relatively small order sizes, executed on behalf of an individual investor. In the EU, a retail trade refers to a securities transaction conducted on behalf of a non-professional investor, as defined under the Markets in

Financial Instruments Directive II (MiFID II). A non-professional investor includes any investor who is not classified as a professional client or an eligible counterparty, according to MiFID II. Although the specific definition of a non-professional investor may vary among EU member states, it generally comprises individual investors and small businesses.

Following the onset of the COVID-19 pandemic, governments and central banks were required to engage in quantitative easing and infuse capital into the economy and households for support (United Nations, 2022). A notable example is the distribution of “stimulus checks” to US citizens, a significant portion of which was invested in the stock market (Friedman, 2021). This led to a surge in financial markets and increased retail trading activity. The stay-at-home and unemployment effects of the pandemic, coupled with commission-free trading and marketing efforts, further fueled this trend (Osipovich & McCabe, 2020; Harty, 2021). Retail trading activity peaked in 2021, as exemplified by the GameStop stock incident in January 2021, where retail traders coordinated to purchase shares shorted by hedge funds². Trading activities declined in 2022 due to broader financial uncertainties and market corrections following central banks’ decisions to raise interest rates and sell portions of their balance sheets (quantitative tightening) to address high inflation (Schnabel, 2023).

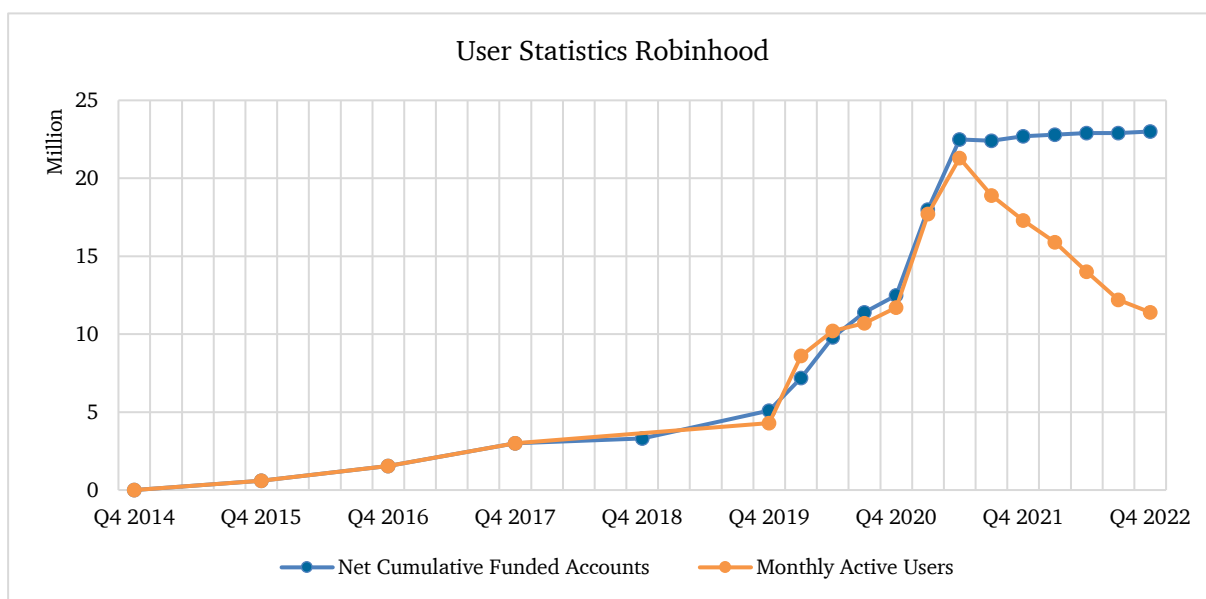


Figure 2: Robinhood User Statistics³

Robinhood, one of the most prominent providers and a pioneer for many other neo-brokers, launched its services in late 2014 (Robinhood, 2014). Since its public launch in 2015 (Robinhood, 2015), the platform has experienced consistent customer growth. The emergence of new competitors, particularly

² See detailed explanation in Chapter 4.5.

³ Data derived from business results, SEC filings and blog entries of Robinhood Markets, Inc. Net cumulative funded accounts are defined by Robinhood, as users that registered and funded their account excluding “churned” accounts (which were previously funded, but their balance dropped to zero or below for 45 consecutive days).

zero-commission trading, prompted major retail brokerages to eliminate trading commissions for retail clients in 2019 (DeCambre, 2019; Talbot, 2019). Figure 2 illustrates the increase in net cumulative accounts and monthly active users of Robinhood from 2014 to 2021 and a decrease in monthly active users in 2022. Robinhood will be regularly utilized as an example to illustrate neo-broker evolution and data in this work, given its relative market share and the accessibility user data.

3.1 Investment and Trading Methods

Many traditional financial products offered by conventional brokerages can also be found at neo-brokers. This section briefly overviews the most common investment and trading methods available through neo-brokers to provide insight into their concept and functionality.

Neo-brokers enable customers to engage in classic equity investment, which entails purchasing shares in publicly traded companies. These shares represent a small ownership stake in the company, allowing investors to partake in its profits and growth. As shareholders, investors have the right to vote on specific corporate matters, such as electing the company’s board of directors. However, many retail investors do not exercise their voting rights (Broadridge, 2013), and often, voting through neo-broker platforms is not possible. Shareholders may receive dividends, which are profit distributions made by the company. Dividends are typically paid to shareholders via their respective broker. Equity usually constitutes the largest share of assets under custody at neo-brokers, as illustrated by Figure 3 for Robinhood. This includes saving or trading Exchange Traded Funds (ETFs), which are investment funds composed of a basket of stocks, bonds, or other securities. Prominent ETFs are designed to track the performance of specific market indices, such as the S&P 500 or MSCI World.

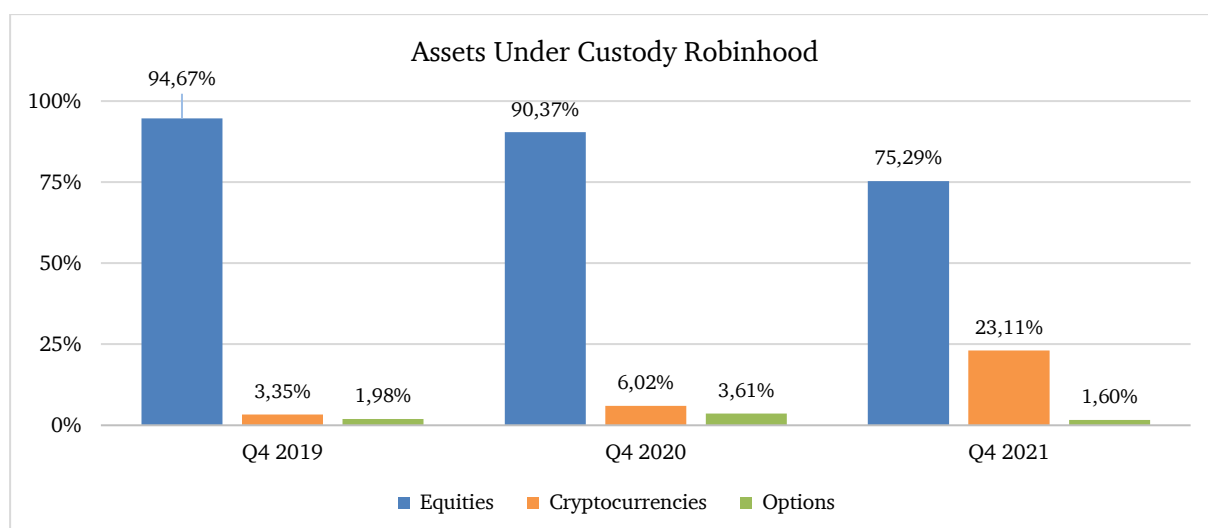


Figure 3: Robinhood Assets Under Custody (excluding Cash and Margin Balances)⁴

⁴ Data derived from business results and SEC filings of Robinhood Markets, Inc.

Additionally, most neo-brokers offer trading in Cryptocurrencies, such as Bitcoin and Ethereum. The exponential growth and relatively high volatility over the past decade make cryptocurrencies an attractive investment, particularly for younger investors and traders (Saad, 2021). Figure 3 shows the “Assets Under Custody” of Robinhood. A significant increase in the share of cryptocurrencies has been observed in the recent years.

Many retail brokerages, including neo-brokers, have begun offering margin trading. Margin trading, a strategy that allows investors to enter larger trades than they could with their capital alone, is facilitated by borrowing money from a broker and using it to purchase assets. The purchased assets secure this loan, and traders must maintain a certain level of equity, known as the margin, in their account to secure it. The created leverage can amplify both gains and losses. To mitigate risk, brokers often impose margin calls on traders whose accounts fall below a certain level, demanding additional funds be deposited to maintain the required margin. If the trader cannot meet the margin call, their position may be liquidated, resulting in a loss. Margin trading’s concept dates back to the early 1900s and has become increasingly popular among retail investors (Wolff-Mann, 2020).

Derivatives, which are financial contracts deriving their value from an underlying asset such as stocks, commodities, or currencies, serve various purposes like hedging risk or speculating on price movements. Examples of derivatives include options and futures contracts. Although futures trading is relatively uncommon among neo-brokers, most offer options trading. Options grant the buyer the right, but not the obligation, to purchase or sell the underlying asset at a predetermined “strike price” on or before the contract’s expiration. Sellers are typically market makers, hedge funds, or companies seeking to sell or buy their own stock. A distinction exists between European options, exercisable only on the expiration date, and American options, which owners can exercise any time before expiration (SEC, 2015). A call option affords the owner the right to buy the underlying asset at a specified price (strike price), while the seller is obliged to sell the asset if the option is exercised. The value of a call option increases as the price of the underlying asset rises. Conversely, a put option gives the owner the right to sell the underlying asset at a specified price. Options trading volume among retail investors has experienced significant growth in recent years (Wigglesworth, 2021; Li, 2021).

3.2 Revenue Streams

Neo-brokers employ a diverse range of revenue models to generate income and ensure the sustainability of their business. Many provide zero-commission trading, while others charge small trading fees on a per-trade basis or through subscription plans⁵. The majority of providers also offer some kind of premium services and subscriptions that grant access to advanced trading tools, research and analysis,

⁵ For example: Scalable Capital charges €0.99/Order or €4.99/Month.

and educational resources for a (monthly) fee⁶. Brokers also generate income by lending cash and securities to users or other brokers and companies against a borrowing fee. Some platforms offer lending programs (McCrank, 2022a) or get users' permission to lend assets through their customer agreement. For Robinhood, interest revenue accounted for approximately 14% of total net revenue in 2021, which can be seen in Figure 4.

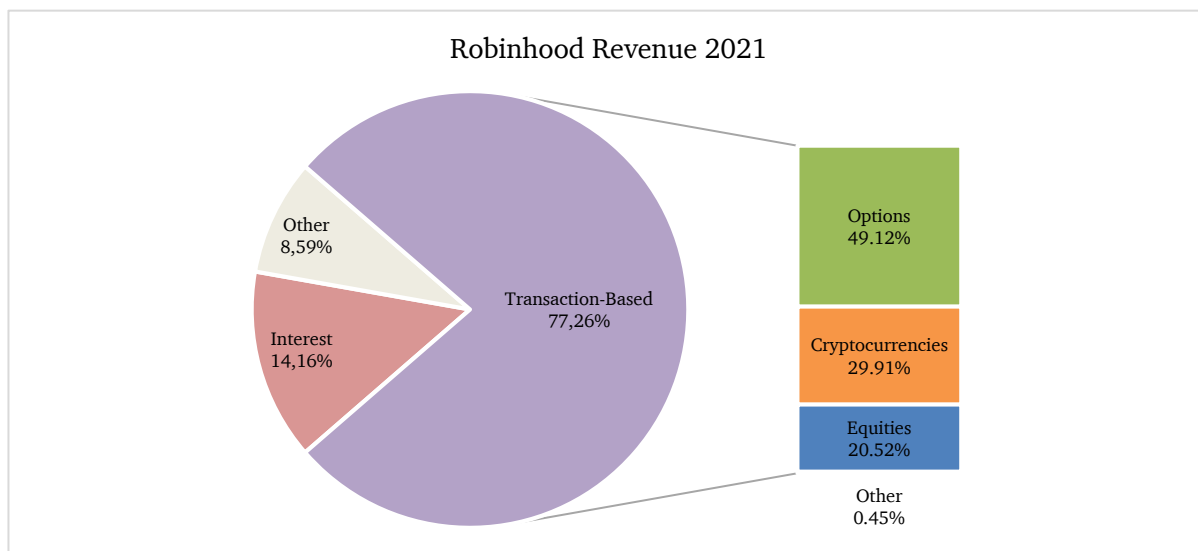


Figure 4: Breakdown of Robinhood Revenue (left) and Detailed Breakdown of Transaction-based revenue (right)

The most substantial revenue source for neo-brokers is transaction-based income, primarily generated through receiving payments for routing user orders to trading partners (PFOF). For example, in 2021, Robinhood's share of transaction-based revenue exceeded 77%, making it the most significant position. As explicitly stated in its annual report, the company is aware of its dependency on PFOF (Robinhood, 2022). A significant fraction of the transaction-based revenue is derived from routing options orders (almost 50%). The underlying reasons for this are discussed in Chapter 4.2.

Other potential revenues include proxy rebates and ACATS fees charged to users. Proxy rebates are revenues earned through partnerships with third-party investor communications companies that send investor materials to shareholders. Robinhood earns a share of the revenue the third-party company receives from issuers. ACATS fees are charged to users for facilitating the transfer of part or all of their accounts to another broker-dealer. Lastly, some brokers may generate additional revenue through advertisements or by providing third parties with financial and personal data.

⁶ For example: Robinhood Gold.

4 Payment for Order Flow

This section commences by introducing fundamental concepts associated with the procedure of PFOF. Subsequently, the process is explained, followed by a presentation of the history, the current market and the meme stock frenzy at the beginning of 2021.

4.1 Orders, Prices and Market Makers

Traditionally, stock exchanges facilitate the buying and selling of equity investments. These exchanges provide a platform for companies to raise capital by issuing shares of stock and for investors to trade these shares in a transparent, regulated market. Besides, ETFs, bonds and options are also traded there.

When investors or traders purchase shares, options or other financial instruments through an exchange, they typically encounter the decision of placing either a limit or market order. In this introductory section, we examine how exchanges match client orders. A limit order allows customers to set a limit price, serving as the maximum price they are willing to pay for an underlying asset or the minimum price they want to receive when selling it. Such orders will only be executed at the specified price or a better rate. However, the execution of these orders is not guaranteed, as the asset's price may never reach the predetermined limit. Limit orders contribute to the formation of an order book, which records all open limit buy and sell orders for a specific financial asset, representing the asset's current demand and supply. The highest limit buy order in an order book is referred to as the "Bid-Price", while the lowest sell limit order is known as the "Ask-Price".

In contrast, a market order only requires specifying the number of assets to be acquired or sold. The order is executed immediately at the current market price (bid- or ask-price, depending on whether it is a buy- or sell-market order). When purchasing an asset, the market order is matched with the lowest ask in the order book. If the order size surpasses the number of assets quoted at the current ask, the order moves to the next lowest ask and repeats this process until the order is fully executed. This dynamic can cause market orders to push the price up or down ("walk the book"), which might result in a detrimental average price. Market orders guarantee execution but not at a specific price. Exchanges that quote trading fees often impose higher fees on market orders because they remove liquidity from the order book. A limit buy order is considered marketable if the bid price is equal to or greater than the best offer (ask) since it will be executed immediately and remove liquidity from the order book. The same principle applies to sell orders with an ask price equal to or lower than the best bid.

Market makers, such as high-frequency trading firms, continuously provide liquidity to the market. The ESMA defines a market maker as "a person who holds himself out on the financial markets on a continuous basis as being willing to deal on own account by buying and selling financial instruments against that person's proprietary capital at prices defined by that person" (MiFID II, Article 4(7)).

Market makers supply liquidity and facilitate order execution by continuously buying and selling at publicly quoted prices. They generate profits by buying and selling securities at prices that yield a spread, the difference between the bid and ask prices. Although market makers operate on exchanges, they also perform order execution themselves. They receive order flow from brokers and execute it without using an exchange. This process is known as “off-exchange execution” and will be assessed in detail in the next section. Off-exchange market makers are often referred to as “wholesalers” or “internalizers”.

4.2 Process

When a customer submits a marketable order through a neo-broker, it is typically routed to an off-exchange execution venue (Greene & Corcoran, 2021). Even with zero commissions, trading systematically incurs transaction costs due to the difference between purchase and sale prices. Marketable orders pay a premium to “cross the spread” to liquidity providers. PFOF is the compensation a broker receives for directing order flow to a specific exchange or off-exchange market maker. This compensation usually involves monetary payments but may also include services, property or other benefits that give the broker-dealer remuneration or consideration in exchange for routing customer orders. In practice, the wholesaler compensates the retail broker-dealer for the opportunity to trade its customers’ order flow while ensuring execution at the quoted or better price (SEC, 2021a). To achieve this, execution venues typically offer price improvement compared to the best market price. The payment received by the broker is partially used to provide the user with a better price, with the remaining amount serving as revenue for the broker. Figure 5 demonstrates the PFOF process:

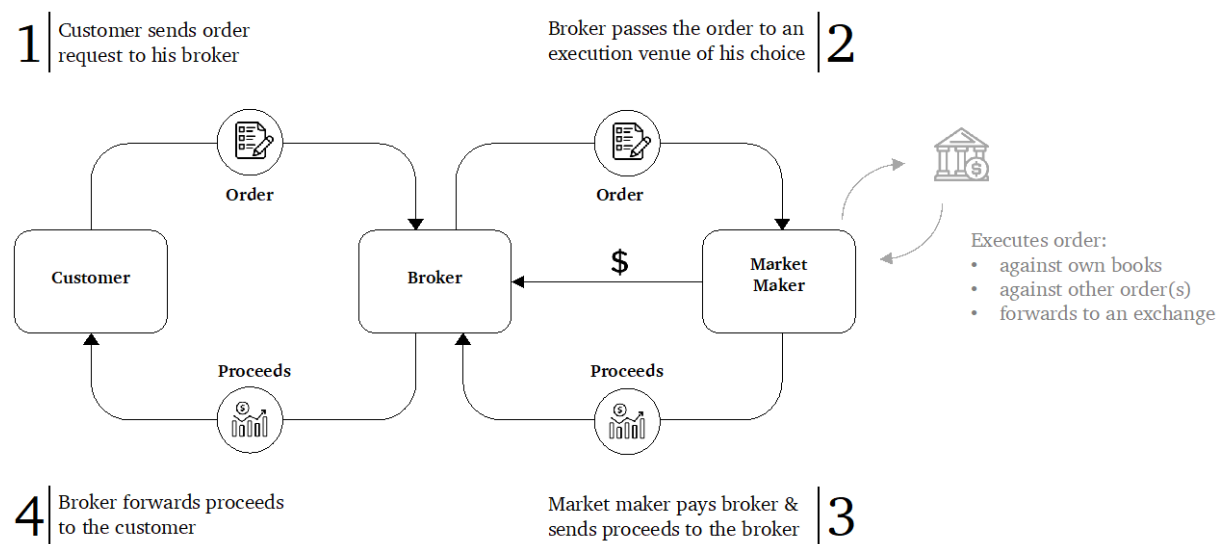


Figure 5: Payment for Order Flow Process⁷

⁷ Inspired by (Massa, 2021).

Limit orders are typically matched with orders from other clients or sent to exchanges by the market maker because there is no spread to be captured. Often, market makers receive rebates for providing liquidity on the exchange through limit orders. On the other hand, market orders are primarily executed by the market maker themselves, who acts as the counterparty for the trade and internalizes it against their own book. Market makers profit from the bid-ask spread by always selling at the current ask-price and simultaneously buying at bid-price. Since the wholesaler can determine the spread themselves, as long as they adhere to regulations, such as not executing worse than certain reference values, they can ensure that the order receives a better price than quoted. Internalizing trades exposes wholesalers to directional risk due to potential price movements against their position. They are compensated for this risk by capturing the bid-ask spread. Market makers typically hedge their market exposure using various financial instruments to protect themselves against price fluctuations.

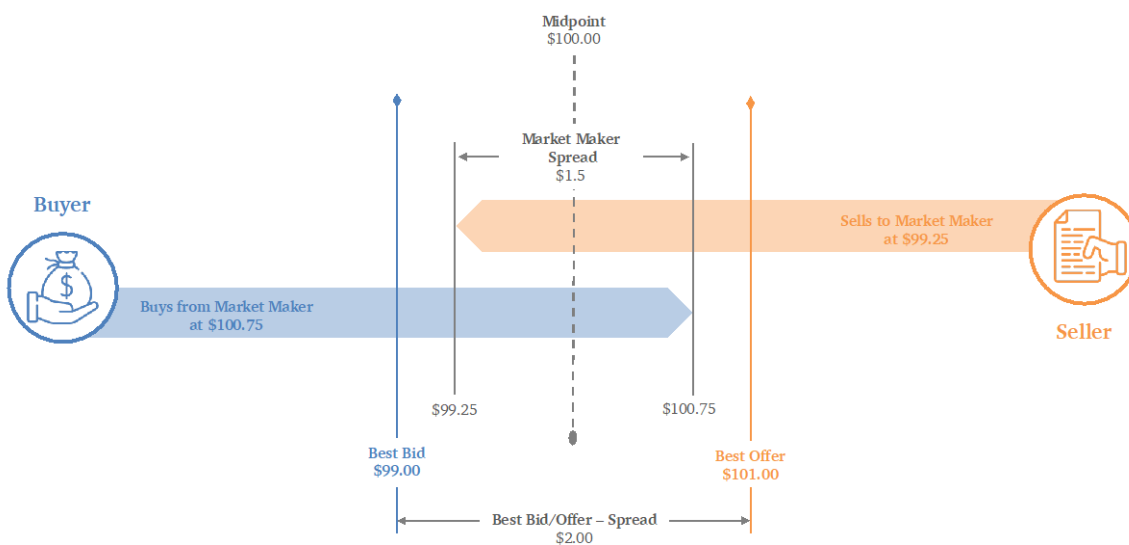


Figure 6: Off-exchange Execution (Internalization) Explained⁸

Figure 6 shows the internalization process: The market maker buys and sells at any time at prices set by themselves, which are usually better than the prices on the reference markets, and thus can offer a better execution price to the broker's clients. Assuming \$99.00 is the publicly quoted best bid on an asset and \$101.00 is the corresponding best ask. An investor buying at these prices would now pay \$101.00 for one share of stock. When his order is sent to a market maker, he might only pay \$100.75, which translates to a 25 basis point (bps) price improvement compared to the spread midpoint or 12.5% of the quoted spread. In our example, if the market maker sells a share for \$100.75 and buys from another order for \$99.25, he generates a profit of \$1.5. Part of this profit flows to brokers that send orders to him.

⁸ Inspired by (Rampell & Kupor, 2021).

Market makers are particularly interested in retail order flow, as this usually involves smaller order sizes, and investors are less informed than institutional ones. The risk of a retail trade moving against the market maker's position – called adverse selection – is smaller. Market makers use a practice called “Segmentation” to differentiate between order flow that correlates with future price movements and less informed order flow (SEC, 2021a). Market makers actively try to evade toxic (informed) order flow and will discontinue relationships with brokers who repeatedly route toxic orders to them (Battalio & Holden, 2001; Angel et al., 2011). Since market makers work primarily with uninformed, profitable order flow, they can typically give a better spread than public exchanges, i.e., better prices for orders and even pay the broker parts of their revenue (Angel et al., 2011; SEC, 2021a).

The amount of PFOF the broker receives is usually negotiated between the involved parties. It can either be determined on a per-contract basis, fixed percentage of the notional value or based on the current spread (Robinhood, 2022). The extent to which these payments are passed on to the customer or contribute to an even more favorable price for the order depends on the respective broker.

Regarding options trading, off-exchange market makers are unable to directly internalize trades against their books due to regulations in the US and most EU markets, which require options to be traded on exchanges (SEC, 2021a). Consequently, wholesalers either forward the order to a partner or initiate a price improvement auction on an exchange. In practice, the market maker often engages on exchanges as well or instructs an affiliated market maker to place a paired order in the price improvement auction. The partner (or the market maker himself) is now about to take the other side of the trade unless another participant offers a better price. Options exchanges usually try to attract market makers seeking to internalize order flow by providing fee structures that benefit them. For instance, a market maker that introduces a retail trade by initiating a price improvement auction receives a reduced take fee or a price-match option against any competitor in the auction. As a result, exchange fees have become prohibitively high for other participants to outbid the market maker or their partner. This structure allows wholesalers to execute client orders against their partners, respectively, their own bids at the price auction. This has led to assertions that brokers indirectly internalize option order flow (Bryzgalova et al., 2022; Ernst & Spatt, 2022). Some exchanges pay market makers for directing orders to them, which in turn generates revenue for the market maker and ultimately for the broker. Since market makers are obliged to find the best possible price, orders are forwarded accordingly or internalized “indirectly”.

Options markets, in general, have lower liquidity and less competition than equity markets. Since there are numerous options with different strike prices and execution dates for a single asset, volume and liquidity in individual options are lower than in the corresponding spot market, which directly influences the bid-ask spread. The minimum tick size is often 5 or 10 cents, resulting in inherently higher spreads. Market makers also face challenges in hedging their options exposure, with the associated

costs reflected in the spread (Battalio & Schultz, 2011). Although options are not internalized directly, the wider spreads generate higher revenues for wholesalers and brokers. These factors explain the relatively high options revenue share in transaction-based revenue in Figure 4 of section 3.2.

4.3 History

The concept of PFOF can be traced back to the 1980s in the US when it emerged as a response to the increasingly competitive securities market (Angel et al., 2011). During this period, the US equity markets were dominated by the NYSE and NASDAQ. However, the advent of electronic communication networks and alternative trading systems posed a challenge to traditional exchanges.

Initially, the primary role of brokers was to route client orders to the NYSE for execution. The commission system was the “lifblood” of the brokerage business (Jennings, 1965). From 1983 onward, exchanges were required to post real-time quotes to the public. Regional stock exchanges or broker-dealers could now offer execution to their clients at the publicly quoted prices of the NYSE. While the NYSE could only post quotes in multiples of \$0.125, broker-dealers were not bound by this rule and could therefore offer a tighter spread and lower fees. As competition intensified, market makers sought ways to attract order flow from broker-dealers and started to compensate them for directing customer orders to them. One of the first to take advantage of this was Bernard Madoff with his company Bernard L. Madoff Investment Securities. He initiated the practice of paying brokers for retail market orders while most exchanges charged fees. Due to its profitability, an increasing number of companies began paying for order flow. Some brokers even expanded their business and started trading against their books (Battalio & Loughran, 2008). Even at that early stage, this emergent market practice faced criticism and was occasionally labeled as a “bribe” or “kickback”. It also came under scrutiny from the SEC and the National Association of Securities Dealers (NASD)⁹ (Roberts, 1993; McMillan, 2000).

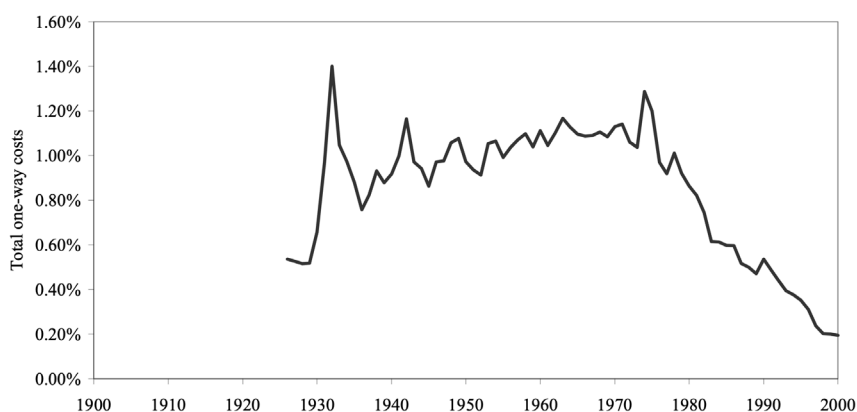


Figure 7: Average One-Way Transaction Cost (NYSE)¹⁰

⁹ The NASD is the predecessor of the FINRA.

¹⁰ Figure from (Jones, 2002).

In the following years, spreads and transaction costs declined due to increased competition, illustrated in Figure 7 (Jones, 2002). Consequently, market makers' profits per trade and payments received by brokers decreased due to tighter spreads. However, as trading volume grew, PFOF remained profitable for both parties. Madoff stated in 2000 that market makers had never experienced better years, and he anticipated that spreads would continue to narrow while PFOF would persist (McMillan, 2000).

4.4 Payment for Order Flow Today

Nowadays, the market-making and brokerage business is highly competitive. Following Robinhood's launch of zero-commission trading in 2015, which garnered significant success and attention, numerous neo-brokers emerged worldwide¹¹, and many existing retail brokers were compelled to reduce or eliminate their fees as well. While neo-brokers primarily rely on revenue from PFOF arrangements, it is also becoming an important income source for larger retail brokerages. With the shift to zero-commission trading in 2019, most retail brokers also changed their order routing behavior, favoring market makers that engage in PFOF instead of exchanges. Brokers renegotiated their arrangements with off-exchange execution venues or attempted to do so (Jain et al., 2021). The transition to commission-free trading has further accelerated retail trading activity. Figure 8 shows the amount of average daily trades for large US brokerages around the introduction of zero-commission trading and illustrates the immediate increase in trading activity. Other factors, such as the stay-at-home orders and expansionary fiscal policies of central banks during the COVID pandemic, also contributed to this growth.

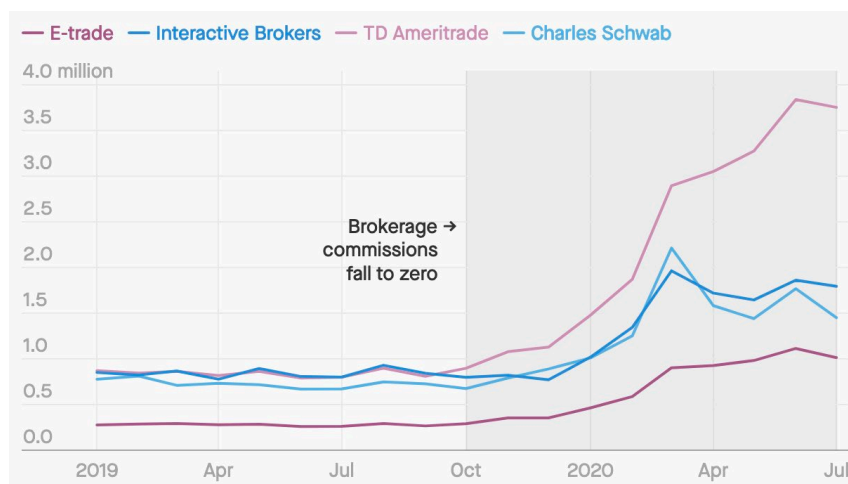


Figure 8: Average Daily Trades on Retail Brokers after the Introduction of Zero-Commission Trading¹²

¹¹ For example: Trade Republic – a neo-broker based in Germany – launched in January of 2019 (Trade Republic GmbH, 2022).

¹² Figure from (Fernholz, 2020).

The estimated number of retail trades in the US increased from around 367 million in 2017 to over 1.8 billion in 2020. Cumulatively, from 2016 to 2021, retail investors executed more than 5 billion trades, totaling over ten trillion dollars in aggregate volume (Kothari et al., 2021). A spokesman for Citadel Securities, the largest US wholesaler, stated that retail traders accounted for up to 25% of the market in 2020, up from just under 10% in 2019, with zero-commission cited as a key factor (Bloomberg, 2020).

Data from the Chicago Board Options Exchange (CBOE) reveal that over 40% of equities volume is typically executed off-exchange (SEC, 2021a)¹³. The majority of this volume is likely derived from retail brokers that receive rebates for providing this order flow (Pisani, 2021). The increasing retail trading volume and the elevated proportion of off-exchange executed orders have led to a rise in PFOF payments, as observed for US brokerages in Figure 9. Particularly in the years 2020 and 2021, a significant uptick can be observed.

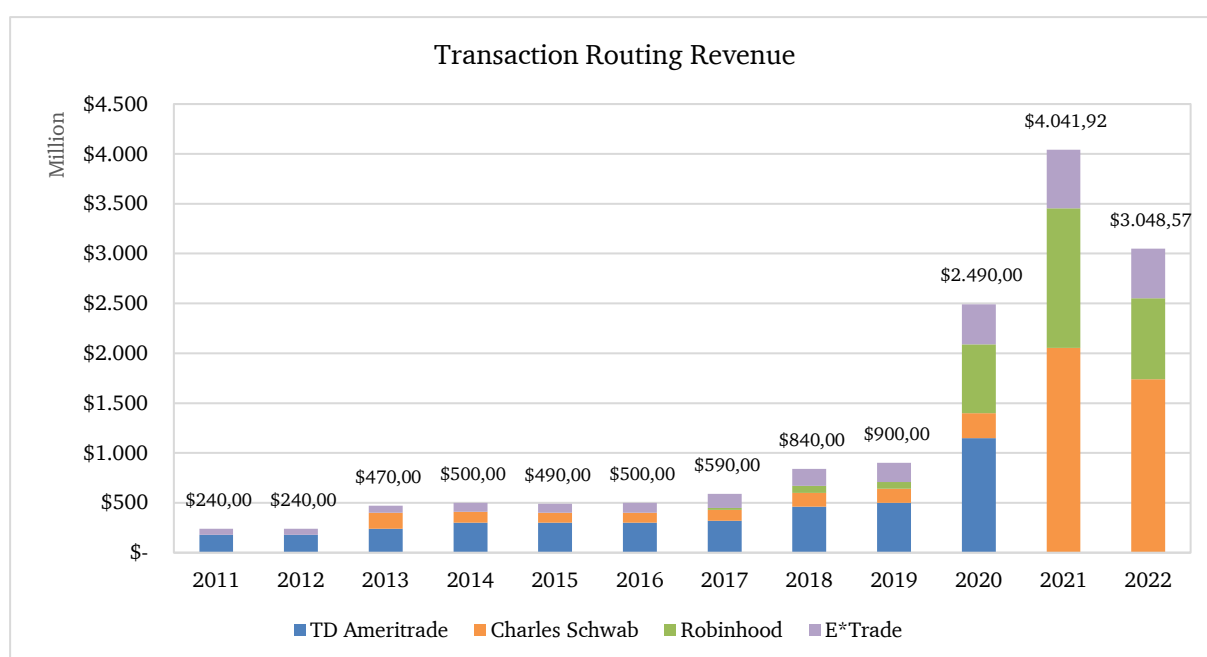


Figure 9: Transaction Routing Revenue of US Brokerages¹⁴

The steady increase over the last decade was significantly amplified by the elimination of trading commissions in late 2019 and the onset of the COVID pandemic in early 2020. US broker transaction routing revenue reached a record high of approximately \$4 billion in 2021 and remained elevated in subsequent years.

¹³ For current data, see: https://www.cboe.com/us/equities/market_share/.

¹⁴ Transaction Routing Revenue of the four biggest US recipients of PFOF (Fidelity does not take PFOF on orders). In 2020, Charles Schwab acquired TD Ameritrade, and as a result, only Charles Schwab is displayed in the 2021 and 2022 columns. Data derived from Company Reports and Yahoo Finance.

In the context of increased retail trades, wholesalers captured a substantial market share from exchanges, accelerated by zero-commission trading. Concurrently, a few off-exchange wholesalers dominate most of the US retail market. The three largest firms, Citadel Securities, Virtu Financial and G1X Execution, handle up to 75% of total retail volume in equity trades (Jain et al., 2021; Hu & Murphy, 2022). Figure 10 shows the market share of wholesalers executing retail order flow in the US. It is evident that the two largest wholesalers were able to extend their market dominance in recent years.

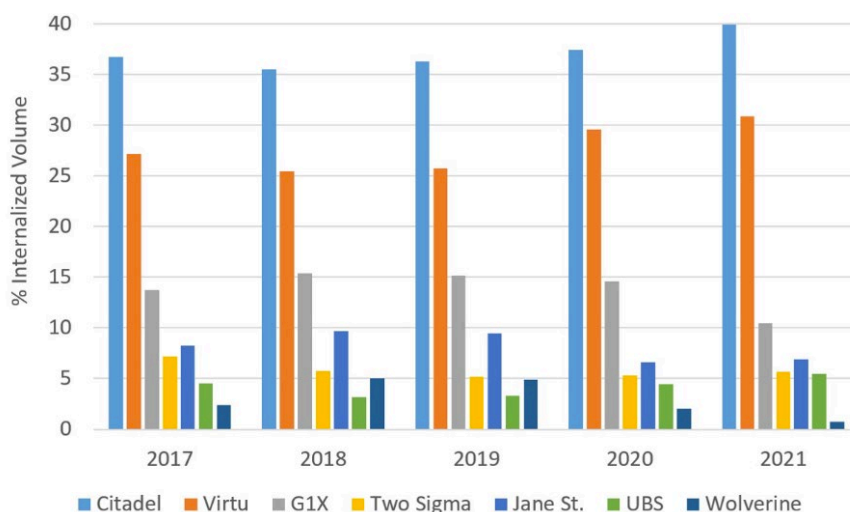


Figure 10: Market Share of the Biggest US Off-exchange Wholesalers in Equity Markets¹⁵

As previously noted, the options market is particularly attractive for wholesalers and brokers due to higher revenues compared to equities. In options markets, the share of retail traders is more prevalent than in equity markets, with approximately 48% of orders executed through off-exchange venues (Li, 2021; Bryzgalova et al., 2022). In fact, wholesaler concentration is even higher, with the three largest wholesalers – Citadel Securities, Susquehanna, and Wolverine – processing, on average, over 85% of retail order volume (Bryzgalova et al., 2022). The high centralization of PFOF providers across both markets is viewed critically by some, and potential effects are examined in studies presented in section 5.1.

4.5 Meme Stock Frenzy

The year 2021 witnessed an unprecedented phenomenon in finance and investing, colloquially referred to as the “meme stock frenzy”. This event not only captured the attention of market participants, regulators, and academics but also thrust the role of social media in the financial markets into the limelight. This chapter aims to provide an overview of the meme stock frenzy, its underlying causes, and its broader implications on the financial landscape.

¹⁵ Figure from (Hu & Murphy, 2022).

The meme stock frenzy can be characterized by the rapid and seemingly inexplicable rise in the share prices of certain publicly traded companies. These stocks, dubbed “meme stocks”, typically belonged to companies that were either struggling or experienced substantial short-selling by institutional investors. Among the factors contributing to this frenzy was the accessibility of zero-commission trading platforms like Robinhood, increased retail investor participation during the COVID-19 pandemic, and a widespread sense of dissatisfaction with the traditional financial system. Furthermore, using social media platforms as a conduit for information sharing and collective action allowed retail investors to harness their collective power.

The main focus of the whole incident was on the American video game, electronics and gaming merchandise retailer GameStop Corporation, Inc. (GameStop). Due to the intense competition from rising online sales, worsened by the COVID-19 pandemic (GameStop, 2021), the company’s stock prices went below \$3 in 2020. Numerous hedge funds were betting on falling prices, so in January 2021, about 140% of the free float shares were sold short (Ponciano, 2021). This resulted in short interest higher than 90%, which was observed rarely during the financial crisis between 2007 and 2008 (SEC, 2021a). Retail investors colluded via the online platform Reddit, especially the subforum r/Wallstreetbets, to provoke a so-called “short squeeze”. A short squeeze occurs when the value of an asset with significant short interest rises and is therefore moving against the positions of short sellers. If the price continues to climb, short sellers may initiate the closure of their positions to prevent additional financial losses or face liquidation if they are unable to fulfill margin requirements. To close a short position, shares need to be repurchased, further increasing the demand for the asset (buy pressure).

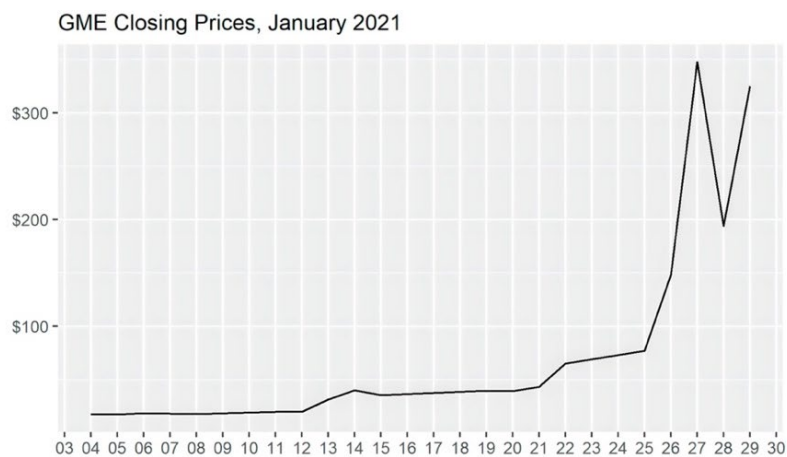


Figure 11: GameStop (GME) Share Closing Prices, January 2021¹⁶

Accompanied by a strong hype triggered by increased media coverage, GameStop share prices continued to rise sharply. The price increase might have been further driven by market makers, that had to

¹⁶ Figure from (SEC, 2021a).

hedge their outstanding call options by buying GameStop shares (“gamma squeeze”)¹⁷. All of the catalysts together caused the price to climb to a high of over \$480 on January 28th (SEC, 2021a). Other shares, such as AMC, Nokia and Blackberry, recorded a similar price increase. On the same day, some brokers in the US but also in Europe introduced short-term trading restrictions on these volatile stocks, which often only allowed the sale of the share (McCabe, 2020; Spiegel, 2021). Restrictions were either justified by higher collateral requirements from clearing houses, system congestion, or investor protection (SEC, 2021a; Spiegel, 2021; Newburger, 2021).

As a result of the events, some hedge funds suffered significant losses (Aliaj et al., 2021; Akhtar, 2021). As it can be assumed that many private investors also had to record losses, authorities such as BaFin, ESMA or the SEC warned investors against investments that arise as a result of collusion on social media (BaFin, 2021a; SEC, 2021b; ESMA, 2021a). Some parties also claimed that the trading restrictions were introduced at the instigation of market makers or hedge funds (Spiegel, 2021). The underlying theory suggests that numerous hedge funds are involved in market-making ventures, such as Citadel (hedge fund) and Citadel Securities (market maker), or maintain close connections with them. Given that some hedge funds have experienced losses and market makers are the primary source of income for neo-brokers through PFOF, it is claimed that the brokers have been requested to limit the purchase of specific stocks. This narrative was the subject of a Congressional Hearing in the US in which involved parties testified that the trading halts were not the result of such pressure ("Hearing Before the United States House of Representatives", 2021). Nevertheless, due to the magnitude of the incident and worldwide media coverage, various discussions about neo-brokers, their connection to market makers, and specifically the market practice of PFOF were initiated (Politi et al., 2021).

¹⁷ Market makers hedge their market exposure to stay neutral (or as neutral as possible) to price changes. In this case short sellers might have bought call options to hedge their position as well as investors that expected higher prices. Both forced the market makers to buy the underlying stock the hedge their own exposure. Option trading in GME went up rapidly during January 2021 which indicates a possible gamma squeeze (Wigglesworth, 2021).

5 Critiques to Neo-brokers and Payment for Order Flow

Potential advantages of neo brokers are simplicity and low barriers to entry. It only takes a smartphone or computer, an internet connection and a bank account to open an account and start trading after a few minutes. Account minimums are low, and broker commissions are often nonexistent, while brokers in the past charged commission fees to generate revenue. These up-front fees made investing cost-prohibitive for many retail investors with small amounts to invest (Vissing-Jorgensen, 2002; Kothari et al., 2021). This barrier for small-scale investors can be circumvented through neo-brokers (Meyer et al., 2021). In addition, the introduction of fractionalized shares for stocks with a high denomination allows small investors to invest in these assets as well.

Straightforward user interfaces (UIs) facilitate an easy entry into investments in stocks, options, and other financial instruments. One of the key aspects of an effective UI is the use of clear, concise language. The utilization of robo-advisors further simplifies the process of entering the investment and trading sector. Consequently, neo-brokers significantly contribute to the democratization of finance, granting universal access to financial markets. Additionally, these brokers often supply educational resources, including articles, videos, webinars, and tutorials, to assist users in grasping financial concepts and investment strategies. Research indicates that user-friendly and game-like UIs can enhance the enjoyment and accessibility of investing, thereby promoting financial literacy (Rodrigues et al., 2016). As neo-brokers incorporate these elements into their platforms, they have emerged as vital drivers in advancing financial education and awareness (Bitrián et al., 2021). For example, users can be motivated to achieve certain financial goals, such as savings (Bayuk & Altobello, 2019).

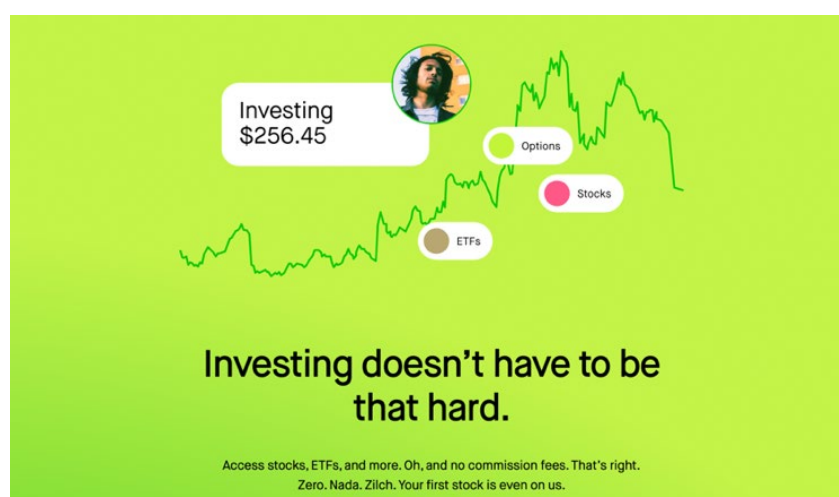


Figure 12: Ad on Robinhood.com

Neo brokers cooperating with off-exchange market makers promote better execution prices than classic exchanges. By receiving PFOF and partially passing on this payment, the customer is promised an even better price. When orders are executed off-exchange, retail investors can benefit from the value of their

– on average uninformed - order flow in the form of low commissions and price improvements (Rosov, 2016). In contrast, when trading on a public exchange, retail investors would likely need to cross the bid-ask spread to trade, resulting in the value of their order flow being distributed throughout the market. In Chapter 4.4 we discussed that the off-exchange market is mainly in the hands of a few market makers. Proponents of PFOF argue that market concentration can be beneficial for all involved parties because large market-makers can use their economies of scale to subsidize online brokerages and retail trading. Large market-makers also naturally have greater inventory capacity, allowing them to internalize large retail orders and thus avoid the need to “walk the order book” and incur costly transaction fees on public exchanges.

Many of the aforementioned advantages of neo-brokers are also cited in the course of criticizing them. A significant part of neo-brokers’ revenue is derived from PFOF. Therefore, their income is strongly linked to the trading volume on the platform, and brokers try to attract as many users and trading volume as possible. The mentioned low entry barrier, including easy signup and low account minimums, is criticized, as the brokers would thereby try to direct especially inexperienced and young retail investors to their platform.

5.1 Payment for Order Flow and Best Execution

The most extensive discussion around neo-brokers and PFOF concerns trading costs and customer execution prices. Brokers are accused of being in a conflict of interest (principal-agent conflict) because they receive payments from market makers, which would influence the trade execution (Rosov, 2016; SEC, 2021a; ESMA, 2022). Since PFOF is the most important revenue stream, brokers might be interested in routing orders through a particular venue that pays them for the order flow. At the same time, customers are not interested in execution against a specific venue but for the best price (Schuster & Raetz, 2022). As a result, the market maker gains substantial pricing power because the competition on the market is less about offered prices and more about payments (SEC, 2000). The introduction of zero-commission trading from the most prominent retail brokerages in 2019 could further worsen agency problems. Participating brokers might have to offset losses of commission revenue with higher PFOF payments¹⁸ (Adams & Kasten, 2021), and execution venues that pay brokers for their order flow might need to maintain a broader spread to recoup the payment (Financial Services Authority, 2012). Their execution might achieve incremental price improvement but not the best price available (Rosov, 2016).

Brokers pass parts of the received payments to customers in the form of a price improvement; however, it is debated whether this can compensate for a potentially higher spread. While the typical rate is that

¹⁸ Stock prices of Charles Schwab, TD Ameritrade and E*Trade saw significant drawdowns after announcing a move to zero-commission trading for retail investors. This might add additional pressure on brokerages to generate revenue.

brokers take about 20% and use 80% for order price improvement, some platforms keep 80% of the received payments (SEC, 2021a). Possible price disadvantages for the customer were already investigated in the 1990s and 2000s and are still the subject of many studies today. For this reason, some jurisdictions, such as Canada and Australia, have implemented rules which mandate substantial price improvement to justify taking trades off-exchange (Rosov, 2016).

While neo-brokers often promote their zero-fee policy, the trades are in reality not free of fees. The fee might not be in the form of a commission but can be hidden in spreads or option premiums (implicit costs)(Financial Conduct Authority [FCA], 2019). The issue of transparency regarding fees and costs is also being critically considered, as is whether advertising with zero fees is compatible with legal provisions. Additionally, zero-commission trading may also increase indirect costs associated with trading, such as lower interest paid to cash balances and higher margin interest rates charged (Jain et al., 2021).

One aspect that has come into focus, mainly due to the incident in January 2021, is the proximity of brokerages to market makers and hedge funds. It is suspected that restrictions introduced by brokers after some stocks experienced extreme volatility were not induced by capital requirements or system congestion but were implemented at the request of the market makers and hedge funds that were suffering losses. Furthermore, it is criticized that market makers may purchase order flow to obtain information (Ernst et al., 2021), which could be used to front run or trade against the received order flow through in-house trading firms or close relationships to them.

Authorities also fear that the use of PFOF may impair the market infrastructure. The concentration of order execution outside of exchanges may lead to market segmentation and disrupt the price discovery process, as wholesalers don't display their quotes to the public (Angel et al., 2011; Chretien, 2021). In addition, due to the segmentation of the order flow, off-exchange market makers primarily process uninformed order flow, and the informed and thus riskier order flow is executed on exchanges. This can lead to spreads on exchanges widening. Since all prices are derived mainly from public quotes, all market participants might receive a poorer execution (Easley et al., 1996; Battalio & Loughran, 2008). SEC chair Gary Gensler mentioned in a speech in 2021 that "market concentration can deter healthy competition and limit innovation" (Gensler, 2021).

5.1.1 Regulation

As mentioned above, much attention has been focused on the regulation of PFOF in recent years (ESMA, 2021b). The main focus is whether the links between brokers and off-exchange market makers trigger a conflict of interest and whether brokers fulfill their duty of best execution for the user (BaFin, 2021b; ESMA, 2021b). In addition, there are discussions about the extent to which neo-brokers need

to inform their customers about the costs of their services, as they often advertise with zero fees or commissions (BaFin, 2021b; ESMA, 2021b).

This section will outline the legal framework in the EU and US before examining the extent to which neo-brokers today comply with these regulations.

5.1.1.1 Regulation in the European Union

Neo-brokers operating in the EU are subject to a regulatory framework that involves both: EU-wide and national-level regulations. The primary authorities responsible for regulating neo-brokers are the ESMA at the EU level and the respective national competent authorities (NCAs) in each member state. On the EU level, the stipulations of the “Markets in Financial Instruments Directive II” (MiFID II) and “Markets in Financial Instruments Regulation” (MiFIR) are to be enforced. Both legislative frameworks were instituted in January 2018, with the primary objectives of enhancing investor protection and optimizing financial market functionality, thus increasing efficiency, resilience, and transparency. MiFID II establishes goals for EU member states to attain, while MiFIR is a binding legislation applicable to all member states and firms within the European Union. In Germany, the primary regulatory authority responsible for overseeing neo-brokers is the Federal Financial Supervisory Authority (Bundesanstalt für Finanzdienstleistungsaufsicht, or BaFin). BaFin is an independent federal institution that supervises and regulates banks, insurance companies, and financial services providers, including neo-brokers. The provisions of the ESMA are integrated into the Securities Trading Act (Wertpapierhandelsgesetz).

In light of the events in January 2021, the ESMA issued a warning to firms and investors regarding potential risks stemming from zero-commission brokers and PFOF. ESMA’s statement conveyed that PFOF presents significant investor protection concerns and that, in most instances, it is improbable that the current form of PFOF complies with MiFID II. Furthermore, NCAs are encouraged to prioritize PFOF in their supervisory endeavors and assess the impact on firms’ adherence to best execution, conflicts of interest, and inducement obligations (ESMA, 2021b).

According to MiFID II, firms must undertake appropriate measures to identify and prevent conflicts of interest arising from the receipt of commission or other benefits for directing clients’ order flow (Article 24 (8-9)). Firms are prohibited from receiving payments if doing so generates conflicts of interest, inducements, or disruption in cost transparency and best execution (Article 27 (2)). Consequently, MiFID II does not impose a comprehensive ban on PFOF but integrates the recipients within its investor protection framework. According to Article 26, investment firms (including brokers) and trading venues (such as off-exchange order execution venues) are required to report details of transactions in financial instruments to their respective competent authorities (for example, BaFin in Germany). This

information typically includes the identity of the parties involved, the financial instrument, the quantity, the price, the date and time of execution, and other relevant details.

Firms are required to disclose the receipt of PFOF and all pertinent costs associated with broker usage for clients (Article 24 (9a)) (ESMA, 2021b). ESMA advises brokers to “disclose the existence, nature and amount of PFOF to the client on an ex-ante and ex-post basis” (ESMA, 2021b). Additionally, firms are expected to report implicit costs to users in greater detail, such as those encompassed within the bid-ask spread offered by the market maker (Article 24 (4)). Regarding the promotion of zero-commission trading, Article 24 (3) of MiFID II mandates that firms must not make misleading statements. ESMA’s warning letter explicitly highlights that brokers frequently violate this provision through deceptive advertising.

As mentioned above, firms are required to avoid conflicts of interest. They can do this by fulfilling their duty of best execution. ESMA points out that the selection of execution venues should not be based on incentives or payments. Firms are obliged to act in their client’s best interest¹⁹. They must take “all sufficient steps to obtain [...] the best possible result for their clients taking into account price, costs, speed, likelihood of execution and settlement, size, nature or any other consideration relevant” (MiFID II, Article 27 (1)). The “best possible result” for retail orders is further specified as the total cost, which comprises the price of the financial instrument and all fees directly related to the execution (ESMA, 2021b). Firms are not explicitly required to find the best price for each individual order but must establish an order execution policy enabling the best possible execution on a consistent basis (Article 27 (4-5)). This “best execution policy” must contain the utilized execution venues and the criteria for the firm’s order routing (Article 27 (5)). While the policy does not have to include every available execution venue, it should include those necessary for a consistent best order execution. MiFID II also requires investing firms and execution venues to publish data on their execution quality regularly. This is often assessed by comparing realized and reference prices, like the European Best Bid and Offer (EBBO). The EBBO is the highest binding bid/lowest binding ask price available in the central limit order books of the regulated markets and Multilateral Trading Facilities (ESMA, 2013)²⁰.

PFOF is not intrinsically incompatible with the current provisions of MiFID and MiFIR; firms may receive payments in full compliance if they ensure it is used to improve the quality of the provided service Article 24 (9a), (ESMA, 2021b). The extent to which brokers may also benefit from the payment in the form of revenue remains a subject of debate in the EU. As the implementation of MiFID provisions falls under the jurisdiction of individual member states, the outcomes of enforcement may vary. For neo-brokers in Germany, regulations are closely aligned with the requirements of the ESMA. The Securities

¹⁹ Article 24 (1) MiFID II.

²⁰ Multilateral Trading Facilities are venues where buyers and sellers of a financial instrument are paired, similar to an exchange. They are not allowed to discriminate clients or execute orders against their own books.

Trading Act mandates that brokers must consistently act in their client’s best interest (Wertpapierhandelsgesetz (63), (82)). In accordance with MiFID II, brokers are only allowed to accept payments for transmitting orders if it enhances the quality of the provided service. Member states also have the discretion to introduce regulations that exceed the provisions of MiFID II, as demonstrated by the Netherlands, where PFOF is disallowed.

In November 2021, a European Commission legislative proposal was introduced to review MiFIR. This proposal aims to incorporate an article to “ban payment[s] for forwarding client orders for execution” (Article 1 (26), COM(2021) 727 final), effectively banning PFOF throughout the EU. While Germany and the BaFin have expressed opposition to a complete ban on PFOF, arguing that its impact must first be thoroughly examined, there are member states that advocate for an EU-wide ban, like the Netherlands. The proposal continues to be discussed until today. Shortcomings or deficits in transparency could be implemented by brokers. Preventing conflicts of interest ultimately comes back to whether clients get the best possible execution. Therefore, the impact of PFOF on order execution and, effectively, on prices for the clients must be examined in order to make a determination as to whether it is in compliance with current regulations. The results may also be decisive for the outcome of the MiFIR Review Proposal.

5.1.1.2 Regulation in the United States

Neo-brokers, like all other brokerage firms in the United States, are subject to a multi-tiered regulatory framework that involves federal and self-regulatory organizations (SROs) to ensure the integrity and protection of investors in the financial markets. The SEC is the principal federal regulatory agency responsible for enforcing securities laws and protecting investors in the United States. Established by the Securities Exchange Act of 1934, the SEC oversees the registration and regulation of broker-dealers, investment advisers, and other market participants. Neo-brokers must comply with SEC regulations that govern the conduct of brokerage firms, ensuring fair practices, disclosure requirements, and best execution obligations. While the SEC is the primary authority responsible for regulating neo-brokers, FINRA and other SROs play a significant role in overseeing their operations. FINRA operates under the supervision of the SEC. Its primary function is to enforce the rules and regulations set forth by the SEC and its own rules. Brokers must register with FINRA and undergo regular examinations and audits.

The Securities Exchange Act of 1934 provides the basis for PFOF in the US, as Section 28(e) allows brokers to receive compensation for their brokerage service as long as they meet the best execution obligations (SEC, 2020a). The SEC is aware of potential conflicts of interest that may arise from brokers receiving payments for routing their order flow to a specific execution venue (SEC, 2020a). In 2005, the SEC adopted the Regulation National Market System (Regulation NMS or Reg NMS), which provides additional provisions for the securities market. Rule 611, also known as the “Order Protection

Rule”, requires the best execution and to avoid trading at prices worse than protected quotes displayed by other trading centers. Similar to regulations in the EU, factors such as price, speed and the likelihood of execution must be considered. Even though a broker-dealer doesn’t need to check each customer order individually to ensure compliance with their responsibility to achieve the best possible execution, they must consistently and thoroughly assess the quality of how customer orders are carried out (SEC, 2020a). In addition, FINRA has implemented rules to ensure that member firms perform reasonable diligence to provide the best execution for their customers and charge fair prices and commissions for their services (FINRA Rule 2121 and 5310). Moreover, the “Manning Rule” or FINRA Rule 5320 prohibits members from placing the firm’s interest before a client’s financial interests.

The reference for execution prices under Rule 611 is the National Best Bid and Offer (NBBO). The NBBO is calculated and disseminated by the Securities Information Processors, which collect and consolidate the bid and ask prices from all participating market centers, including the number of securities available for that price. This consolidated data feed provides real-time quotes to market participants, ensuring they have access to the most competitive prices. The SEC also notes that considerable trading activity occurs within the NBBO. The accessibility of prices superior to the NBBO for individual investors underscores the limitations of using the NBBO as a benchmark for evaluating retail execution quality. For instance, it does not encompass off-exchange liquidity or numerous optimal exchange prices, such as odd lots²¹ and non-displayed orders. Statistics might therefore overstate the execution quality when compared to the NBBO (SEC, 2021a).

As part of Regulation NMS, Rule 606, also known as “Execution Quality Rule”, mandates that broker-dealers provide quarterly reports on their order routing practices, including information on venues they route customer orders to and any financial arrangements or relationships they have with those venues, such as PFOF agreements. In addition, brokers are obliged to inform their clients about all costs and fees. In addition, under Rule 605, the SEC requires brokers to publish monthly reports about the average quality of executions. This includes data on the share of trades with price improvement, the average price improvement, the distribution of execution times for different types of trades and trade sizes. The intent is to increase transparency and enable customers to make informed decisions when selecting a broker (SEC, 2021a).

An instance where the SEC executed enforcement action: In 2017, the SEC found that some of the algorithms used by Citadel Securities to route retail orders did not seek to obtain the best price on the marketplace, leading to a settlement fee of \$22.6 million (SEC, 2017). In December 2020, the SEC charged Robinhood Financial LLC with violating Rule 606 of Reg NMS by failing to disclose its PFOF practices adequately and failing to satisfy their duty of best execution. The SEC alleged that Robinhood

²¹ An odd lot is a term used in securities trading to describe an order for a number of shares that is not a multiple of 100 shares. Therefore, orders of less than 100 shares are considered an odd-lot.

provided inferior trade prices to its customers by seeking “unusually high payment for order flow rates“ while advertising “commission-free” trading. Robinhood paid a \$65 million fine to settle charges with the SEC (Johnson, 2020; SEC, 2020b). Obviously, regulators are closely monitoring brokers and PFOF. In July 2021, the United States House of Representatives Committee on Financial Services passed the “Order Flow Improvement Act” (H.R. 4617), which requires the SEC to monitor and study the potential impacts of payment arrangements between brokers and execution venues. This includes potential conflicts arising, the impact on execution quality, and how firms have to disclose these arrangements. Based on the results of these studies, existing regulations are to be updated if necessary. SEC Chair Gary Gensler announced in August that the SEC is considering several options and a potential ban of PFOF (Phillips, 2021). The SEC is in the process of proposing a series of new regulations regarding order execution and transparency (Beyoud & Doherty, 2022; SEC, 2022). The planned rule changes would require brokers to report in greater detail on how they achieve the best execution. A potentially significant change entails that specific retail orders must be subjected to competitive, fair, and open auctions before any trading center can execute them internally. The goal is to boost competition within the industry and create a more equitable trading environment for non-institutional retail investors (McCrack, 2022b). Similar to the situation in the EU, the legality of PFOF in the US mainly depends on whether brokers comply with the regulation regarding transparency and best execution.

5.1.2 Impact of Payment for Order Flow and Internalization on Execution Quality

Brokers in the EU and the US must be careful to achieve the best possible execution for their clients. It is crucial for the legitimacy of PFOF today and in the future. Macey and O’Hara (1997) noted that “the obligation to give customers the benefits of best execution of orders is one of the most well-established principles of securities law” (Macey & O’Hara, 1997). There is no precise definition of the term “best execution”. It varies with the client, order size, market and other parameters, and can therefore be hard to examine. For regulators, the execution quality of retail orders seems mainly determined by the execution price, taking all incurring costs and fees into account. The prices achieved by brokers for their clients are documented and contextualized using various metrics. Execution prices of retail orders are frequently compared with the quoted spread, which represents the prices and associated spread displayed to the client during order placement. These prices typically rely on reference markets or databases, like the NBBO.

Widely used figures to determine the implicit costs of order execution are the liquidity premium (LP) and the effective spread. The liquidity premium represents the difference between the execution price and the midpoint of the bid-ask spread (often NBBO spread). The midpoint of the spread is generally considered the “fair value” of the underlying asset. The liquidity premium, therefore, shows how much more a buyer is paying, respectively how much lesser a seller is receiving for his order (Lee, 1993;

Macey & O'Hara, 1997). The effective spread is a similar figure, measuring the difference between the executed price (volume-weighted-average) and the midpoint of the quoted spread at the time of the order execution multiplied by 2. Similar to the Liquidity Premium, it represents the implicit costs of a trade. A smaller effective spread indicates lower trading costs and better execution quality, as the executed price is closer to the midpoint of the bid-ask spread ("fair value"). The effective spread is typically expressed in percent in reference to the quoted spread or the midpoint of the quoted spread.

$$\text{Effective Spread} = 2 * (\text{Execution Price} - \text{Midpoint})$$

$$\text{Effective Spread [\%]} = \frac{2 * (\text{Execution Price} - \text{Midpoint})}{\text{Best Bid/Offer Spread}} \text{ or } \frac{2 * (\text{Execution Price} - \text{Midpoint})}{\text{Midpoint}}$$

One of the most used indicators for execution quality is price improvement, which refers to the difference between the quoted price at the time an order is placed and the actual price at which the order is executed. A positive value indicates a more favorable price than what was initially quoted. A negative price improvement, sometimes referred to as price deterioration, implies that the order got executed at a worse than quoted price. Price improvement is a key factor for the evaluation of broker performance, as it can lead to reduced trading costs and better returns for investors.

$$\text{Price Improvement (PI)} = \text{Execution Price} - \text{Best Offer}$$

$$\text{Price Improvement [\%]} = \frac{\text{Execution Price} - \text{Best Offer}}{\text{Best Bid/Offer Spread}} \text{ or } \frac{\text{Execution Price} - \text{Best Offer}}{\text{Midpoint}}$$

Figure 13 shows an example where a trader places an order to buy a stock with a quoted price of \$101.00. The order gets executed by the market maker at a price of \$100.75, effectively giving the buyer a price improvement of \$0.25. Similar to the effective spread, the price improvement is typically expressed in percent in relation to either the quoted spread, which is derived from the NBBO, or the value of the underlying asset in the form of the midpoint. Price improvement in the example: 12.5% of the spread or 25 bps of the order value.

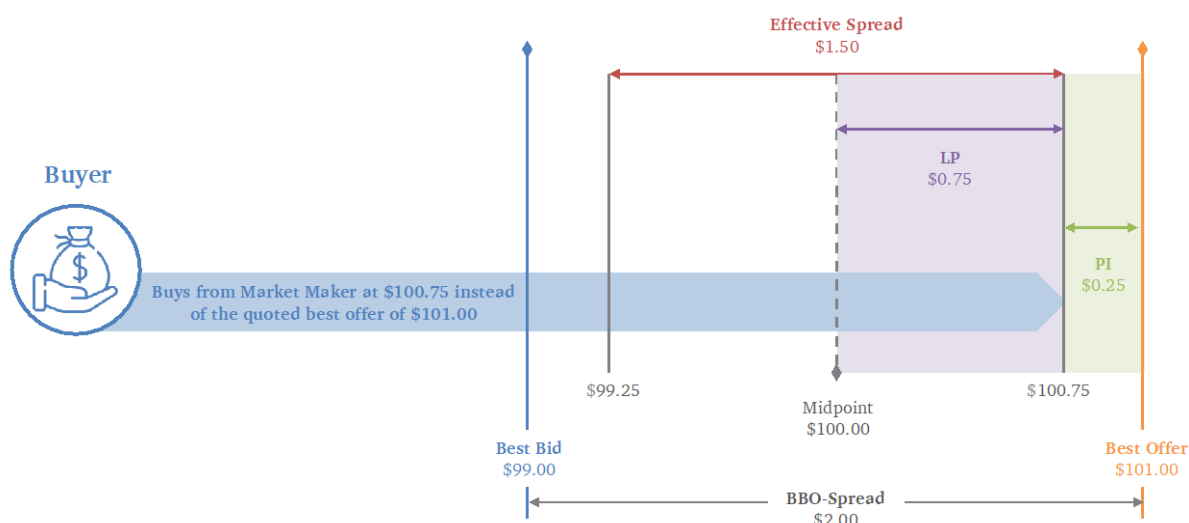


Figure 13: Illustration of Relevant Key Figures for Execution Quality

An essential indicator for market makers is the realized spread. It measures the difference between the executed trade price and the midpoint of the bid-ask spread after a certain amount of time following the trade execution. The realized spread captures the price movement after a trade and observes if the price moves against the market maker. Accordingly, it can be used to estimate the market maker's profit.

$$\text{Realized Spread} = 2 * (\text{Execution Price} - \text{Midpoint}_{\text{after time } k})$$

The following subsections examine the execution quality of equity markets in Europe and the US. In addition, studies on the influence of PFOF on options markets are considered, and other studies relevant to the topic are analyzed. It will be checked whether routing orders to venues that pay rebates results in the retail client paying more in the end or not.

5.1.3 Equity Markets in the EU

In 2021, **Meyer et al.** conducted a study on behalf of the German neo-broker Trade Republic, a recipient of PFOF, to determine the implicit and explicit costs of trading on the platform. To accomplish this, the authors compared executed trade prices from Trade Republic (in cooperation with their off-exchange execution venue) with prices from the German Electronic Exchange (XETRA), the most liquid German market. They used a sample of trading data from 100,000 customers between July 2020 and June 2021 to compare the execution of stock and ETF trades with order book prices on XETRA at the time of the execution.

The study found that 21.1% of the executed trades on Trade Republic received a better price than available on XETRA, 78.05% of the orders received an equal price, and 0.85% an inferior price. Consequently, a trader on average pays €0.52 less per €1,000 traded on Trade Republic (5.2 bps). Using the quoted spread from XETRA at the time of the trades as a reference, the average effective spread on Trade Republic is 57.1%, equating to a 42.9% improvement over XETRA's quoted spread. Additionally, the authors analyzed explicit costs, comparing the fees with two other German online brokerages (Flatex and Comdirect). The fees for other brokers are higher, ranging from 1.5%-3.5% for low-activity traders and 0.5%-1.0% for high-activity traders, compared to Trade Republic's 0.25% (low activity) and 0.08% (high activity) fee. The authors concluded that PFOF does not harm and can even benefit private investors. However, it should be noted that most of the price improvement occurred in foreign stocks and ETFs, which are likely to be less liquid in the German markets. Also, no reasoning is provided for the selection of the brokerages chosen for the comparison of explicit costs (Meyer et al., 2021).

In response to the ESMA's warning on the risks arising from PFOF in 2021, the **Dutch Authority for the Financial Markets (AFM)** performed a study published in 2022. The study investigated the execution quality of two PFOF venues and one non-PFOF venue, all used by low-cost neo-brokers in the

EU, considering only Dutch stocks. The AFM noted that using the Best Bid and Offer (BBO) as a benchmark can lead to suboptimal results, as pre-trade data (BBO) is compared with post-trade data (execution prices from brokers), and hidden liquidity is not incorporated. Therefore, the "Comparative Pricing Model" was introduced to achieve a better evaluation of execution quality and to create a framework that could be used by other institutions as well. This model constructs a reference price based on actual transactions executed in the exact second on ten reference trading venues. With the help of the reference transactions, a "range" of prices consisting of the "minimum" and "maximum" price is established. The evaluated orders are then categorized into one of three groups: "Better", "similar", and "worse" (see Figure 14).

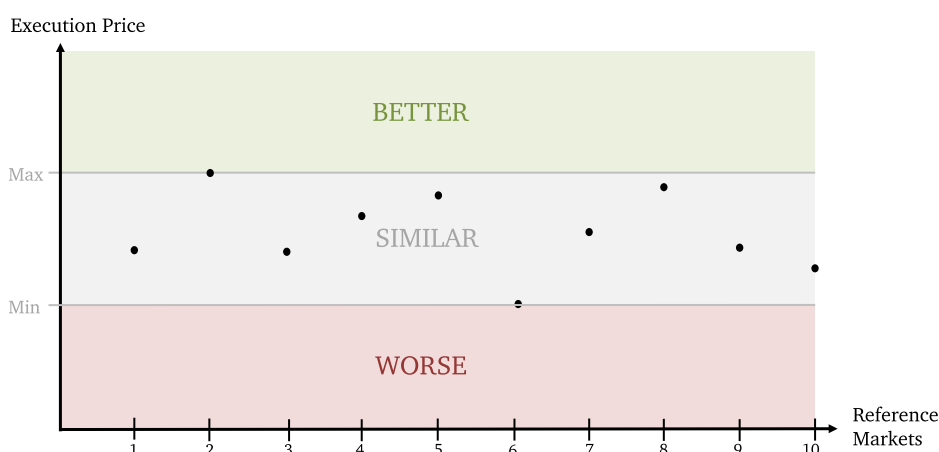


Figure 14: Classification in the Comparative Pricing Model for a Sell Transaction

In addition to comparing the orders with the formed reference ranges, transactions are compared to Euronext Amsterdam, the single most liquid exchange in the Netherlands, which is also part of the ten reference venues.

On average, for the two PFOF venues, 71.34% of transactions were executed at a worse price against the reference markets, and 74.18% were executed at a lower price than Euronext Amsterdam alone (see Table 3 for detailed data).

	PFOF Venue 1			PFOF Venue 2		
	"worse"	"similar"	"better"	"worse"	"similar"	"better"
Vs Reference Venues	68.8%	23.5%	7.6%	81.5%	11.7%	6.8%
Vs Euronext Amsterdam	72.0%	22.4%	5.7%	83.3%	9.8%	6.9%
Avg. Price Improvement (vs. Euronext Amsterdam)	-4.8 bps			-11.5 bps		

Table 3: Comparison PFOF Venues vs. Reference markets (Study by AFM) ²²

²² Data from (AFM, 2022).

For the non-PFOF venue, the execution quality regarding prices was inferior for around 23% of the transactions and better for about 1.8%. A similar execution price was achieved approximately 75% of the time. When considering the average price deterioration with Euronext Amsterdam as a reference, it was 4.8 bps and 11.5 bps for the PFOF venues and 0.8 bps for the non-PFOF venue. The AFM concluded that for the two PFOF trading venues studied, most retail client transactions were executed at a worse price compared to the most liquid reference markets. The non-PFOF (off-exchange) venue’s execution quality was better but, on average, still inferior to the reference markets (AFM, 2022).

Following the AFM study, the **Comisión Nacional del Mercado de Valores (CNMV)** – the National Securities Market Commission in Spain – released a study based on the Comparative Pricing Model. The study compared a Spanish PFOF venue that pays brokers for their order flow to the ten most liquid venues for Spanish equities (excluding systematic internalizers) and the venue with the single best liquidity. A variation to the AFM’s framework is that the calculation of price improvement or price deterioration is not only calculated against the single most liquid venue but against the reference prices of the ten venues as well. For the latter, the worst price for the customer is always taken as a reference. In comparison against the top ten venues, 86.4% of the trades fell into the worse execution category. 10.2% received a similar price and 3.3% a better one. This resulted in a -11 bps average price improvement for orders executed by the PFOF venue.

	PFOF Venue		
	“worse”	“similar”	“better”
Vs Reference Venues	86.4%	10.2%	3.3%
Avg. Price Improvement		-11 bps	
Vs Single Most Liquid	85.9%	10.6%	3.5%
Avg. Price Improvement		-12 bps	

Table 4: Comparison PFOF Venues vs. Reference markets (Study by CNMV)²³

Compared to the single most liquid venue for Spanish stocks, the distribution among the three categories changed slightly (see Table 4). The same applies to the average price improvement, which was -12 bps (CNMV, 2022).

²³ Data from (CNMV, 2022).

A third European study based on the Comparative Pricing Model was published by BaFin in 2022. The aim was to evaluate purchases and sales on relevant PFOF markets. The four largest PFOF venues in Germany are Tradegate Exchange, the Lang & Schwarz Exchange, Gettex and Quotrix. The data were derived from transaction reports under Article 26 of MiFIR and the Financial Instrument Database System. From 20 million retail trades identified on the four PFOF markets in the sample period, 3.4 million had a simultaneously executed trade on the reference markets and can be compared. Similar to the two previously presented studies, the execution quality was compared with the ten most liquid venues for German shares in the EU. The most important reference market was XETRA. Some details in the study framework were changed. BaFin made some adjustments to the study framework, including incorporating fees into the execution prices of the reference markets to enable a better comparison. Furthermore, the execution quality was determined depending on the transaction size, and a distinction was made between markets with different liquidity (DAX and non-DAX markets).

When the transaction size executed by the PFOF venue was smaller than the trading volume on all reference markets at the same time, 71% of analyzed transactions involving DAX equities and 63% of analyzed transactions non-DAX equities were executed at comparable or improved prices (see Figure 15). In detail, 47% of the DAX equities and 39% of the non-DAX equities were executed at a similar price, while around 24% of both received a better price than on the reference markets. In a more detailed analysis, considering only trades with a volume of less than €2,000, the percentage of orders executed at similar or better prices rises to 81% for DAX equities and 70% for non-DAX equities (indicated by the darker part of the bar in Figure 15).



Figure 15: Number of transactions on PFOF Venues with transaction sizes not exceeding the trading volumes on all reference markets. Orders executed with a transaction size <€2,000 are shaded more darkly. ²⁴

Figure 16 shows that transactions in the PFOF markets that exceed the total volume of all reference transactions mainly translate into worse execution prices, especially for orders over €2,000. As it is

²⁴ Figure from (BaFin, 2022).

unclear to what extent a (good) execution is possible outside the PFOF markets, given the low volume on the reference markets, this case is not considered in the further course of the study.



Figure 16: Number of transactions on PFOF Venues with transaction sizes exceeding the trading volumes on all reference markets. Orders executed with a transaction size <€2,000 are shaded more darkly.²⁵

The overall results tend slightly toward worse average executions on PFOF venues. For orders with a transaction size smaller than €2,000, it seems that in markets with high liquidity and volume (i.e., DAX equities), PFOF can be beneficial for execution quality. In BaFin’s study, price improvement is calculated as the difference between the execution prices on the PFOF markets and the volume-weighted execution prices on the reference markets (including fees or commissions), divided by the latter. Consistent with the three-category classification mentioned earlier, the price improvement is correlated with the transaction volume on PFOF and reference markets. Table 5 displays the average price improvements for various transaction sizes, illustrating that larger transaction sizes yield smaller improvements. The threshold at which execution on reference markets becomes preferable is reached earlier for non-DAX equities.

Transaction Size	DAX equities	Non-DAX equities
EUR 500	12.34 bps	0.28 bps
EUR 1,000	5.56 bps	-5.01 bps
EUR 2,000	3.76 bps	-5.45 bps
EUR 5,000	1.08 bps	-8.46 bps
EUR 25,000	-0.30 bps	-10.03 bps

Table 5: Average Price Improvement on PFOF Markets Compared to Reference Markets (for transactions where volumes do not exceed volume of the corresponding reference markets)²⁶

For DAX equities orders up to €15,000 it is more advantageous, on average, to settle orders via PFOF markets rather than reference markets. This threshold is slightly above €500 for non-DAX equities.

The authors conclude that, on average, executing trades on venues that offer PFOF is beneficial for clients with smaller transaction volumes. According to the transaction data, the median transaction

²⁵ Figure from (BaFin, 2022).

²⁶ Data from (BaFin, 2022).

size for neo-broker clients is approximately €350 for DAX equities and about €250 for non-DAX equities. As a result, a considerable number of retail orders from neo-brokers are expected to fall below the specified threshold, thus receiving better execution prices through PFOF venues. The advantage of smaller transactions on PFOF venues may be attributed to venue-related transaction fees. Some reference markets impose minimum order fees, which can be relatively large for small orders and lead to overall worse execution. The study demonstrates that both the underlying liquidity of the traded equity and the transaction size relative to the volume on reference markets impact execution quality (BaFin, 2022).

Elsas et al. carried out a field experiment on PFOF and market quality in collaboration with Trade Republic in 2022. Over a sample period of five days in April 2022, the trading activity of 22 stocks was examined, with Trade Republic holding a significant market share of 2-5% of the XETRA volume for these stocks. Ten of these stocks (hereafter referred to as the “treatment group”) had all orders during the sample period sent to XETRA instead of their partner Lang & Schwarz Exchange, which typically pays Trade Republic for the opportunity to trade their order flow. The remaining stocks served as a control group, with orders processed by their partner as usual. The goal was to identify differences in quoted, effective, and realized spreads, as well as price impact. It was hypothesized that these market characteristics would decrease in the treatment group, suggesting an advantage of order execution on XETRA.

The study found that the number of trades on XETRA for treatment group stocks increased as expected due to Trade Republic routing orders there. However, the quoted, effective, and realized spreads did not significantly differ between the treatment and control groups. The proposed hypotheses (that market characteristics would decrease during the treatment period) were rejected, as all p-values of the tests were at least 0.19²⁷. Furthermore, the increased trading resulting from a significant growth in retail orders on the XETRA market did not have a substantial impact on liquidity measures (Elsas et al., 2022).

5.1.4 Equity Markets in the United States

In a study conducted by **Adams & Kasten** in January 2021, the impact of zero-commission trades on execution quality in the US was analyzed. The objective was to determine the effect of zero-commission trading, introduced by most retail brokerages, on effective and realized spreads for orders executed by off-exchange market makers and exchanges. The execution quality of the largest off-exchange wholesalers (Citadel Securities, Virtu Financial, and two others) was compared to the NYSE, NASDAQ, and

²⁷ A smaller p-value indicates a higher degree of statistical significance for the observed discrepancy. Typically, a p-value of 0.05 or below is deemed statistically significant. Since the values in this case considerably exceed the threshold for statistical significance, the hypotheses are rejected.

the American Stock Exchange (AMEX). Data were gathered from companies' 605 and 606 reports and the "NYSE Trade and Quote database" (TAQ) across two periods: the pre-commission cut period (April 2019-September 2019) and the post-commission cut period (October 2019-February 2020). The study focused on marketable orders between 100-499 shares, corresponding to an average transaction size of approximately €4,000-22,000.

The authors discovered that effective spreads decreased for both market makers and exchange groups following the introduction of zero-commission trading (see Figure 17). The decline in the market maker group, from an average of 0.435% in the pre-commission cut period to an average of 0.365% after the introduction, was more pronounced than in the exchange group. Comparing the effective spread of market makers with exchanges directly, the market maker spread is 87.7% of the exchange spread (post-commission), while it was similar in the pre-cut period.

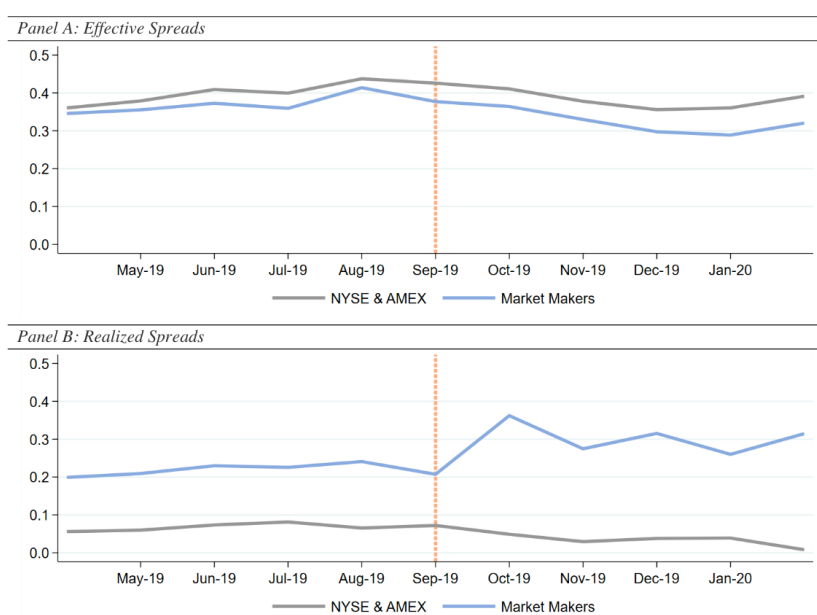


Figure 17: Effective Spreads and Realized Spreads Pre- and Post-Commission Cut for Exchanges and Market Maker group²⁸

Market makers' price improvement was superior to exchanges both before and after the commission cut. The average reported price improvement in the market maker group increased slightly from 0.163% to 0.166%, while it decreased from 0.141% to 0.137% for the exchange group. The divergence could be attributed to the change in average realized spread, a useful proxy for market maker profits, which are partially passed back to customers through PFOF. With the elimination of commissions, the average realized spread for market makers increased significantly and fell for exchanges (see Figure 17). Additionally, Adams and Kasten calculated the adverse selection for both groups in both periods²⁹.

²⁸ Figure from (Adams & Kasten, 2021).

²⁹ Adverse selection is a phenomenon that occurs in financial markets when informed traders (those who possess private information about an asset's value) consistently trade against market makers, who may not have access to the same information. This causes market makers to suffer losses as informed traders take advantage of their superior knowledge.

A noticeable decrease in adverse selection in the market maker group was captured, which indicates that market makers dealt with less informed order flow after the commission cut. The authors noted that the reduction in adverse selection might be related to optimized collaboration with brokers and better segmentation of order flow. The lower amount of adverse selection explains the greater realized spreads (profits) and, consequently, better price improvement and lower effective spreads (Adams & Kasten, 2021).

A subsequent study by **Adams et al.**, published at the end of 2021, examined effective spreads as the primary cost for retail traders submitting market orders under zero-commission. Key figures from the periods of August to September 2019 (“Pre-period”) and November to December 2019 (“post-zero period”) were revisited, and a “COVID period” (March to April 2020) was introduced. This time, distinctions were also made between different transaction sizes (0-99 shares, 100-499 shares, 500-1999 shares).

A proxy introduced by Boehmer et al. was utilized to identify marketable retail orders. Institutional orders are typically sent to exchanges or dark pools, where sub-penny trades are not allowed, and only trades at full-penny prices or at the midpoint are possible. Retail orders executed off-exchange and reported to the TAQ consolidated tape afterward tend to have sub-penny prices due to small price improvements. A trade is classified as a retail trade if the sub-penny component ranges from (0, 40) for sells and (60, 100) for buys (Boehmer et al., 2021).

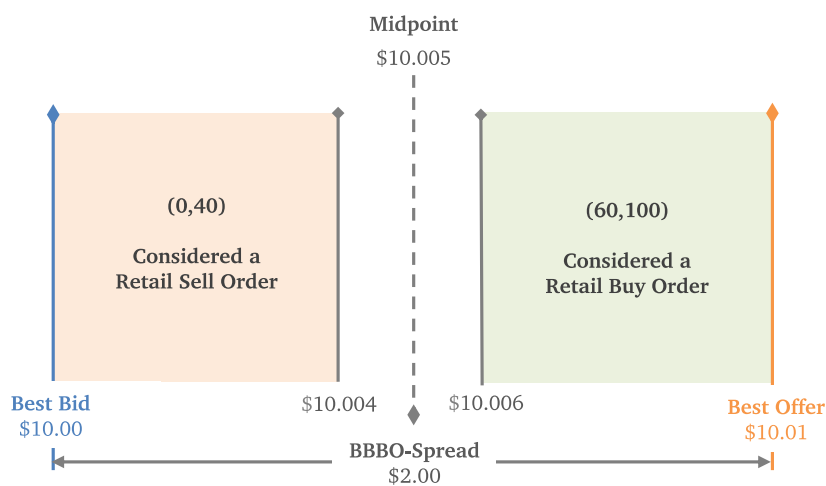


Figure 18: Identification of Retail Orders as Proposed by Boehmer et al. (2021)

Figure 18 illustrates the process of identifying retail orders with this approach: Consider an asset with a National Best Bid of \$10.00 and a National Best Ask of \$10.01. The quoted spread is at the minimum tick size of one penny. Reported trades with execution prices greater than \$10.00 up to \$10.004 are considered retail sell orders and prices below \$10.01 down to \$10.006 are considered retail buy orders.

During the pre-period, off-exchange retail trades were executed at better prices than on exchanges across all order sizes (see positive PI difference in Figure 19). On average, retail orders were executed with a price improvement of 34.16% of the quoted spread, while it was 13.52% for exchange orders. In the post-zero period, execution costs for retail traders increased slightly (price improvement decreased) for orders up to 499 shares, and a minor decrease for larger orders was recorded. Overall, effective spreads and price improvement remained at comparable levels to the pre-period. Retail traders incurred lower implicit costs measured by the effective spread. During the COVID period, characterized by high volatility and volume, retail price improvement relative to the quoted (NBBO) spread increased significantly (see NBBO improvement, black bars, in Figure 19). Additionally, price improvement on retail trades increased compared to exchanges, where the cost advantage roughly doubled, as reflected in the PI difference.

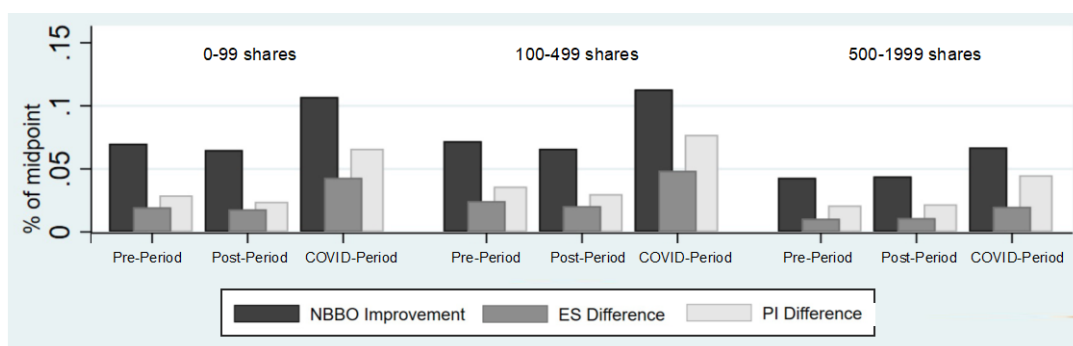


Figure 19: Price Improvement Compared to (a) the NBBO (NBBO Improvement), (b) On-exchange Execution (PI Difference) and Effective Spread Compared to On-exchange Execution (ES Difference)³⁰

It was also observed that retail trades tend to have a lower price impact, which reduces the risk of adverse selection and allows market makers to capture a larger portion of profits in the form of realized spreads. During the COVID period, the price impact decreased substantially for retail trades. The authors attributed the decline in price impact to less informative retail trades during this period. This allows wholesalers to generate larger profits and offer smaller effective spreads and more significant price improvements. The results suggest that retail orders routed to PFOF venues receive overall cheaper execution than exchange-based benchmarks. The reporting regulations for brokers and wholesalers in the US define price improvement relative to the NBBO at the time of execution. Using the NBBO as a benchmark overstates price improvement because exchanges offer better prices than the NBBO as well. The authors recommend comparing the effective spread between wholesalers and exchanges or calculating price improvement with exchange rates as the benchmark (Adams et al., 2021).

³⁰ Figure from (Adams et al., 2021)[edited].

In a report published by **Mittal and Berkow** for BestEx Research in May 2021, the advantages and disadvantages of PFOF were examined for both: clients of brokers and the entire market. The study utilized data from the 605 reports of the five largest US wholesalers and the TAQ database in December 2020. The researchers discovered that, during the sample period, the average price improvement of the wholesalers was 24.5% of the NBBO spread. Depending on the wholesaler, 60-80% of the orders received price improvement. Marketable orders on exchanges, on the other hand, achieved an average price improvement of 8.7%. This indicates that significant price improvements are possible on exchanges due to liquidity between the NBBO spread. The authors estimated that the improvement achieved by wholesalers compared to exchange execution is likely less than 15%. Figure 20 demonstrates that wholesalers achieve better prices than exchanges and price improvements is greater for higher-priced stocks, potentially due to more hidden liquidity not represented in the NBBO.

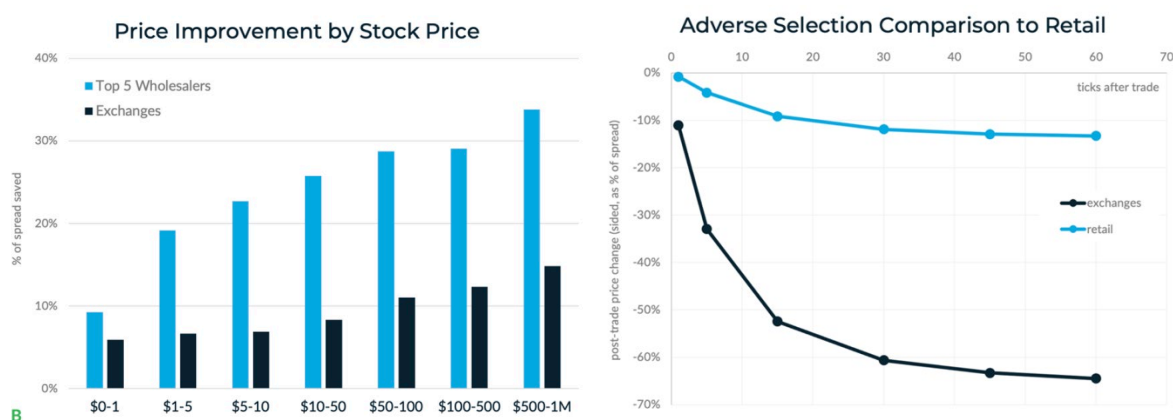


Figure 20: Price Improvement on the Top 5 Wholesalers Compared to Exchanges and Adverse Selection on Exchanges Compared to Retail Orders³¹

Adverse selection represents the largest cost for on-exchange market makers, generally resulting in wider spreads compared to off-exchange trading. To assess how spreads would change if all retail flow were executed on exchanges, TAQ and off-exchange execution data were utilized to estimate adverse selection 60 ticks after the trade. While adverse selection accounts for 61% of the spread on exchanges, it is approximately 12% for retail orders executed off-exchange. When calculating a “new” volume-based average for adverse selection, assuming all trades occurred on exchanges, the result was approximately 45%, representing a decline of over 25%. Consequently, spreads should tighten at a similar rate. As mentioned, wholesaler execution is roughly 15% better than on-exchange execution (24.5% against NBBO). A significant spread tightening could suggest that retail traders might benefit from trading in a market where all order flow is executed on-exchange. This could particularly benefit retail limit orders, as wholesalers often send them to exchanges where they compete with more toxic order flow. These orders do not interact with retail market orders, which are internalized by market makers

³¹ Figures from (Mittal & Berkow, 2021).

off-exchange. The authors concluded that PFOF and the internalization of order flow by wholesalers offer significant price improvement. Retail traders receive a portion of the profits from their uninformed order flow. However, they also noted that using the NBBO as a benchmark overestimates price improvement, as it assumes customers would otherwise have to pay the cost of the NBBO spread. Additionally, spreads on exchanges could tighten significantly if retail order flow was executed through them, benefiting all market participants (Mittal & Berkow, 2021).

Jain et al. (2021) examined the effects of commission cuts on retail brokerages using data from the TAQ database and 605 and 606 reports from wholesalers. The authors analyzed 13 US-based retail brokerages, six of which introduced zero-commission trading in 2019. They found that participating brokers experienced a 7% increase in client assets in the following quarter, while those that continued to charge commission fees saw a 9% decrease on average. This indicates that commissions are essential for retail investors when choosing a broker. Market makers witnessed an increase in marketable orders sent to them from brokers, particularly in the 100-1999 shares category, where a 28% uptick was recorded. Possible reasons include an overall increase in retail activity and a preference for brokers to route orders to off-exchange market makers that engage in PFOF following the commission cut. As a result, zero-commissions significantly increased the market share of off-exchange wholesalers, as shown in Figure 21.

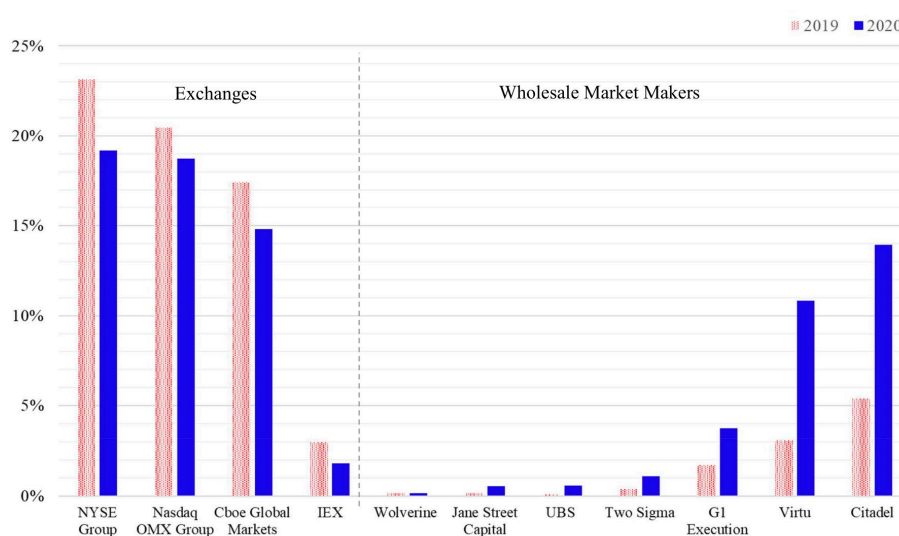


Figure 21: Market Share of Exchanges and Wholesale Market Makers in 2020 Compared to 2019³²

To investigate differences in market quality, Jain et al. employed the approach of Boehmer et al. to identify retail trades from the TAQ database. They compared the four months prior to the introduction of zero-commission (06/2019 - 09/2019) with the subsequent months (11/2019 - 02/2020), referred to as the “immediate comparison”. Additionally, they compared the pre-period against a corresponding

³² Figure from (Jain et al., 2021).

timeframe in 2020 (June to September) to minimize the effects of seasonality and COVID, referred to as the “1-year comparison”.

In the immediate comparison, the average price improvement increased slightly by 0.95% for all shares considered. However, this effect reversed in the 1-year comparison, where the average price improvement declined by 7.11%. Furthermore, the top 100 stocks held by Robinhood users, as identified by Robintrack.net, showed a decrease of -8.62% in the immediate comparison and a decrease of 11.87% in the 1-year comparison. The results, summarized in Table 6, suggest that retail brokerages may offer less price improvement after the fee-cut to compensate for the lack of commission revenue, particularly for stocks heavily traded by retail investors.

	Period	Price Improvement Difference [%]
All Stocks	Immediate Comparison	0.95
	1-Year Comparison	-7.11%
Top 100 Robinhood	Immediate Comparison	-8.62%
	1-Year Comparison	-11.87%

Table 6: Price Improvement Before and After the Introduction of Zero-Commission Trading³³

The authors submit that the elimination of commissions improved overall market quality in stocks preferred by retail investors. Effective spreads declined, while realized spreads (a proxy for market maker profits) remained similar, suggesting that wholesalers serve as cost competitors. It appears that brokers do not pass the lower rates market makers onto their customers in the form of price improvement. The price impact of orders was reduced, implying that the order flow to market makers is less informed than before (Jain et al., 2021).

Kothari et al. (2021) conducted a study in collaboration with Robinhood to examine commission savings and execution quality for off-exchange retail trades. The researchers benchmarked data provided by Robinhood against on-exchange trades derived from the TAQ database between August 2016 and September 2021. They focused on odd-lot orders to identify retail trades from wholesalers and exchanges, and compared them with trades from their Robinhood dataset.

During the sample period, the average price improvement for odd-lot orders was 1.1 bps on exchanges, 1.6 bps for other wholesalers, and 2.9 bps on Robinhood. Robinhood data revealed that 24% of orders had a transaction size of more than 100 shares, accounting for nearly 92% of the total dollar trade volume. When considering all order sizes, the average price improvements dropped slightly for other

³³ Data from (Jain et al., 2021).

wholesalers (to 1.5 bps), remained the same for exchanges, and increased for Robinhood (to 3.2 bps). In a second iteration, only “matched trades” were analyzed, i.e., trades that could be matched with the Robinhood data on other platforms. The price improvement values for other wholesalers and exchanges increased significantly but remained below Robinhood levels (Figure 22). The researchers attributed this improvement to Robinhood’s focus on popular and liquid markets, where other venues in these markets achieve better prices accordingly.

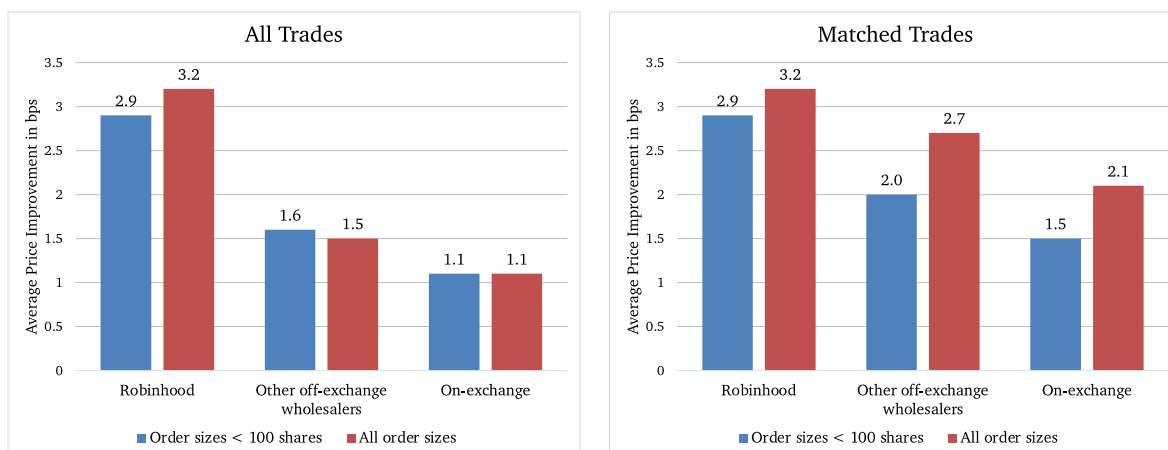


Figure 22: Average Price Improvement from Robinhood, Other Off-Exchange Wholesalers and On-Exchange³⁴

The authors concluded that orders routed to off-exchange execution venues received better average execution prices than those sent to public exchanges. Robinhood clients obtained even better prices than the average retail brokerage customers. The average price improvement for orders on Robinhood was 16% better than the typical retail brokerage and approximately 50% higher than public exchange executions. The authors noted that execution quality was notably better for trades with smaller transaction sizes in markets with relatively high spreads (Kothari et al., 2021).

In 2022 the National Bureau of Economic Research published a study by **Ernst and Spatt**. Data from the TAQ database and the Options Price Reporting Authority from January 2019 to October 2021 for 6,900 securities were used to examine the effects of PFOF on execution quality in equity and options markets. Boehmer et al.’s (2021) framework of sub-penny price improvement was utilized to determine retail trades. Additionally, 606 reports from wholesalers were incorporated to study the amounts of PFOF that wholesalers pay to brokers.

In equity trades, sub-penny price improvements saved retail investors an average of 0.5 bps. The authors also demonstrated that realized spreads for sub-penny trades (retail) were significantly more profitable for market makers compared to all trades. Most sub-penny improvements occurred when the prices of the underlying assets were relatively constant, and the larger the quoted and realized spreads in an asset, the more trades received sub-penny price improvement. The authors were not

³⁴ Data derived from (Kothari et al., 2021).

concerned about internalization leading to higher quoted spreads, as over 50% of sub-penny price improvements occurred when the spread was at the minimum tick size of one penny. They found that internalization and sub-penny improvements were associated with tighter spreads.

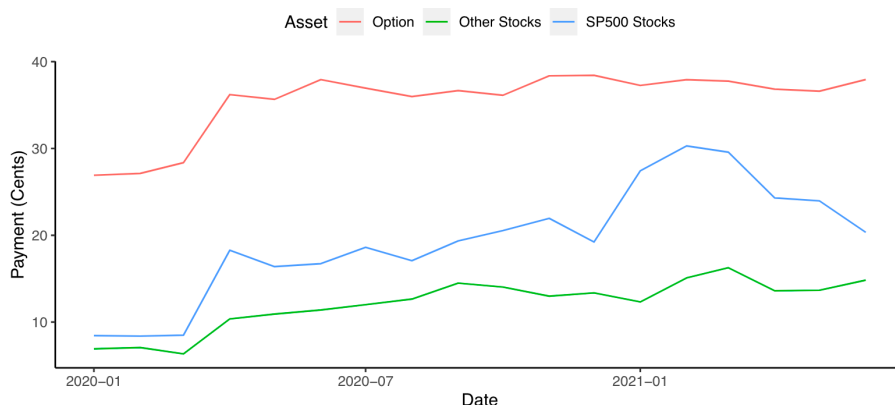


Figure 23: Payment for Order Flow per 100 shares³⁵

In options markets, the authors found that price improvement was more common but of lower quality. Clearing regulations hinder direct internalization, and due to reduced competition and minimal tick sizes of 5 to 10 cents, spreads in options markets are generally wider. Consequently, the bar for price improvement is lower, as market makers can generate greater profits and could potentially offer higher price improvements. In reality, price improvement in options markets was higher compared to equity markets. It is stated that in relation to the increased profits of market maker and PFOF to brokers, the price improvement should be significantly greater. The median order received a 5-cent price improvement, which amounted to around 3% of the order value. While a 100-share equity trade paid approximately 20 cents in PFOF to brokers, the same amount of options on average paid around 40 cents. Considering average lower options prices of roughly \$5 compared to \$25 for stocks, a \$1,000 order yielded 8 cents of PFOF revenue for an equity trade and 80 cents for an options trade. Furthermore, the authors found that average improvement in execution prices was worse when brokers received PFOF in both equity and options markets.

Ernst and Spatt summarize that internalization can be beneficial for customers, particularly in equity markets. However, for options markets, the average price improvement appears to be undersized in relation to market maker and broker revenue. Figure 23 illustrates the increased PFOF payments resulting from increased profits in options order execution. Market makers employ sub-penny improvement, and rebates induce brokers to route more profitable retail orders to their venues. It was found that brokers receiving PFOF, on average, achieve lower price improvements for their clients in both markets (Ernst & Spatt, 2022).

³⁵ Figure from (Ernst & Spatt, 2022).

Levy (2022) conducted a randomized controlled trial, comparing trades executed by him through PFOF brokers (TD Ameritrade and Robinhood) and a broker with direct market access (Interactive Brokers). This approach offers an advantage, as the author filled out orders, eliminating the need to approximate trade direction. Between May and June 2022 orders were placed for random NYSE, NASDAQ and AMEX stocks, at random times, with the different brokers. The order size was randomized to the extent that it was always representative of a retail trade.

The average effective spread for direct market access orders was roughly half of the quoted spread regardless of trade direction (52.15% for buy and 55.48% for sell orders). Price improvement compared to the NBBO was observed for 85% of orders, with an average improvement of 3.68 bps. Levy interprets this as an indication that the NBBO does not accurately reflect predominant market conditions and therefore compares the results from PFOF brokers to orders with direct market access as well.

	PFOF Brokers	
	Vs. NBBO	Vs. Direct Market Access
Orders with Price Improvement	94.53%	8.13%
Avg. Price Improvement	7.45 bps	3.77 bps

Table 7: Price Improvement from PFOF Brokers Compared to the NBBO and Direct Market Access³⁶

Compared to the NBBO, 94.53% of orders on the two PFOF brokers executed at better prices, which is 8.13% more than direct market access orders. The average price improvement was 7.45 bps, an increase of 3.77 bps compared to direct market access. The trading costs expressed in the effective spread were less than one quarter of the quoted spread. Table 7 presents the results in a compact format. The order execution speed of PFOF venue orders (442.02ms) was significantly slower compared to direct market access (80.52ms), and he attributes this difference to the order routing process.

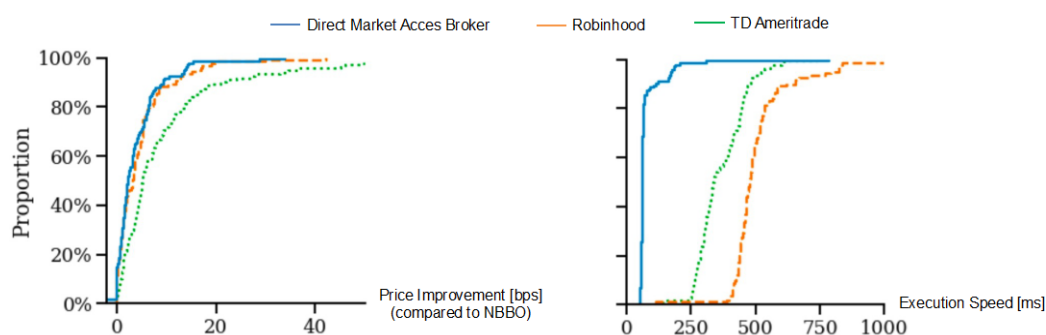


Figure 24: Comparison of Price Improvement and Execution Speed of Robinhood, TD Ameritrade and a Direct Market Access Broker³⁷

³⁶ Data from (Levy, 2022).

³⁷ Figure from (Levy, 2022)[edited].

In a comparison between the two PFOF brokers, TD Ameritrade, which receives smaller order routing payments than Robinhood, outperforms in terms of price improvement (see Figure 24). While TD Ameritrade on average achieves 9.81 bps of price improvement compared to direct access orders, there is limited evidence that Robinhood can attain better prices. Additionally, by examining the execution prices of wholesalers, it was observed that execution prices vary depending on the broker that sent the order. A possible reason could be differences in arrangements between brokers and market makers. Levy acknowledges that PFOFs can benefit retail investors, but agency problems might prevent some brokers from passing those savings on to their clients. (Levy, 2022)

In a similar approach to Levy's, Schwarz et al. (2022) conducted a study in which they executed and analyzed trades themselves, examining the execution quality of the five largest brokerages with different commission and PFOF levels in the US. A sample of 85,000 simultaneous market orders in 128 stocks was generated between December 2021 and June 2022. The average trade size was set to \$100. Routing practices and received payments were calculated from the 605 and 606 reports of brokers and execution venues.

Figure 25 shows that around 10-20% of all orders receive price improvement greater than 50% (execution price is better than midpoint). Many studies using TAQ data assume that orders do not receive improvements bigger than 50% when classifying trades as buy or sell orders, thus understating the granted price improvement.

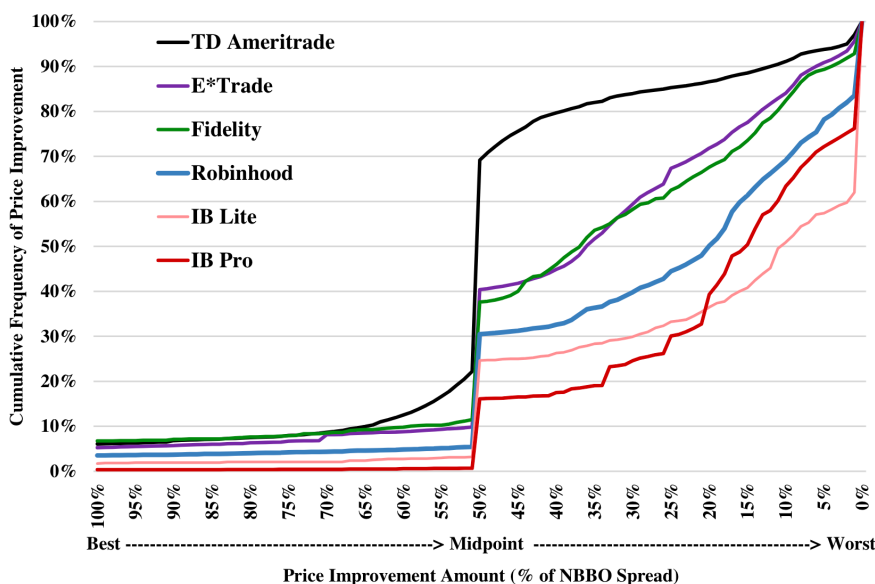


Figure 25: Frequency of Price Improvement for Different (Neo-)Brokerages³⁸

On average, brokers achieve 34.17% of the quoted spread in price improvement, translating to a 7.89 bps improvement of the dollar value. Figure 25 shows significant differences in price improvement

³⁸ Figure from (Schwarz et al., 2022).

between individual brokers. The average price improvement ranges from \$0.03 to \$0.08 per share in total numbers. PFOF explains almost none of the variations between execution prices, as it varies from \$0.001 to \$0.002 per share, which is small compared to price variations. For instance, TD Ameritrade charges no commissions, participates in PFOF arrangements, and offers the best prices to their clients in this setting. Two brokers without PFOF (Fidelity and IBKR Pro) have worse execution prices. E*Trade and Robinhood, on average, receive around double the amount of PFOF per share and offer their customers inferior prices compared to TD Ameritrade. By analyzing specific routing data from brokers and wholesalers, the authors found price differences between the same trades executed at the same venue and time but sent from different brokers. This can be observed for all execution venues and explains the differences in prices. A potential reason for the different execution prices could be the quality and size of the order flow of each broker. It is also possible that brokers assign different priorities to various dimensions of execution quality (speed, likelihood, and more), which results in varying prices (Schwarz et al., 2022).

Hu and Murphy (2022) examine the effects of internalization and concentration in the retail market-making space. Internalization data and the TAQ database were used to analyze quoted spreads and price improvement in the sample period (January 2017 to May 2021). To measure internalizer market concentration, the Herfindahl-Hirschman-Index (HHI) was utilized³⁹. The findings reveal that the total volume and proportion of internalized trades increased between 2017 and 2021, as illustrated in Figure 26. The internalizer market underwent rapid consolidation in recent years. The average internalizer HHI significantly increased from a low of 2,450 in 2018 to a high of 2,900 in 2021. The Department of Justice (DoJ) classifies an HHI exceeding 2,500 as highly concentrated.

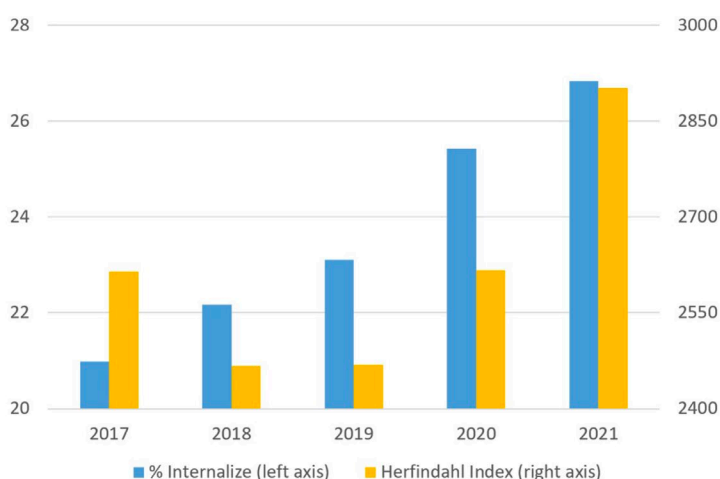


Figure 26: Wholesaler Internalization and Concentration in the US from 2017 to 2021⁴⁰

³⁹ The Herfindahl-Hirschman Index (HHI) is a measure of market concentration, used to evaluate the level of competition within an industry. HHI values range from close to 0 (perfect competition) to 10,000 (monopoly), with higher values indicating greater concentration and less competition.

⁴⁰ Figure from (Hu & Murphy, 2022).

The authors found that quoted spreads are wider in a market with a high percentage of internalized trades due to more toxic order flow and the resulting risk of adverse selection on exchanges. Also, stocks with a high concentration of internalized volume among a few market makers (high HHI) show wider average spreads than stocks with lower HHI. This suggests that internalization profits are less likely to be used to reduce spreads in markets with less competition. Additionally, it was found that higher internalization rates lead to less price improvement, regardless of market maker concentration. This suggests that large internalizers do not use their economies of scale to provide better price improvement.

The study concludes that retail order execution might be suboptimal when markets are less competitive and that the best execution obligation may not be sufficient to guarantee efficient execution. The cost for all market participants could be lowered in a more competitive market (Hu & Murphy, 2022).

5.1.5 Options Markets

In 2016, Battalio et al. investigated the execution quality of marketable orders across eight US options exchanges, comparing PFOF models with Maker-Taker (MT) models. The study revealed that retail volume is significantly lower (approximately 29%) on exchanges that have a MT model compared to exchanges that induce market makers with PFOF. The researchers assessed cost differences by evaluating MT fees, marketing fees, and effective spreads, assuming that PFOF inducements and other rebates were entirely passed on to customers. When examining unadjusted effective spreads, the liquidity cost was approximately 100 bps higher on average for the PFOF model. When accounting for fees in the MT model, the average liquidity demander in the PFOF model pays about 40 bps less than in the MT model for lower-priced options. The MT model is more cost-effective for options priced above \$3.75, whereas the PFOF model is better for options below that price. The authors suggest that brokers are more likely to route to the PFOF model because of the payments and because they can avoid taker fees, which increase liquidity costs. Brokers should act accordingly to achieve the best execution for each order and should not route all orders to the same venue. The study also highlights that the benefits for small orders heavily depend on the extent to which received payments are passed on to clients, as the analysis assumed they were fully used to secure better prices (Battalio et al., 2016).

In a subsequent study by Battalio et al. (2021), the authors analyzed limit order routing to options exchanges that purchase order flow in the US options markets. The research measured execution quality for orders by examining price improvement and execution speed for limit orders routed to different exchanges. The principal findings align with those of the previous study on market orders, as limit orders directed to exchanges that buy order flow tend to receive better price improvement than orders routed to exchanges that do not engage in PFOF. Additionally, the study reveals that smaller orders are trending toward greater price improvement than larger orders. The authors concluded that brokers

should route especially small limit orders to exchanges purchasing order flow to enhance execution quality for their customers (Battalio et al., 2021).

Hendershott et al. (2022) analyzed the execution quality of retail options orders executed through price improvement auctions on exchanges. The results indicated that auctions could offer substantial price improvement up to 25% of the quoted spread (77 bps of the average option price). However, approximately 45% of orders only received the minimum level of price improvement. Additionally, the authors found that the auctions were not fully competitive, and it was unclear whether retail orders received better prices through price improvement auctions compared to alternative market structures. To enhance the competitiveness of the auctions, the authors proposed several measures. First, they recommended eliminating guaranteed participation rights and auto-match provisions to encourage more aggressive bidding. Second, they suggested restricting asymmetric fees for the auction initiator (wholesaler). These measures could potentially increase the competitiveness of price improvement auctions and provide better prices for retail options orders (Hendershott et al., 2022).

5.1.6 Summary, Challenges and Proposed Solutions

BaFin's analysis of the German market reveals that PFOF can benefit retail investors. It delves into the conditions necessary for obtaining an advantage, suggesting that better prices are achievable for smaller transactions in markets with higher liquidity. In Meyer et al.'s study, which supports the benefits of PFOF in terms of execution prices, the average transaction size was relatively small as well (€1,433). In addition, Elsas et al. discovered that quoted spreads and effective spreads did not change significantly when orders were routed to exchanges instead of off-exchange market makers. In contrast, studies from the Netherlands' AFM and Spain's CNMV found that PFOF venues generally yielded worse execution prices than the most liquid reference markets. The AFM study had a relatively high average transaction size of over €80,000. Additionally, Dutch and Spanish markets are generally less liquid than German markets. These factors should be considered when assessing the results, as they could support BaFin's findings that liquidity and transaction size are important factors.

Most studies conducted in the US suggest that PFOF can be fundamentally beneficial for retail order execution (see Main Findings in Table 11 in the Appendix). Comparing the cost of liquidity in terms of effective spreads before and after the introduction of zero-commission, it appears to have decreased (Adams & Kasten, 2021), particularly during the COVID-19 period (Adams et al., 2021; Jain et al., 2021). However, price improvement decreased slightly, which may be attributed to overall tighter spreads from 2020 onwards due to increased volume (Jain et al., 2021). Similar to findings from the EU, price improvement seems to be higher for smaller order sizes (Adams et al., 2021; Kothari et al., 2021; Levy, 2022) and higher priced stocks, which could be explained by more hidden liquidity not presented in the quoted spread (Mittal & Berkow, 2021). Assets with relatively high spread average

higher amounts of price improvement, as the barrier for improvement is lower (Kothari et al., 2021). Conversely, it has been argued that while internalization process is associated with improved prices, brokers who are paid for their order flow do not always achieve the best prices (Ernst & Spatt, 2022). Furthermore, wholesalers execute at different prices depending on the broker sending the order flow, which may be due to differences in agreements between the two parties or the quality and volume of order flow from a specific broker (Levy, 2022; Schwarz et al., 2022).

When comparing results between the US and EU, it is important to note that US markets, on average, are more liquid. The wholesale market in the EU is also smaller and more fragmented compared to the US. As mentioned above, liquidity can be a deciding factor when it comes to the evaluation of PFOF.

In options markets, due to lower liquidity and higher spreads, the bar for price improvement is lower. The average price improvement achieved is higher but of poorer quality, indicating that market makers and brokers could offer even better prices, but they retain a large portion of the profits for themselves (Ernst & Spatt, 2022; Hendershott et al., 2022). Consequently, a significant part of PFOF revenue comes from processing options orders. It has also been shown that exchanges that pay market makers for their order flow can achieve better prices for limit orders for lower-priced options. Similar to findings in the equity markets, price improvement is greater for smaller transaction sizes (Battalio et al., 2021). However, there seems to be suboptimal competition in price improvement auctions on exchanges, preventing even better prices for retail traders. A renewal of the fee structure and the elimination of rules that favor the market maker who brings the order flow to the auction could increase competition (Hendershott et al., 2022).

Regarding the effects of PFOF on the entire market structure, these have been a topic of discussion since the 1990s. Research demonstrated that the share of informed (toxic) orders on exchanges increased as uninformed retail order flow started to get predominantly executed off-exchange (Easley et al., 1996). As bid-ask spreads depend on the ratio of informed to uninformed traders, this results in wider average spreads (Glosten & Milgrom, 1985). Conversely, some early studies indicated that the quoted spreads tightened after more orders were executed off-exchange (Battalio, 1997).

Current studies remain divided on this subject. Some argue that with the introduction of zero-commission trading and increased internalization of order flow, adverse selection on exchanges has risen while declining off-exchange, which led to wider overall spreads (Adams & Kasten, 2021). The high degree of wholesaler concentration in the US is also said to contribute to increased spreads due to information asymmetry between large wholesalers and the rest of the market (Mittal & Berkow, 2021; Hu & Murphy, 2022). Other researchers contend that quoted spreads did not change significantly because of PFOF (Elsas et al., 2022), and that most price improvement occurred during orders where the spread is already at the minimum tick size (Ernst & Spatt, 2022).

Evaluating the effects of PFOF poses challenges, as studies often employ different metrics or define them differently. For instance, some studies report price improvement in basis points of the midpoint, while others report it as a percentage of the quoted spread. Furthermore, some studies include exchange fees, while others do not. Some assume PFOF payments are fully passed on to retail traders, whereas others do not consider the payments at all. It is difficult to compare studies or contextualize findings without complete data.

Many authors have noted that the NBBO or quoted spread is not a reliable benchmark for execution quality and does not reflect the current market conditions. Although Reg NMS explicitly mentions it as a measure for best execution, trades take place within it on a regular basis⁴¹. The NBBO ignores odd-lot orders on exchanges that might offer price improvement (Kothari et al., 2021) and is based on round-lot orders of 100 shares or more, even though odd lots now account for over 60% of all trades (Schwarz et al., 2022). As a result, comparing off-exchange execution to the NBBO overstates potential savings (Adams et al., 2021; Mittal & Berkow, 2021; Schwarz et al., 2022), as the assumption is made that traders would have to cross the entire spread on exchanges. The same applies to the BBO and quoted spread on European markets, where studies also showed that there is liquidity in-between the concurrent spread. Several suggestions have been proposed to strengthen the NBBO. These include incorporating odd-lot orders, particularly for higher-valued assets, as many retail orders are excluded (NASDAQ, 2023; Adams et al.) and reducing the minimum tick size to enable exchanges to compete with off-exchange execution (particularly for lower-priced assets) (Adams et al., 2021; NASDAQ, 2023).

Another limitation is that many studies rely on post-trade data, such as the TAQ database, which does not include odd-lots, and often lacks information on whether an order is a buy or sell. Assumptions must be made to determine trade direction, which can lead to inaccurate categorization and distorted results. For example, the approach of Boehmer et al., used in many studies shown here, assumes that orders do not receive a better price than the midpoint of the spread. Schwarz et al. show that about 10-20% of orders receive price improvement larger than 50%, which would be falsely classified using this approach, thus understating the amount of price improvement. Comparing post-trade transaction prices to pre-trade prices can also be problematic, as the quoted spread does not account for hidden liquidity and odd-lot orders. Therefore, it is difficult to make precise statements about whether best execution has occurred.

Several solutions have been proposed to enhance execution quality and its measurement. A precise definition of the term “Best Execution”, which also involved inter-NBBO liquidity, would allow investors to benefit from liquidity within the quoted spread on exchanges as well. This approach would

⁴¹ For example, when Amazon was priced at around \$3,230 in January 2021, the NBBO spread was \$5.40. A lot of trades took place within this spread, so the “true spread” (incorporating odd-lot orders) was about \$0.82 (Bartlett, 2021).

require brokers to not only exceed the NBBO but also compare the prices among off-exchange wholesalers. In doing so, the conflict of interest is reduced, as the market maker with the most favorable price would obtain the order flow (Mittal & Berkow, 2021). Consequently, it is suggested to measure execution quality using execution-based benchmarks (e.g., comparing effective spreads) (Adams et al.).

It is particularly important to adjust the applicable regulations in this regard. In the EU, establishing a consolidated trade and quote database could provide brokers and wholesalers with a guide for their best execution. The weaknesses of the TAQ database and the NBBO in the US should be addressed simultaneously. Introducing specific regulations for circumstances in which internalization and PFOF are permitted, such as the liquidity of the underlying asset or transaction size, could be a potential solution. Further research must be conducted to determine these thresholds. The BaFin study serves as a valuable starting point for this endeavor. Similarly, regulations could also be envisaged that would force wholesalers to execute all orders uniformly, irrespective of the broker that routed them. To prevent brokers from taking most of the received payments, regulations that require brokers to pass on a fixed share to their clients are also conceivable.

In regards to transparency, more detailed reporting would help retail investors choose their broker and also make it easier to conduct studies (NASDAQ, 2023). For example, US wholesalers and brokers currently don't have to publish data around the execution of odd-lot orders.

A complete ban on PFOF could also lead to better average execution quality. According to a model introduced by Glosten and Milgrom (1985) model, bid-ask spreads reflect the ratio of informed to uninformed traders. Moving retail flow to a public forum where all market makers compete could result in tighter spreads. Mittal and Berkow (2021) also stated that moving all orders to public exchanges could tighten spreads significantly.

In 2021, the UK banned PFOF and introduced the Retail Service Provider Model, a platform where brokers send all their retail orders, and market makers bid for the best rates. A study by the CFA Institute (CFA) found that after the ban the amount of retail-sized trades that were executed at the quoted BBO increased at the expense of a lower amount of orders that received price improvement. As this seems like retail customers are worse off, CFA states that due to the competition, average spreads tightened significantly. The quoted spread for large-cap stocks for trades executed at the best price declined from 6.8 bps in 2010 to 4.6 bps in 2014. For trades executed with price improvement, spreads fell by one-third over the same period, and for midpoint trades, the associated spread fell by more than 40%. It is concluded that this change is positive for the overall market. It supports displayed orders and rewards liquidity providers that post competitive quotes, resulting in better price discovery and a more efficient market.

Alternative exchange models, such as Euronext’s “Best of Book” (BoB) model, could help ensure the best execution. The BoB model from Euronext is designed for retail order flow from brokers and uses limit order books, where market makers have to compete to get retail order flow by posting competitive quotes. A study comparing BoB with similar platforms that pay for their order flow found that BoB offered better average price improvement. The extent to which brokers can benefit from this model needs further investigation. The findings may be relevant as brokers and market makers need to find other sources of revenue in case PFOF gets banned. Building exchanges that are solely designed for retail order flow could, on the one hand, avoid the disadvantages of execution on an open exchange, where the uninformed order flow from retail investors competes with informed order flow, and on the other hand, prevent the conflicts of interest triggered by PFOF payments.

5.2 Digital Engagement Practices and Investor Performance

Digital engagement practices, also known as behavioral designs, encompass strategies, techniques, and technologies to attract, engage, and retain users in digital environments like websites and mobile apps. According to the SEC, DEPs “include behavioral prompts, differential marketing, game-like features [...] and other design elements or features designed to engage with retail investors on digital platforms” (SEC, 2021c)

While regulators acknowledge that DEPs and, specifically, the gamification of investment apps can contribute to the accessibility of investing, they express concerns that these practices may encourage emotionally driven actions rather than rational decisions (ESMA, 2022). Neo-brokers have been criticized for using DEPs to increase user trading activity. For example, the SEC has flagged concerns that these features may encourage investors to trade more often and negatively impact investors’ outcome (SEC, 2021c). The ESMA states that especially younger, less experienced investors might be vulnerable to such marketing campaigns or other influences (ESMA, 2022). Consequently, regulatory authorities are increasingly focusing on DEPs employed by neo-brokers and, to a lesser extent, traditional retail investment platforms, examining how these may raise investor protection concerns (SEC, 2021c; ESMA, 2022).

Neo-brokers are often criticized for their low barriers to entry. The entire registration process is designed for maximum simplicity and speed. As processes become faster and require fewer clicks, users are more likely to complete them (Service et al., 2014). This ease of use allows investors with little to no prior knowledge to start trading immediately, even with complex financial instruments like options. For example, Robinhood grants customers access to options trading almost instantly, unlike larger brokerage firms that review all applications for options trading⁴².

⁴² For example: Charles Schwab states on their website that users have to apply for options trading and the approval can take 5-10 days (Schwab, 2023).

Neo-broker apps and websites are known for their intuitive design and visually appealing presentation. Neo-brokers frequently employ sharp colors and flashy designs, and every navigable screen features distinct, colorful graphics. One example of this are animations whenever the price of an asset changes, which attracts the user’s attention. ESMA points out that neo-brokers often use dark patterns, such as brightly colored buy and sell buttons, while cancel buttons are gray and smaller (ESMA, 2022). While simplifying the user experience (UX) and reducing friction is typically considered positive, these practices can also make it too easy to engage, which can result in undesirable behaviors, such as overtrading (T. Fleming et al., 2022). The simplicity of the UX has led critics to argue that it is too easy to invest money. For instance, purchasing an asset only requires entering the desired investment amount and clicking buy/sell. Figure 27 shows the process of buying stock on the Trade Republic app, a German neo-broker.

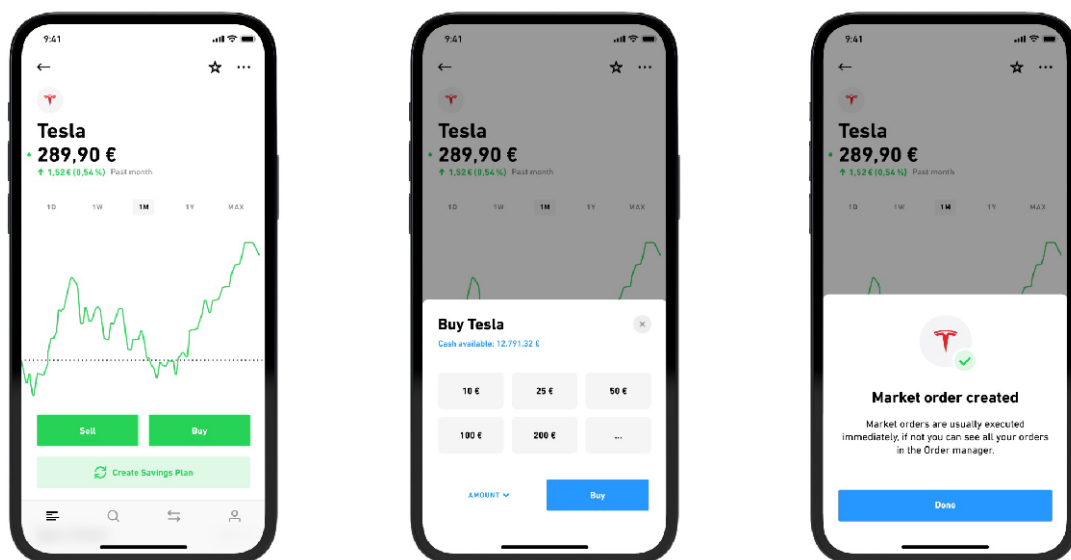


Figure 27: Buying Process on the Trade Republic App⁴³

Additionally, it is argued that the absence of explicit transaction costs and the promotion of this aspect may encourage customers to trade more than they would naturally (ESMA, 2022). Some brokers also set default investment amounts and leverage irregularly high when a user is about to place a trade (FCA, 2022). Research suggests that investors are likely to adhere to a proposed default (Madrian & Shea, 2001).

The integration of game-related elements into the non-gaming context of investing, which is referred to as “Gamification” (Deterding et al., 2011), is used to enhance UX and engagement on the platform (SEC, 2021a). However, these game-like features can make trading feel less like a financial decision and more akin to gambling, leading to the occasional use of the term “gambification” (T. Fleming et

⁴³ Figures from: <https://traderrepublic.com/>.

al., 2022). For example, FINRA stated in 2021 that platforms and apps using interactive and “game-like” features could mislead investors about the risks of certain trading strategies (FINRA, 2021). A notable example was the confetti animation in the Robinhood app when users executed a trade, which could create the impression of a successful transaction even though the trade had just been placed and might result in negative returns. Due to significant criticism, this feature has since been removed from the app (McCabe, 2021).

The choice to make financial products available via a smartphone app is criticized insofar as it constantly keeps the broker accessible. This is supposed to lead to a “trivialization” of financial matters. Moreover, research suggests that screen size, spatial layout, and touch screens on mobile devices can negatively impact users’ decision quality (Grant, 2020).

Rewards and promotions for tasks or goals, such as referring new customers or reaching specific trading objectives, contribute to the abovementioned gamblification. Although these rewards usually have insignificant financial value, they can encourage increased trading, which may be detrimental to investors’ returns (T. Fleming et al., 2022). A survey by the Financial Conduct Authority in the UK (2022) raised concerns that trading applications that use DEPs, like animations, could contribute to gambling-like investor behavior (FCA, 2022).

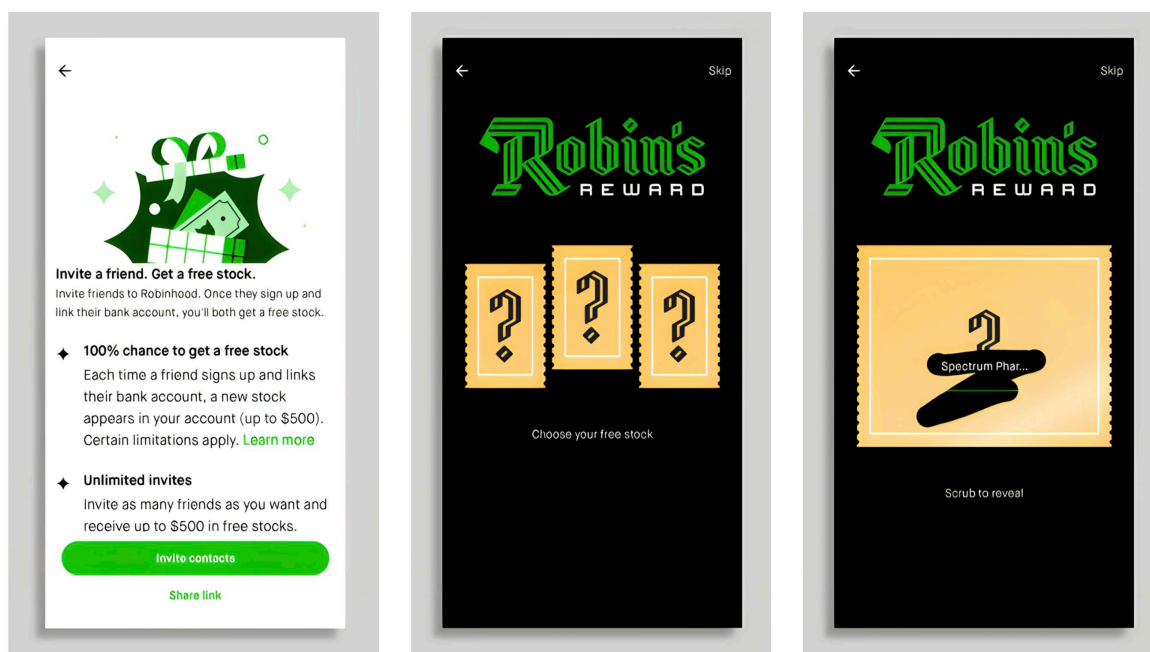


Figure 28: Referral Program and “Gamification” on the Robinhood App⁴⁴

Neo-brokers also use notifications, like price and portfolio activity or curated stock lists, to draw users back to their platform (FCA, 2016). Many popular providers feature lists of stocks on their home screens, including “Top Movers” and “Most Popular” stocks, often combined with notifications (FCA,

⁴⁴ Figures from (Wilson, 2021).

2022). Some neo-brokers even display leaderboards of top-performing users, which can promote social comparison and competition. Users can sometimes copy-trade these top performers with a single click, making investing even easier since they don't have to trade themselves.

In conclusion, digital engagement practices and gamification in neo-brokers' platforms have made investing more accessible. However, regulators and critics express concerns over the potential negative impact on investor outcomes, especially among inexperienced traders (SEC, 2021a; ESMA, 2021b, 2022). This highlights the importance of striking a balance between accessibility and responsible trading practices.

5.2.1 Regulation

MiFID II is the key legislation covering the distribution of financial instruments in the EU. It “covers the provision of different investment services (including investment advice and the reception, transmission and execution of orders) in relation to any financial instruments to different categories of investors, including retail clients” (ESMA, 2022). While it does not explicitly address DEPS or gamification, these regulations set standards for transparency, fairness, and investor protection that investment platforms, including neo-brokers, must follow. Firms need to ensure that their actions do not create conflicts of interest.

Article 24 (3) of MiFID II mandates that “all information, including marketing communications, addressed by the investment firm to clients or potential clients shall be fair, clear and not misleading. Marketing communications shall be clearly identifiable as such”. Moreover, the regulation requires that clients are provided with information about the investment firm, its services, and all related costs (Article 24 (4)) to help them understand the risks of specific investments. However, there is currently no concrete definition of the term marketing communications. ESMA asserts that suggesting complex financial products are suitable for all investors would not comply with MiFID II. While contracts for differences (CFDs) require a risk warning (also on social media), no such warning exists for other financial services or instruments at the EU level (ESMA, 2022).

ESMA believes that when a client receives a pop-up message, email or any other communication nudging them to make a transaction in a specific financial instrument, it can be considered a personal investment recommendation. Consequently, these fall under the provision of MiFID II and brokers must ensure they act in their clients' best interests (ESMA, 2022). As part of firms' distribution strategies, gamification techniques are subject to the current regulatory frameworks under product governance requirements and the mandate that information must be fair, clear and not misleading. However, gamification is less prominent on European neo-broker platforms, as German regulator BaFin found in a survey focusing on trading apps (ESMA, 2022).

In the US, consumer protection is addressed through the SEC's Regulation Best Interest (Reg BI), which was introduced in 2019. It requires brokers to refrain from placing any interest, including their own, ahead of the clients' interest when making a recommendation for any transaction involving securities (Hunley, 2019). Reg BI also obliges brokers to disclose all relevant facts about the broker-customer relationship, including potential conflicts of interest. Brokers must exercise reasonable diligence and care when making recommendations, ensuring their interests do not supersede the investor's. To be compliant with Reg BI, strategies to identify and address conflicts of interest, as well as policies and procedures, need to be established.

However, Reg BI does not impose a fiduciary standard, because the term "recommendation" remains undefined. Regulators are aware of DEPs used in financial services, as a SEC spokesperson stated, they may blur the distinction between solicited and unsolicited transactions. They may also encourage investors to trade specific securities or increase trading activity in general, even when not recommending a specific security. Aiming to regulate this new generation of online brokers effectively, the SEC first wants to fully understand the scope of DEPs in the industry and how they influence investor behavior and decision-making (R. Fleming, 2021). Regulators are looking to better incorporate behavioral designs into Reg BI. The SEC requested more information regarding the use of DEPs from brokerages in 2021 and is debating "whether regulatory action may be needed to enhance investor protection" (SEC, 2021c).

One example of local regulatory action is a complaint filed against Robinhood by the Massachusetts Securities Division, accusing the company of gamification and enticing customers to trade more through "aggressive marketing" tactics and platform design elements (Raymond, 2020).

5.2.2 Impact of Digital Engagement Practices on Investors

Several studies analyze the performance of retail investors using online platforms such as neo-brokers. While the performance of retail investors is the subject of the following chapter, this one focuses on understanding the behavioral differences induced by DEPs that could lead to varying performances.

Kalda et al. (2021) conducted a study using transaction-level data from two German banks that introduced trading applications for mobile devices. They analyzed the effects of smartphones on investor behavior by comparing trades executed by the same investor in the same month across different platforms. The average investor adopting smartphone trading in their study was 45 years old with nine years of investing experience with the banks. Therefore, the study can capture the effects of smartphone trading with a representative sample. The authors found that smartphone trades involved assets with higher volatility and more positive skewness⁴⁵. Smartphone users were 67% more likely to

⁴⁵ In trading, skewness refers to the asymmetry of an asset's return distribution and is a measure of the tendency of asset returns to deviate from a normal distribution. Positive skewness indicates more volatile and risky investments.

buy these “lottery-type stocks”. The study also examined the effects of smartphones on the tendency to chase past returns, finding that smartphones increased the probability of buying assets that performed well for investors in the past. The authors also investigated whether investors selectively used smartphones to execute their risky, lottery-type and trend-chasing trades. They discovered that investors were more likely to purchase risky, lottery-type assets and chase past investments on non-smartphone platforms after beginning to trade on smartphone apps. Lastly, it is stated that the effects were observed across all asset classes and not influenced by the highlighting of specific assets within the app. Moreover, no impact from the device screen size was detected.

Before the emergence of online brokerages, investors had to call their broker or wait for a bank statement to receive updates on their financial information. Smartphone apps allow users to access information anytime and anywhere, even more easily than on their computers. Levi and Benartzi (2021) published a study analyzing the impact of access to personal financial information from mobile devices on consumer behavior. The authors studied the effects on customers who installed a broker app after using an online platform on their computers for several months. They found that users increased their attention to personal finances upon installing. The login frequency increased from four times per month before, to more than 16 times immediately after installing the app. This shows that the use of apps seems to stimulate increased usage of a specific service.

Barber et al. (2021) found that Robinhood’s mobile app and game-like features led to more “attention-induced trading”, reflected in higher turnover rates and more speculative trading than other brokerages. Robinhood users’ behavior was also more correlated, with users drawn to trading both extreme gainers and losers displayed in the app’s top mover section. They also provide information that “herding” due to attention-induced trading led to negative average returns.

In 2021 a study comparing investor behavior on gamified apps versus standard trading apps was conducted by Chapkovski et al. Participants were assigned to either a simple trading app or an app that features game-like elements similar to existing platforms. The researchers discovered that investors using gamified trading apps took on more risk, especially when trading high-volatility asset classes such as derivatives and cryptocurrencies. They found that celebratory messages and badges could influence users to take on more risk when investing. Results indicated that the more financially literate someone was, the less they were influenced by gamification. Conversely, inexperienced traders were more likely to be swayed by the effects of gamification.

Arnold et al. (2022) examined the influence of standardized push messages containing no fundamental news or information on stocks sent to retail investors. They found that such attention triggers stimulated people to trade more riskily, using, on average, 19% higher leverage and trading larger amounts. The effect was mainly observed directly after the notification was sent (1-2 hours after). The impact of attention triggers on risk-taking was stronger for younger investors and declined for more

experienced traders. In addition, the authors state that the increase in risk-taking was mainly driven by the notification itself and not by the content of the message.

The effects of gamification, in the form a reward system and a “Top-Traded” list of stocks, are analyzed by Fleming et al. in a study carried out for the Ontario Securities Commission in 2022. They found that a reward system stimulated trading activity, with participants making 39% more trades, even though rewards had negligible value. Participants exposed to a top-traded list did not increase the number of trades. However, trading activity was shifted towards listed stocks, with participants who saw the top-traded lists being 14% more likely than participants in the control group to buy and sell those top-listed stocks. This implies that platforms can direct users to specific assets by presenting them through curated stock lists or other types of nudges on their platform.

Apesteguia et al. (2020) found that traders featured on leaderboards often used risky strategies. Traders that observe these leaderboards are more willing to take risks to achieve similar results (Apesteguia et al., 2020).

5.2.3 Retail Investor Performance and Behavioral Patterns

As detailed in the previous chapter, digital engagement practices (DEPs) promote more frequent and riskier trading among users of neo-broker platforms. For instance, during the first quarter of 2020, Robinhood users, on average, traded about nine times the number of shares (per dollar) compared to E-Trade customers and around 40 times more than those from Charles Schwab (Popper, 2020). This section delves into the performance of individual investors, particularly on online platforms. Older studies are also incorporated to identify any progressive differences, especially considering the significant increase in (small) retail investors and the decline in fees.

Retail investor’s performance and also the reasons for certain behavior have been studied for a long time. As early as 1979, for example, Shefrin and Statman demonstrated in a study that average individual investors are hesitant to sell positions for a loss but are open to selling positions that are in profit. This behavior is widely known as the disposition effect. They also showed that it leads to suboptimal returns (Shefrin & Statman, 1985).

In 1999, Odean published a study examining the trading behavior of users of discount brokerages. The study found that users of such platforms tend to trade more frequently, resulting in deteriorating returns. The securities investors purchased underperformed those they sold by 3.3% on average. Reasons for this underperformance include increased trading costs, investor overconfidence and the selection of traded assets. Investors typically buy assets with higher price changes in the two years prior compared to those they sell. Odean suggests that exceptional performance attracts investor attention, leading to the purchase of past winners or losers, believing that they will either follow trends or reverse recent losses respectively. They buy similar numbers of winners and losers, with investors preferring

to sell securities that have seen significant price increases in the last two weeks (disposition effect) (Odean, 1999).

In another study, Barber and Odean (2000) demonstrated that individual investors who actively trade underperform due to overtrading and trading costs such as bid-ask spreads and commissions. The average yearly turnover of an individual investor's portfolio was around 75%, resulting in underperformance compared to simple market indices (Barber & Odean, 2000).

In a study investigating investors who transitioned from phone-based to online trading (Barber & Odean, 2002), it was discovered that mainly experienced investors that outperformed the market by over 2% annually before the switch began using online platforms. However, online trading led them to trade more actively and speculatively, resulting in a 3% annual underperformance compared to the market. Prior success-induced overconfidence, reinforced by better access to information and control over portfolios, contributed to the decline in returns. The authors noted that the decline in returns was not directly attributable to trading costs or the ease of access, although the latter could encourage overtrading. For investors who do not increase their trading activity, reduced costs are beneficial. Oh et al. (2008) found similar evidence that online traders perform worse than those who do not trade online. Additionally, they suggest that individual investors supply liquidity to profitable, primarily institutional, investors because they are attracted to assets that have seen good returns in the near past. Individual investors allow other investors to realize their returns in these assets. As a result, individual investors underperform, with this trend being more noticeable online (Oh et al., 2008).

Chen et al. (2007) discovered that individual Chinese investors exhibit similar trading behaviors to US investors. They also tend to sell assets that have risen in price and hold those that have fallen (disposition effect). Their trading behavior appears to be influenced by overconfidence, resulting in overtrading and lower returns. Individual investors are also prone to buying assets that have experienced a significant uptick in the recent past. Furthermore, the authors found that experienced investors cannot escape these behavioral biases, although the effects are weaker on average (Chen et al., 2007). In a study by Barber et al. (2009), it was shown that individual investors in Taiwan returned approximately 3.8% of their returns due to trading. The authors attribute most of the losses of individual investors to their aggressive (market) orders⁴⁶. This comparatively high value is presumably explained by a very high annual turnover of about 300%. The authors propose that overconfidence and gambling-like behavior are the primary reasons for such extensive trading and diminishing returns (Barber et al., 2009).

Kaniel et al. (2008) found that individual investors tend to purchase stocks that have recently declined and sell those that have recently increased in value. They analyzed retail order imbalances to examine

⁴⁶ Passive trades (also known as passive orders or passive execution) involve placing limit orders on the order book, waiting for the market to move in the desired direction. Aggressive trades (also known as aggressive orders or aggressive execution) involve placing market orders or limit orders that are immediately executable, meaning the trader is actively seeking to execute the trade as quickly as possible.

the performance of assets after a significant number of retail investors have bought or sold. Retail order imbalance refers to the difference between the number of buy and sell orders placed by individual or retail investors in the stock market. It is an indicator for the overall sentiment of retail investors regarding a particular asset or the market as a whole. When there is a positive retail order imbalance, it means that there are more buy orders than sell orders, indicating bullish sentiment among retail investors. Conversely, a negative retail order imbalance suggests that there are more sell orders than buy orders, reflecting bearish sentiment. Kaniel et al. observed positive returns in the month following substantial buying by individual investors and negative average returns in the month following the pronounced selling of an asset. The authors link these observations to the demand of institutions to exit positions (quickly). Individual investors act as liquidity providers and are rewarded with returns in the following month (Kaniel et al., 2008). Another study by Kaniel et al. from 2012 finds that individual investor buying (selling) predicts large positive (negative) abnormal returns on and after earnings announcement dates. Similar to before, the returns are partly due to the role of individual investors as liquidity providers, but they are also explained by private information. This information can either come from traders who have insider information or be explained by the fact that there is also information content in the aggregate crowd of individual investors (Kaniel et al., 2012).

This theory is further supported by Kelley and Tetlock (2013), who also examine the difference in predictive power between retail market and limit orders. They find that both daily buy-sell imbalances in market and limit orders of retail participants contain predictive power on a monthly timeframe. This effect is stronger for stocks with a higher share of retail orders. For news events regarding cashflows (e.g., earnings), market order imbalance, on average, predicts the tone of the news, suggesting that retail orders overall contain information about the cash flow of companies (Kelley & Tetlock, 2013). Building upon previous research, Boehmer et al. (2021) published a study showing that retail market orders predict future stock returns. They found that stocks with positive retail market imbalances outperform those with negative imbalances by approximately 10 bps in the first week, with the average outperformance lasting roughly 12 weeks. Since trends in assets, liquidity provisions and news could not fully explain the effect; the authors suggested that retail market orders contain information not yet priced in (Boehmer et al., 2021).

Barrot et al. (2016) investigated the extent to which retail market participants provide liquidity to the market and whether they receive excess returns as a result. Focusing on European markets during the 2008 financial crisis, they found that retail investors increasingly provide liquidity when traditional providers can't, often during periods of high volatility. However, retail investors fail to benefit from liquidity provision returns due to poor execution prices on the trading day. They experience negative intra-day returns on the day they buy, which can offset potential gains from price reversals. Additionally, their average holding period of over 300 days is too long since most returns from liquidity

provision dissipate after 20 days. The slow reversal of trades contributes to retail investors' underperformance (Barrot et al., 2016).

Loos et al. (2020) examined the disposition effect in an experiment using transaction data from a German retail bank offering brokerage services. They found that the decision to buy or sell an asset, which should be based on expectations of future performance, is often driven by the current price and whether an investor made a gain or loss compared to the entry price (Loos et al., 2020).

Welch (2020) analyzed retail investor performance on the Robinhood platform. He also discovered that smaller Robinhood investors tend to buy assets that recently experienced high price changes. His data also revealed that investors began buying during the COVID crash in early 2020. Welch replicated a "Robinhood portfolio" based on the number of users holding a specific asset and examined its performance from 2018 to 2020. During this period, the portfolio outperformed the risk-free rate and the overall market. Furthermore, it exhibited statistically significant positive returns compared to the Fama-French 5-factor model, a widely used method for measuring portfolio performance against different risk factors. The author acknowledged that the portfolio he created does not represent individual users' trades but can serve as a proxy for the average performance of Robinhood users (Welch, 2020). In 2021, Barber et al. conducted a study focusing on the performance of Robinhood users as well. They found that these users trade more frequently in assets displayed in the app's top mover category, which includes the day's top gainers and losers. Analyzing the performance of stocks bought the most on each day during the sample period, they found an average return of -4.7% over the next 20 days. The authors attributed the strong concentration in certain assets on specific days to the representation of top movers, suggesting that negative returns in the following days could be partially due to the increased buying pressure from Robinhood users as well as other retail participants and price reversals in subsequent days (Barber et al., 2021). In a similar approach, Da et al. (2022) studied the association between aggregate retail investor attention and market returns. Using Google search volume as a proxy for retail attention toward specific assets, they found that heightened retail attention predicts significantly negative returns in the following week. This effect is more pronounced during periods of low liquidity when retail traders are likely to have a greater impact on the stock market. The results imply that increased retail attention is associated with a temporary rise in price, which quickly reverses, leading to negative returns in the following days (Da et al., 2022).

Jones et al. (2022) published a study on the performance of retail traders in China, dividing participants into different account sizes to generate more insights. They found that small account sizes (up to a value of approximately \$450,000) do not predict future returns and exhibit behavioral patterns such as overconfidence and gambling-like behavior. As a result, small-sized retail traders have an average annual performance of -5.61%, mainly due to poor stock selection and trading costs. Retail investors with larger account balances can predict future returns. This effect is more pronounced in

stocks that attract investors with behavioral biases. Their annual return on average is close to zero, as they benefit from good stock selection but are offset by trading costs (Jones et al., 2022).

Lastly, Barber et al. (2023) discussed the paradox that while numerous studies suggest retail buying activity can predict future returns, many studies have shown a negative average performance. The authors proposed that both phenomena can co-occur: retail order imbalances can predict future returns over short periods, but retail traders still lose money. One key finding that explains this is that retail buying activity is highly concentrated in poorly performing trades. Most order imbalance studies suggesting the predictive power of retail trading activity use hypothetical portfolios built using the discovered order imbalances without examining the actual returns of investors and their portfolios. Thus, while retail investors' trades can provide a positive signal for short-term returns, these trades do not necessarily benefit the retail investors themselves. Retail investors tend to underperform on the day they make trades, particularly in stocks they buy aggressively. This underperformance may be linked to attention-based trading, where retail investors buy attention-catching stocks, leading to temporary price increases followed by reversals. Cases where investors do not realize their successful trades, which again result in negative returns, or close positions too quickly due to the disposition effect, are also conceivable explanations for this phenomenon (Barber et al., 2023).

In summary, research suggests that retail investors, particularly those using online platforms, tend to underperform in the stock market. This underperformance is often attributed to behavioral biases such as overconfidence, the disposition effect and attention-based trading. Digital engagement practices on neo-broker platforms may exacerbate these issues, promoting more frequent and riskier trading. Although experienced investors are not entirely immune to these behavioral biases, the impact tends to be less severe. While some studies indicate that retail buying activity can predict short-term returns, this does not necessarily translate to positive outcomes for investors. Retail investors often underperform on the day they make trades, and their buying activity is highly concentrated in poorly performing trades.

6 Conclusion

Regarding the topic of best execution, it is crucial to emphasize that the market structure facilitating optimal execution for individual traders may not necessarily provide the most favorable bid and ask spreads or the highest liquidity for the overall market (Macey & O'Hara, 1997). The effects of PFOF on market structure and execution quality remain an ongoing debate among researchers, with various studies in the US and EU yielding contrasting results due to differences in methodology and applied metrics. Nevertheless, it is evident that PFOF can lead to improved execution quality under certain circumstances, such as transaction size, market liquidity, and the specific broker involved. Studies suggest that order execution through an off-exchange market maker is beneficial for smaller orders in markets with higher liquidity. Moreover, the selection of a broker and the proportion of PFOF it distributes to its clients are relevant factors.

Given the many factors at play, the research situation must first be improved and standardized. This involves refining the definition of the concept "best execution" to ensure clarity and precision within the scientific context. Additionally, scholars and regulators should work towards developing more reliable and comprehensive benchmarks for execution quality, such as incorporating odd-lot orders into the NBBO, reducing minimum tick sizes, and harmonizing quoting and trading increments across markets. Introducing a uniform comparison method that includes all incurring fees (e.g., effective spreads) seems reasonable. A more coherent assessment of the research situation can only be achieved by integrating these factors.

An enhanced research situation could provide a solid foundation for regulators to implement meaningful and fair rules for brokers and wholesalers. At present, the compliance of PFOF in its existing form remains indeterminate. For instance, the ESMA suggested that a significant part of the PFOF markets is most likely not adhere to MiFID II. The SEC imposed several charges against brokers due to their order routing practices, yet neo-broker utilization and PFOF payments are higher than ever. If PFOF was prohibited, numerous neo-brokers might not be profitable anymore. This might result in the reintroduction of commissions and a setback for the democratization of the financial world. Following the incidents at the beginning of 2021, there were initial indications that PFOF might be banned in both the EU and the US. However, despite facing regulatory scrutiny, neo-brokers and PFOF seem unlikely to disappear in the foreseeable future.

The meme stock phenomenon has demonstrated that while herd mentality and hype can generate remarkable gains for some, they can also lead to financial devastation for others. In terms of retail investors' performance, studies from the early 2000s generally found that these investors underperformed due to their trading activities, particularly when utilizing online trading platforms. A more effective strategy would have been to purchase and hold market indices like ETFs. Although the majority of current research continues to indicate that trading negatively impacts retail investors' returns,

a few studies suggest otherwise. There may be a subtle trend that trading today results in less wealth destruction, potentially due to the decreased trading commissions.

Throughout the entire period, behavioral patterns such as purchasing assets with recent significant price changes and the disposition effect were observed. Overconfidence among retail traders can lead to excessive trading, which negatively impacts portfolio performance. Studies often conclude that DEPs, such as the gamification of investment apps, can exacerbate behavioral patterns and biases like overconfidence and excessive trading. When people make financial decisions on their smartphones in a playful environment, they may underestimate the potential consequences of their actions. These effects are regularly reported to disproportionately affect young, inexperienced investors. Another possible explanation is that investors adopt innovative technology as they are open to altering their trading habits, and greater risk tolerance is a common trend, not exclusively observed in younger investors.

Similar to order routing inducements, regulations regarding DEPs and gamification in the EU and the US are vaguely formulated. It is unclear when brokers issue a recommendation (a prerequisite for the application of Reg BI in the US) or when marketing communications (MiFID II) are present. The topic of DEPs is still relatively new, and it will take time to fully examine and integrate it into the regulatory framework. The significant advantage of neo-brokers, enabling widespread access to financial markets, should not be underestimated. Particularly within our liberal market economy, individuals should not encounter exclusion due to elevated fee structures or the complexity of applications. An essential approach to offset the negative points of neo-brokers could be to promote financial literacy among investors (e.g., better integration into the education system). Greater knowledge of topics such as PFOF, the influences of DEPs, general behavioral patterns of investors, and other relevant subjects could potentially mitigate or eliminate many negative aspects.

The future remains exciting, as emerging technologies such as blockchain and AI could significantly impact internalization practices, investors performance and the overall market. AI and machine learning algorithms could be further used to optimize order routing practices and minimize conflicts of interest arising from PFOF by making data-driven decisions based on execution quality. Another potential application are AI-driven systems to monitor wholesalers' and brokers' order routing in real-time, ensuring compliance with their best execution obligations. Blockchain-based trading systems do not particularly need intermediaries like brokerages and wholesalers in the trading process. This could lead to a more decentralized market structure, potentially reducing the role of PFOF and internalization. Additionally, AI can impact retail investor returns, for instance, through the increased use of robo-advisors in the investment process. These algorithms and machine learning techniques can mitigate human biases and promotes more rational, data-driven investment decisions. Furthermore, they contribute to cost efficiency by automating trade execution and portfolio rebalancing. The implications of these technological advancements in the financial sphere present promising opportunities.

Appendix

Studies included in section 5.1.5 (Impact of PFOF and Internalization on Execution Quality in Options Markets):

Study	Author(s)	Year
To Pay or Be Paid? The impact of Taker Fees and Order Flow Inducements on Trading Costs in U.S. options markets	Battalio et al.	2016
Do (Should) Brokers Route Limit Orders to Options Exchanges That Purchase Order Flow?	Battalio et al.	2021
Option Auctions	Hendershott et al.	2022

Table 8: Studies – Options Markets

Studies included in section 5.2.2 (Impact of Digital Engagement Practices):

Study	Author(s)	Year
Copy Trading	Apestequia et al.	2020
Smart(Phone) Investing? A within Investor-Time Analysis of New Technologies and Trading Behavior	Kalda et al.	2021
Mind the App: Mobile Access to Financial Information and Consumer Behavior	Levi & Benartzi	2021
Attention-Induced Trading and Returns: Evidence from Robinhood Users	Barber et al.	2021
Does gamified trading stimulate risk taking?	Chapkovksi et al.	2021
Attention triggers and investors' risk-taking	Arnold et al.	2022
Digital Engagement Practices in Retail Investing: Gamification & Other Behavioural Techniques	Fleming et al.	2022

Table 9: Studies – Digital Engagement Practices

Studies included in section 5.2.3 (Retail Investor Performance and Behavioral Patterns):

Study	Author(s)	Year
Do Investors Trade Too Much?	Odean	1999
Trading Is Hazardous to Your Wealth: The Common Stock Investment Performance of Individual Investors	Barber & Odean	2000
Online Investors: Do the Slow Die First?	Barber & Odean	2002
Trading performance, disposition effect, overconfidence, representativeness bias, and experience of emerging market investors	Chen et al.	2007
Investors' trading behavior and performance: Online versus non-online equity trading in Korea	Oh et al.	2008
Individual Investor Trading and Stock Returns	Kaniel et al.	2008
Just How Much Do Individual Investors Lose by Trading?	Barber et al.	2009
Individual Investor Trading and Return Patterns around Earnings Announcements	Kaniel et al.	2012
How Wise Are Crowds? Insights from Retail Orders and Stock Returns	Kelley & Tetlock	2013
Are retail traders compensated for providing liquidity?	Barrot et al.	2016
The Consumption Effects of the Disposition to Sell Winners and Hold Losers	Loos	2020
Retail Raw: Wisdom of the Robinhood Crowd and the COVID Crisis	Welch	2020
Tracking Retail Investor Activity	Boehmer et al.	2021
Attention-Induced Trading and Returns: Evidence from Robinhood Users	Barber et al.	2021
Market Returns and a Tale of Two Types of Attention	Da et al.	2022
Understanding Retail Investors: Evidence from China	Jones et al.	2022
Resolving a Paradox: Retail Trades Positively Predict Returns but are Not Profitable	Barber et al.	2023

Table 10: Studies – Individual/ Retail Investor Performance

Main Findings – Impact of Payment for Order Flow and Internalization (section 5.1):

Study	Main Findings
<i>European Union (Equity Markets) [Chapter 5.1.3]</i>	
<p><u>Meyer et al. (2021):</u> Private investors and the emergence of neo-brokers: Does payment for order flow harm private investors? (Germany)</p>	<ul style="list-style-type: none"> ▪ 21% of trades executed on Trade Republic received a better price than on XETRA, 78% an equal price ▪ Average effective spread on Trade Republic is 57.1% of XETRA spread ▪ Explicit fees on Trade Republic are lower than on other German online brokerages
<p><u>AFM (2022):</u> Assessing the quality of executions on trading venues (Netherlands)</p>	<ul style="list-style-type: none"> ▪ PFOF venues execute at worse prices than reference markets in 68-82% of the examined trades ▪ Average price deterioration: 4.8- 11.5 bps
<p><u>CNMV (2022):</u> Payment for order flow: an analysis of the quality of execution of a zero-commission broker on Spanish stocks</p>	<ul style="list-style-type: none"> ▪ PFOF venue executes at worse prices than reference markets in around 86% of the examined trades ▪ Average price deterioration: 11- 12 bps
<p><u>BaFin (2022):</u> Study into execution quality on selected German trading platforms</p>	<ul style="list-style-type: none"> ▪ For transactions up to €15,000 in DAX equities and up to €500 in non-DAX equities execution via PFOF markets is beneficial (given that volume on PFOF market < volume on reference markets at that time) ▪ When volume on PFOF markets > volume on reference markets at the same time: off-exchange execution mostly inferior
<p><u>Elsas et al. (2022):</u> Payment for Order Flow and Market Quality: A Field Experiment</p>	<ul style="list-style-type: none"> ▪ Quoted, effective and realized spreads did not significantly change when sending orders from Trade Republic to XETRA (on-exchange) instead of their affiliated market maker (off-exchange)
<i>United States (Equity Markets) [Chapter 5.1.4]</i>	
<p><u>Adams & Kasten (2021):</u> Retail Order Execution Quality under Zero Commissions</p>	<ul style="list-style-type: none"> ▪ Effective spreads decreased for market makers and exchanges after the introduction of zero-commission trading ▪ Decline more pronounced in market maker spread, which was around 88% of the exchange spread (post-commission) ▪ Average price improvement increased marginally for market maker execution, small decline on exchanges

<p><u>Adams et al. (2021):</u> Do Investors Save When Market Makers Pay? Retail Execution Costs Under Payment for Order Flow Models</p>	<ul style="list-style-type: none"> ▪ Off-exchange execution orders receive better execution than exchanges before and after zero-commission introduction ▪ During high volatility (COVID) period: Price improvement from market makers even higher compared to exchanges
<p><u>Mittal & Berkow (2021):</u> The Good, The Bad & The Ugly Of Payment For Order Flow</p>	<ul style="list-style-type: none"> ▪ 60-80 of orders from wholesalers received price improvement (compared to NBBO), on average 24.5% of the NBBO spread ▪ On-exchange avg. price improvement: 8.7% (of NBBO spread) ▪ Price improvement from wholesalers compared to exchange execution around 15% of the spread ▪ Price improvement higher for high priced stocks ▪ Spreads would tighten significantly, if all orders traded on exchange
<p><u>Jain et al. (2021):</u> Trading Volume Shares and Market Quality: Pre- and Post-Zero Commissions</p>	<ul style="list-style-type: none"> ▪ Price improvement increased immediately after zero-commission cut but decreased over a year (around 8%) ▪ Decline was more pronounced for Top 100 stocks traded on Robinhood
<p><u>Kothari et al. (2021):</u> Commission Savings and Execution Quality for Retail Trades</p>	<ul style="list-style-type: none"> ▪ Average price improvement off-exchange better than on-exchange ▪ Robinhood price improvement greater than average off-exchange wholesaler
<p><u>Ernst and Spatt (2022):</u> Payment for Order Flow and Asset Choice</p>	<ul style="list-style-type: none"> ▪ Average price improvement off-exchange: 0.5 bps (of transaction \$ value) ▪ In options market: Price improvement more common, but of lower quality (Market makers could achieve even better prices, due to relatively high spreads) ▪ PFOF venues achieve lower price improvement than venues that aren't paid for order routing
<p><u>Levy (2022):</u> Price Improvement and Payment for Order Flow: Evidence from A Randomized Controlled Trial</p>	<ul style="list-style-type: none"> ▪ Around 95% of orders executed by PFOF brokers achieve better price than NBBO ▪ PFOF brokers achieve average price improvement of 7.45 bps (vs. NBBO) and 3.77 bps (vs. brokers with direct market access) ▪ Significant difference in price improvement between different brokers
<p><u>Schwarz et al. (2022):</u></p>	<ul style="list-style-type: none"> ▪ Around 10-20% of trades executed by retail brokers received price improvement greater than 50%

The 'Actual Retail Price' of Equity Trades	<ul style="list-style-type: none"> ▪ Significant difference in price improvement between different brokers ▪ Difference not explained by PFOF payments
Hu & Murphy (2022): Competition for Retail Order Flow and Market Quality	<ul style="list-style-type: none"> ▪ Assets with a high share of internalized trades tend to have overall wider spreads ▪ Assets where internalized trades are highly concentrated on a few market makers tend to have overall wider spreads

Options Markets (US) [Chapter 5.1.5]

Battalio et al. (2016): To Pay or Be Paid? The Impact of Taker Fees and Order Flow Inducements on Trading Costs in U.S. Options Markets	<ul style="list-style-type: none"> ▪ Exchanges with PFOF model achieve better net prices than exchanges with MT model for options priced lower than \$3.75 ▪ For options with prices greater than \$3.75 orders executed through the MT model receive better prices
<u>Battalio et al. (2021):</u> Do (Should) Brokers Route Limit Orders to Options Exchanges That Purchase Order Flow?	<ul style="list-style-type: none"> ▪ Better price improvement for orders routed to exchanges that pay broker for order flow ▪ Smaller orders tend to get greater price improvement
<u>Ernst and Spatt (2022):</u> Payment for Order Flow and Asset Choice	<ul style="list-style-type: none"> ▪ Price improvement more common in options markets (compared to equity markets), but of lower quality ▪ Market makers could achieve even better prices, due to relatively high spreads ▪ PFOF venues achieve lower price improvement than venues that aren't paid for order routing ▪
Hendershott et al. (2022): Option Auctions	<ul style="list-style-type: none"> ▪ Options auctions offer significant average price improvement (up to 25% of quoted spread/ 77 bps of option price) ▪ Market makers could offer higher price improvement ▪ 45% of orders receive minimum level of price improvement ▪ Auctions not fully competitive

Table 11: Main Findings - Impact of Payment for Order Flow and Internalization on Execution Quality

Main Findings – Impact of Digital Engagement Practices (section 5.2.2):

Study	Main Findings
<u>Apestequia et al. (2020):</u> Copy Trading	<ul style="list-style-type: none"> ▪ Traders on leaderboards often use risky strategies ▪ Investors that see leaderboards are more willing to take risks
<u>Kalda et al. (2021):</u> Smart(Phone) Investing? A within Investor-Time Analysis of New Technologies and Trading Behavior	<ul style="list-style-type: none"> ▪ Smartphone trades involve assets with higher volatility and skewness (users were 67% more likely to buy such assets) ▪ Smartphone investors tend to chase past returns ▪ Patterns also observed on other platforms after beginning to trade on smartphone ▪ Observed behavior not caused by asset highlighting
<u>Levi & Benartzi (2021):</u> Mind the App: Mobile Access to Financial Information and Consumer Behavior	<ul style="list-style-type: none"> ▪ Banking apps increase investors' attention to personal finances ▪ Apps stimulate usage of a specific service
<u>Barber et al. (2021):</u> Attention-Induced Trading and Returns: Evidence from Robinhood Users	<ul style="list-style-type: none"> ▪ Robinhood app leads to more “attention-induced trading” (higher turnover rates, speculative trading) ▪ User behavior more correlated than on other brokerage platforms ▪ Users tend to buy assets from the app's top mover section (top gainers and losers) ▪ Concentration leads to negative average return
<u>Chapkovski et al. (2021):</u> Does gamified trading stimulate risk taking?	<ul style="list-style-type: none"> ▪ Gamification in trading apps can lead to higher risk taking ▪ Effects were less pronounced for experienced investors
<u>Arnold et al. (2022):</u> Attention triggers and investors' risk taking	<ul style="list-style-type: none"> ▪ Attention triggers (such as push notifications) can stimulate risk taking (higher leverage and larger trading amounts) ▪ Effect mainly triggered by the notification itself, not the content
<u>Fleming et al. (2022):</u> Digital Engagement Practices in Retail Investing: Gamification & Other Behavioural Techniques	<ul style="list-style-type: none"> ▪ Reward system in trading apps stimulates trading activity ▪ No signs that a “top mover section” increases activity, but it can drive users to a specific asset

Table 12: Main Findings - Impact of Digital Engagement Practices

Main Findings – Investor Performance and Behavioral Patterns (section 5.2.3):

Study	Main Findings
<p><u>Odean (1999):</u> Do Investors Trade Too Much?</p>	<ul style="list-style-type: none"> ▪ Investors tend to trade more online ▪ Investors buy assets with high price changes in the last 2 years ▪ Disposition effect ▪ Increased trading leads to underperformance ▪ Reasons: Trading costs, overconfidence
<p><u>Barber & Odean (2000):</u> Trading is Hazardous to Your Wealth</p>	<ul style="list-style-type: none"> ▪ Individual investors that actively trade underperform ▪ Overconfidence results in excess trading activity ▪ Reasons: Trading costs and commissions
<p><u>Barber & Odean (2002):</u> Online Investors: Do the Slow Die First?</p>	<ul style="list-style-type: none"> ▪ Online-trading encourages overtrading ▪ Returns deteriorated when investors switched from phone-based to online-trading
<p><u>Chen et al. (2007):</u> Trading performance, disposition effect, overconfidence, representativeness bias, and experience of emerging market investors</p>	<ul style="list-style-type: none"> ▪ Disposition effect ▪ Overconfidence leads to overtrading and lower returns ▪ Individuals tend to buy “Winners”
<p><u>Oh et al. (2008):</u> Investors’ trading behavior and performance: Online versus non-online equity trading in Korea</p>	<ul style="list-style-type: none"> ▪ Online traders perform worse (compared to non-online traders) ▪ Individual investors supply liquidity to profitable investors
<p><u>Kaniel et al. (2008):</u> Individual Investor Trading and Stock Returns</p>	<ul style="list-style-type: none"> ▪ Disposition effect ▪ Retail order imbalance can predict short term returns (month) ▪ Individual investors act as liquidity provider
<p><u>Barber et al. (2009):</u> Just How Much Do Individual Investors Lose by Trading?</p>	<ul style="list-style-type: none"> ▪ Individual investors give back parts of their returns due to trading ▪ Reasons: Aggressive market orders and high turnover
<p><u>Kaniel et al. (2012):</u></p>	<ul style="list-style-type: none"> ▪ Retail order imbalance predicts returns on and after earning announcements

Individual Investor Trading and Return Patterns around Earnings Announcements	<ul style="list-style-type: none"> ▪ Reasons: Liquidity provision and private information
<u>Kelley & Tetlock (2013):</u> How Wise Are Crowds? Insights from Retail Orders and Stock Returns	<ul style="list-style-type: none"> ▪ Daily retail imbalance in market and limit orders can predict returns on monthly timeframe ▪ For “cash-flow” news events imbalance on average predicts the tone of the news
<u>Barrot et al. (2016):</u> Are retail traders compensated for providing liquidity?	<ul style="list-style-type: none"> ▪ Retail investors supply liquidity in periods of high volatility, but fail to benefit from it ▪ Reasons: Negative returns on the day they buy, long holding period after price reversals
<u>Loos et al. (2020):</u> The Consumption Effects of the Disposition to Sell Winners and Hold Losers	<ul style="list-style-type: none"> ▪ Disposition effect
<u>Welch (2020):</u> Retail Raw: Wisdom of the Robinhood Crowd and the COVID Crisis	<ul style="list-style-type: none"> ▪ Robinhood investors tend to buy assets with recent high price changes and bought during “COVID crash” ▪ “Robinhood-Portfolio” outperformed risk-free rate and overall market between 2018 and 2020
<u>Boehmer et al. (2021):</u> Tracking Retail Investor Activity	<ul style="list-style-type: none"> ▪ Stocks with positive retail market imbalance outperform stock with negative imbalance (by around 10 bps in the first week) ▪ Effect lasts around 12 weeks ▪ Reasons: Price Trends, Liquidity Provision, News, Information in retail crowd
<u>Barber et al. (2021):</u> Attention-Induced Trading and Returns: Evidence from Robinhood Users	<ul style="list-style-type: none"> ▪ Most bought stocks on Robinhood on average return -4.7% over the following 20 days ▪ Reason: Price uptick due to retail buying pressure and price reversal in the following days
<u>Da et al. (2022):</u> Market Returns and a Tale of Two Types of Attention	<ul style="list-style-type: none"> ▪ Retail attention (measured by Google Search Volume) predicts negative returns in following week ▪ Likely due to price upswing because of retail buying pressure and price reversal after
<u>Jones et al. (2022):</u> Understanding Retail Investors: Evidence from China	<ul style="list-style-type: none"> ▪ Smaller retail investors do not predict future returns, negative average annual performance ▪ Bigger retail investors (around 450k\$+) predict future returns on average, annual return close to zero (due to fees)

<p><u>Barber et al. (2023):</u> Resolving a Paradox: Retail Trades Positively Predict Returns but are Not Profitable</p>	<ul style="list-style-type: none"> ▪ While retail investor trades can provide a signal for short-term returns, they don't necessarily benefit from this ▪ Potential reasons: Bad execution, price reversal, disposition effect
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Table 13: Main Findings - Retail Investor Performance and Behavioral Patterns

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Das Forscherteam



Die Technische Universität Darmstadt zählt zu den am stärksten international geprägten Universitäten Deutschlands. Ihre Spitzenforschung bündelt sie in drei Feldern: Energy and Environment, Information and Intelligence, Matter and Materials.

Die Universität zeichnet eine große, problemzentrierte Interdisziplinarität zwischen Geistes-, Ingenieur-, Natur- und Sozialwissenschaften in Forschung und Lehre aus. Sie steht eng mit Stakeholdern aus Gesellschaft, Wirtschaft und Politik in intensivem und produktivem Austausch. Aus dieser kooperativen Vielstimmigkeit erwachsen langfristig wirkende Fortschritte für eine weltweit nachhaltige Entwicklung.



Das Fachgebiet Unternehmensfinanzierung beschäftigt sich in Forschung und Lehre vor allem mit Fragestellungen rund um das börsennotierte, kapitalmarktorientierte Unternehmen, insbesondere auch im Zusammenhang mit der digitalen und nachhaltigen Transformation der Wirtschaft.

Professor Dr. Dirk Schiereck ist Leiter des Fachgebiets Unternehmensfinanzierung an der Technischen Universität Darmstadt. Seine Forschungsschwerpunkte liegen in den Feldern Corporate Finance, Digital Finance und Sustainable Finance. Mit seinen akademischen Erfahrungen wurde er Aufsichtsratsmitglied der BayernInvest und der creditshef AG sowie Mitglied im Wissenschaftlichen Beirat des IQ-KAP – Privates Institut für quantitative Kapitalmarktforschung, des Deutsche Kreditmarkt Standard e.V. und des Deutschen Derivate Verbands (DDV). Die Wirtschaftswoche zählt ihn aktuell zu den 30 forschungsstärksten Betriebswirtschaftlern im deutschsprachigen Raum.

Marius Jonas Maduch hat das Forschungsprojekt zu Payment for Order Flow am Fachgebiet Unternehmensfinanzierung an der Technischen Universität Darmstadt geleitet. Seine Forschungsschwerpunkte liegen in den Feldern International Capital Markets, Regulation und Digital Finance.
