

Robinhood and Financial Technology's Impact on Risk-Taking Behavior and Financial Markets

A Research Paper submitted to the Department of Engineering and Society

Presented to the Faculty of the School of Engineering and Applied Science
University of Virginia • Charlottesville, Virginia

In Partial Fulfillment of the Requirements for the Degree
Bachelor of Science, School of Engineering

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Spring 2024

On my honor as a University Student, I have neither given nor received unauthorized aid on this assignment as defined by the Honor Guidelines for Thesis-Related Assignments

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Technological Citizenship

While at the University of Chicago, Philip J. Frankenfeld (1992) developed *technological citizenship*, a normative sociotechnical framework that seeks to reconcile technological innovation with the autonomy and dignity of laypersons for the purposes of analyzing risk and environmental hazards. Acknowledging that experts and laypeople have differing relationships with technology, technological citizenship seeks to equalize relevant political resources among citizens, enabling laypeople to safeguard themselves from hazards that arise from technology. Frankenfeld argues that regulatory efforts by government agencies and institutions on specific technologies extend the domain of citizenship, granting individuals additional rights and responsibilities with respect to that technology. Importantly, this citizenship includes both laypeople and experts, as though their relationship with it differs, both experience the effects of technology. Furthermore, he posits that this technological citizenship arises whenever political protections from technology are instituted, regardless of geographical or organizational scale.

Recognizing “technology’s unlimited potentials for human benefit and ennoblement with its unlimited potentials for human injury, tyrannization, and degradation” (Frankenfeld, 1992, p. 462), technological citizenship establishes a set of rights and obligations for those impacted by a technology. Frankenfeld organizes these rights into four types: “rights to knowledge or information,” “rights to participation,” “rights to guarantees of informed consent,” and “rights to the limitation on the total amount of endangerment of collectivities and individuals” (Frankenfeld, 1992, p. 465). Further, he partitions the various obligations of technological citizens into “obligations to use knowledge for one’s own self validation of safety and peace of mind,” “obligations to participate and to accept the will of the majority unless one is a strong

natural rights individualist,” and “obligations to exercise technological civic literacy and technological civic virtue” (Frankenfeld, 1992, p. 473).

With these rights and responsibilities, technological citizenship expands on the traditional Enlightenment concepts of the social contract and citizenship by applying them to technology. As Rousseau identified “the need for both freedom and chains” in his concept of the social contract, technological citizenship attempts to balance technological innovation with the potential risks and hazards that may occur as a result (Frankenfeld, 1992, p. 463). Where the traditional social contract emphasizes the relationship between a government and its citizens, technological citizenship emphasizes the relationship between a technology and the laypeople it impacts. This research applies the technological citizenship framework to the effects of financial technology, analyzing how it simultaneously infringes on and enhances a technological citizen’s rights and obligations.

While technological citizenship as a framework typically focuses on traditional technological environmental hazards like chemical exposures, I aim to apply it to possible hazards resulting from financial technology. Modern society makes interactions with financial markets almost unavoidable: a 2023 Gallup survey found that sixty-one percent of Americans had money invested in the stock market (Gallup, 2023). Accordingly, individuals inhabit a “financial environment” like the physical environment that impacts them both through their own financial dealings and through larger overall shifts. As financial technology increases in prominence, it will impact the financial environment in an analogous manner to nuclear energy proliferation affecting the physical environment. Thus, in this context, technological citizenship establishes rights and responsibilities for both laypeople and experts affected by the financial environmental hazards of financial technology.

FinTech

Broadly defined as “the application of technology for the provision of financial services,” financial technology, commonly referred to as FinTech, has and will continue to reshape social and financial systems (Anyfantaki, 2016). As an overarching term, FinTech is generally considered to contain a diversity of technologies and financial applications, including but not limited to blockchain, online payments systems, digital lending services, and electronic brokerages (S&P Global, 2016). Though they implement differing technologies and offer different financial services, these FinTech efforts collectively represent a shift away from centralization, regulation, and bureaucracy in the financial system. With their growing usage, FinTech companies have elevated influence over the financial behavior of individuals, which in turn could influence the behavior of financial markets.

In recent years the FinTech sector has experienced rapid growth and is expected to play an increasingly important role in both the United States and the global financial system. The consulting firm McKinsey & Company reports that publicly traded FinTech companies had a market capitalization of \$550 billion in July 2023, which represents double their value in 2019. Furthermore, McKinsey projects the revenues of FinTech companies to grow three times faster than the revenues of banks between 2023 and 2028 (McKinsey, 2023). In contrast, despite their long-established position as the bulwarks of the financial system, traditional banks have seen diminishing profit margins and a pessimistic growth outlook, likely due to the threats posed by increasing regulation and competition (McKinsey, 2022). With this continued growth, FinTech will play an ever-larger role in the functioning of the financial system.

The 2008 global financial crisis greatly injured public trust in the United States financial system. As a result of apparent disregard for ethics, transparency, and responsibility by banks

and regulators, many among the American public became disillusioned with the existing financial system (Green, 2012). Though trust factors into most transactions, it is particularly important in financial transactions, where many of the products exchanged are essentially promises of future payment. Thus, as individuals lost trust in institutions, decentralized and individualized FinTech alternatives arose to take their place (van der Crujisen et al., 2023). When it became public in 2009, Bitcoin, currently the most prominent cryptocurrency, exemplified this motivation explicitly by including in its raw data a single message: an excerpt from the London newspaper *The Times* which reads “The Times 03/Jan/2009 Chancellor on brink of second bailout for banks.” (Tardi, 2023). Often citing similar reasoning, numerous FinTech companies claim to “democratize” finance by cutting bureaucracy and tailoring their products to individuals, yet they often engage in business practices that harm their users by obfuscating their level of risk. FinTech company Robinhood embodies many of these motivations and has emerged as a leader in the sector, so my analysis will focus primarily on it.

Robinhood

A commission-free stock trading and investing app, Robinhood has established a prominent position in the FinTech sector with a market capitalization of almost \$10 billion as of February 2024. Many first heard of Robinhood in early 2021 due to a media frenzy surrounding the stock of GameStop, which was primarily fueled by retail investors using Robinhood to invest in the company. As a result of this widespread attention, Robinhood acquired many new users, many of whom were inexperienced with investing, trading, and financial markets. Since then, Robinhood has continued as a primary brokerage option for retail investors.

On its website Robinhood states that it is “on a mission to democratize finance for all” and that it believes “the financial system should be built to work for everyone” (Robinhood,

n.d.). However, Robinhood's design includes many elements that encourage users to invest in risky assets like stocks, derivatives, and cryptocurrencies with dubious levels of warning as to the potential for financial loss. To entice new users to the platform, Robinhood requires no minimum deposit to open an account and provides a free stock for signing up to the platform, which encourages inexperienced consumers to invest, perhaps while unaware of the associated risks (Mao, 2021). Moreover, a portion of Robinhood's revenue comes from a practice known as *payment for order flow* whereby the brokerage receives compensation for routing client orders to specific market-makers and broker-dealers that issue financial instruments. As such, Robinhood is rewarded per order routed, which may incentivize it to encourage its consumers to trade more than is in their best interests (Bryzgalova, Pavlova, & Sikorskaya, 2022)

Robinhood also advertises its stock option and cryptocurrency trading services, which can prove especially volatile. Typically used by institutional investors to hedge other investments, derivatives like stock options are contracts which have worth based on the value of some other underlying financial asset. These contracts can be purchased cheaply and, depending on the movements of the underlying asset, their value can skyrocket relative to their cost, which makes them appealing to individual retail investors who are often priced out of other investments. However, research has shown that options contracts offer poor returns to individual investors (Bauer, Cosemans, & Eichholtz, 2009). Additionally, Robinhood offers margin trading, allowing users to borrow from the brokerage to invest more than they deposit using their investments as collateral. Should a user trade on margin and the value of their assets decrease significantly, they could be liable for a margin call which requires them to post additional collateral they might not have. In one tragic incident, a Robinhood user committed suicide after

mistakenly believing they had lost hundreds of thousands of dollars trading options on margin while being unaware of the risk they were assuming (Tan, 2021).

Robinhood and Technological Citizenship

Through the lens of technological citizenship, Robinhood both supports and infringes the rights of technological citizens. In accordance with its mission, Robinhood grants users the freedom to engage in a range of financial transactions, leveling the playing field between institutional and retail investors by making traditionally esoteric financial products widely available. This objective aligns strongly with the ideals of technological citizenship by granting financial laypeople the same privileges as experts. Research by Fjesme (2020) found that retail investors tend to receive better returns as they grow in experience, indicating that Robinhood's offerings further the right to access to knowledge afforded by technological citizenship. Additionally, Fisch (2022) argues that engaging with financial markets incentivizes citizens to engage with civic issues like corporate accountability and regulation, implying that Robinhood's activities encourage its users to fulfill the duties of a technological citizen. Nevertheless, as previously discussed, Robinhood engages in business practices that seem to promote hazards to laypeople and infringe upon a technological citizen's rights to informed consent and reasonable levels of risk exposure.

While as a brokerage Robinhood impacts the ways its users interact with their financial environment, it also contributes to shifts in the overall financial environment itself. Because market behavior represents the aggregate of its participants' behaviors, financial markets will reflect the effects of Robinhood and other financial technology. Should FinTech introduce a significant number of inexperienced, misinformed, or adversely incentivized retail investors to financial markets, asset prices in those markets would diverge from those previously set by

knowledgeable and sophisticated institutional investors, thereby increasing short-term market volatility. According to economic theory, efficient markets price financial assets according to their intrinsic value, defined as the current value of all future cash flows derived from the asset. Deviations from this price interfere with the market's efficiency by preventing demand from meeting supply, hindering the utility-maximizing, or societally optimal, asset allocation (Krause, 2001). Therefore, FinTech's hazards are not limited to the individual experiences of its users. Rather, they ripple through the financial system and society. As such, this research seeks to analyze how the proliferation of FinTech has affected financial markets and financial environmental hazards by influencing the freedom and risk-taking behavior of individual investors.

Methods

To explore this question, I performed several regression analyses of operating performance data reported by Robinhood on the Chicago Board Options Exchange's Volatility index, known as the *VIX*. With this analysis, I aimed to determine the effect of FinTech-influenced retail investors on expectations of stock market volatility. Since 2022, as part of its communications to investors, Robinhood has released its number of active users as well as the value of assets held in Robinhood accounts. Specifically, Robinhood reports monthly values of its "funded customers," which it defines as a unique person who had a positive account balance or completed a transaction on Robinhood within the preceding 45 days, and its *assets under custody* (AUC) defined as "the sum of the fair value of equities, options, cryptocurrency, and cash held by users in their accounts, net of receivables from users" (Robinhood, 2024). These values were used to measure the quantity of FinTech-influenced investors participating in the stock market. The *VIX* is an index created by the Chicago Board Options Exchange to represent

the stock market's expectations of the size of near-term price changes, commonly referred to as risk or volatility. Consequently, the VIX gauges aggregate market sentiment for volatility in the next 30 days and measures the fear or flightiness of investors (Kuepper, 2023). The United States stock market is among the most liquid and efficient markets in the world, thus changes in the assets being traded or aggregate investor behavior are quickly reflected (Kolchin, Podziemska, & Song, 2023). Therefore, it follows that FinTech's influence on financial markets should be reflected materially in the stock market.

Results

A single-variable ordinary least squares linear regression of the number of active Robinhood users on the VIX index estimated a negative coefficient on the term for number of active users. Specifically, the coefficient was estimated as -20.064 with a standard error of 2.4303, which implies a ninety-five percent confidence bound on the coefficient of -25.0802 to -15.0485. To assess the statistical significance of this model, I performed a t-test against the null hypothesis that the coefficient is zero, which returned a t-statistic of -8.256, indicating a p-value of less than 0.000000018. Moreover, the regression resulted in an R-squared value of 0.74 and an adjusted R-squared of 0.729. Thus, this linear regression analysis estimated a statistically significant linear relationship between a month's number of active Robinhood users, referred to with the variable x , and the month's average value for the VIX upon the close of a trading day, represented by the variable y . The regression model predicts y given x by the equation $y = -20.064 * x + 483.51$. Figure 1 below provides a graphical representation of this relationship along with a scatterplot of the data itself and the computed ninety-five percent confidence bounds.

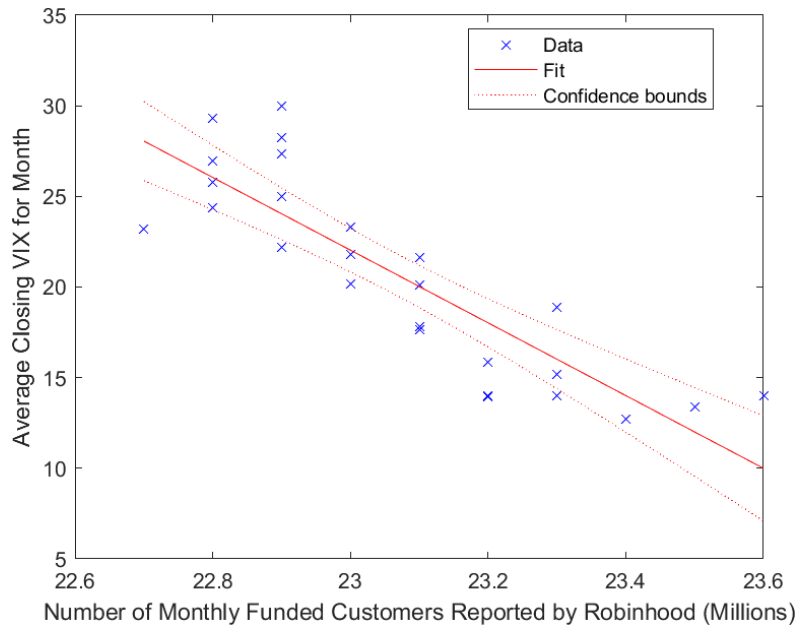


Figure 1. Linear Regression of Robinhood Users on Stock Market Volatility

An alternative single-variable ordinary least squares linear regression of Robinhood’s monthly assets under custody on the VIX index also estimated a negative coefficient on the explanatory variable. For this model, the ordinary least squares coefficient was estimated to be -0.28065 with a standard error of 0.060701. Accordingly, I computed a ninety-five percent confidence interval for this value of between -0.4059 and -0.1554. As with the first regression, I performed a t-test against the null hypothesis that the coefficient is zero, which resulted in a t-statistic of -4.6235 and a p-value of 0.00010818. Now with x representing Robinhood’s monthly assets under custody, the regression predicted a month’s average closing VIX index value by the equation $y = -0.28065 * x + 43.802$. This fit had an R-squared value of 0.471 and an adjusted R-squared measure of 0.449. A graphical depiction of this model with associated ninety-five percent confidence bounds is given in Figure 2.

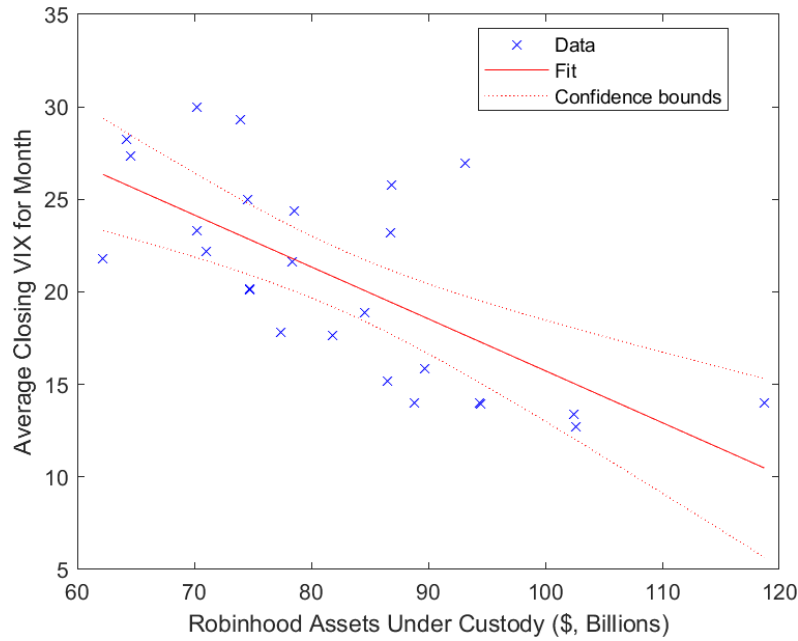


Figure 2. Linear Regression of Monthly Robinhood AUC on Stock Market Volatility

Discussion

An estimated negative coefficient on the term for monthly active Robinhood users indicates a decreasing linear relationship between the number of active Robinhood users and the closing values for the VIX. Accordingly, the first regression results imply that increased Robinhood usage correlates with decreased levels of stock market volatility. Moreover, the second regression supports this result, as an estimated negative coefficient on Robinhood’s assets under custody, another indicator of the brokerage’s prominence, implies the same decreasing linear relationship between Robinhood’s assets under custody and the closing VIX values. Taken together these regressions imply an inverse relationship between FinTech’s prominence and expectations of near-term stock market volatility. As such, my regression analysis contradicted my initial hypothesis that increased FinTech investment activity and usage would increase market volatility. Rather, these results imply that increased participation by FinTech-influenced retail investors leads to reduced expectations of near-term price changes in the stock market.

These findings differ from previous studies which show a negative aggregate effect on market quality from the increased popularity of zero-commission brokerages (Eaton et al., 2021).

From an economic perspective, several behavioral factors and market mechanisms could drive this relationship. First, FinTech influenced retail investors may be more momentum driven than other market participants. Due to inexperience, a new retail investor could miss new information driving an ongoing price trend and trade expecting an asset to revert to its previous average price. Such a phenomenon occurring on a large scale would reduce the size of short-term price changes, as seen in the regression results. Alternatively, perhaps aware of their relative unsophistication and inexperience, FinTech influenced investors may often follow the trades and investment decisions of established institutional investors. In doing so, these new investors would simply reinforce existing price trends, thereby reducing volatility. Moreover, due to their shared influences and motivations as evidenced by their common decision to engage with FinTech, new users are likely to prefer similar investment strategies to each other, which would magnify this effect. Regardless of the mechanism for this relationship, in the context of technological citizenship, this result provides evidence that Robinhood, and by extension FinTech as whole, do not contribute significant hazards to the financial environment of technological citizens.

This finding has significant implications on the suggested actions of technological citizens with regards to FinTech dictated by the technological citizenship framework. Having identified minimal risk to doing so, technological citizens should familiarize themselves with FinTech to fulfill the obligation to engage with technology and demonstrate technological literacy. On a governmental basis, the lack of evidence for financial hazard on a market scale suggests that additional regulation is unnecessary to ensure technological citizens' right to

protection from excessive risk. Rather, the results indicate that FinTech's benefits like providing individuals access to financial products, investment knowledge, and reasons to engage with financial policy, outweigh its risks on aggregate. As such, restrictions on FinTech would seemingly have the overall effect of infringing on technological citizens' rights rather than reinforcing them. Therefore, these results suggest that the government should incentivize market participation via financial technology, though action should await further verification.

Several limitations to the regression analysis and data availability factors could have skewed this model. Due to inconsistency in Robinhood's reporting of operating data prior to its initial public offering in 2021, I restricted the data used in this analysis to include only values beginning in 2022. As such, the analysis covers only the limited period from January 2022 to February 2024, which notably excludes the GameStop trading frenzy in 2021. Consequently, the linear regressions utilized only twenty-six observations. Accordingly, despite the statistical significance of the regression coefficients, the limited data points available hamper the usability of the results. Furthermore, in its investor press releases, Robinhood reports its number of funded customers and assets under custody rounded to the nearest tenth, which limits the model's sensitivity to smaller changes in those values. This factor could prove especially influential in the assets under custody regression analysis, where a tenth constitutes one hundred-million dollars and could sizably contribute to the relationship.

Although evidence for excessive risk-taking due to FinTech does not appear on a market-wide basis, it may arise as the scope of analysis narrows. The relative size of retail investors and FinTech remains small compared to institutional investors and traditional financial institutions. The VIX tracks the volatility expectations for the entire stock market, thus trends due to FinTech-influenced retail investors could be drowned out by the much larger movements driven

by institutions. Therefore, the relationship with overall market volatility shown by the regression model may be skewed by larger market movements independent of FinTech and retail activity. Additionally, this study's use of Robinhood as representative of FinTech services as a whole may cause the results to exclude sector trends which involve Robinhood to a lesser extent and to magnify features unique to Robinhood. The focus on the stock market may have also obfuscated the hazards presented by FinTech in alternative markets like commodities and derivatives. Moreover, this research's focus on the investing aspects of FinTech ignore much of the sector including decentralized currencies and electronic money transfers.

While aggregate trends provide valuable insight on the relationship between individuals and technology, a complete analysis of hazards to the financial environment to users from FinTech requires more detailed study. To identify the specific market impacts of FinTech influenced investors, further research could perform a similar analysis to this research while isolating the specific assets that were most heavily traded by Robinhood users. Alternatively, a holistic understanding of the financial hazards requires examining the individual experiences of users. A case study or large-scale survey of FinTech users would provide much additional color to the broad analysis here. Finally, Overall, further research should focus on isolating the impacts on and of FinTech users over a longer period and detailing the specific experiences of those users.

Conclusion

This research provides an initial overview of FinTech's impact on the financial risk-taking behavior of individuals. Using the assumption that markets reflect changes in the financial behavior of individuals, I performed a linear regression analysis of Robinhood's prominence on stock market volatility to assess their relationship. Contrary to my prior hypothesis, the analysis

returned negative coefficients on both measures of Robinhood's prominence with statistical tests indicating strong significance. These findings imply that the proliferation of FinTech has not increased excessive risk-taking in the stock market in a manner that would increase overall volatility. Rather, greater numbers of FinTech-affiliated investors were associated with reduced overall volatility expectations. I speculate that this relationship could be driven by potential behavioral properties specific to retail investors such as a propensity to follow momentum.

The efficiency and fairness of financial systems is determined by the interactions between institutions, individuals, and regulators. As new technology in the form of FinTech continues to reshape these interactions, technological citizenship provides a useful lens for assessing and regulating the environmental hazards that result. Despite concerns about their incentive systems, this research indicates that FinTech contributes positively to technological citizens by distributing financial resources and opportunities more evenly between experts and laypeople. As such, future policies and regulations that target specific aspects of FinTech should avoid hindering its long-term growth and ability to provide access to complex financial products.

Though my results depict FinTech as societally beneficial, technological citizenship focuses on the experiences of individuals. Accordingly, further research should be performed to assess particular properties and practices of FinTech, like *payment for order-flow*, that could infringe upon a technological citizen's rights. Subsequent analysis should consider the features and behaviors of FinTech more granularly to identify interactions that may not appear on an abstracted scale. For instance, a study of the experiences of FinTech users on a case-by-case basis would provide additional insight into the incentives they experience while using the technologies. Furthermore, examination of markets traditionally riskier and more esoteric than the stock market, like the derivatives market, could identify means by which FinTech exposes its

users to excessive risk. More precise studies of FinTech can identify opportunities for regulation to refine and curtail the technologies to ensure the rights of technological citizens.

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