Doing Less with More*

Rawley Z. Heimer†
Boston College

Alex Imas‡
Carnegie Mellon University

Abstract

According to standard theories of decision-making, access to leverage should make investors better off. The ability to borrow expands investors' choice sets, allowing them to take advantage of trading opportunities without having to liquidate current holdings. This paper argues that leverage can interact with existing behavioral biases – specifically, the reluctance to realize losses – to impair decision-making and hurt performance. Two data sources provide support for this claim. First, we exploit regulation that restricts the amount of leverage available to U.S. retail traders of foreign exchange. Traders constrained by the regulation are more willing to realize losses, exhibiting a smaller disposition effect, and improve their market timing. We replicate these findings in an experimental asset market. Access to leverage leads to significantly lower earnings. This decrease in performance is driven by levered participants holding on to losses for longer, deviating further from an optimal trading strategy than those without access to leverage. Together, our findings imply more choice may not always be better than less and suggest scope for policy to improve financial decision-making.

Keywords: **Loss Chasing, Disposition Effect, Prospect Theory, Behavioral Finance**

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†Boston College, Carroll School of Management. Phone: +1 (216) 774-2623, Email: heimer@bc.edu

‡Carnegie Mellon University, Department of Social and Decision Sciences. Email: aimas@andrew.cmu.edu

1 Introduction

Standard theories of economic decision-making predict that individuals should be at least as well off, if not better, when their choices are less constrained. However, recent studies provide compelling evidence that expanding the available set of choices can lead to inferior outcomes. For example, Sydnor (2010) and Bhargava et al. (2017) find that many individuals choose financially dominated insurance plans and would be better off with fewer options. Such suboptimal decisions are often attributed to bounded rationality (Simon, 1955), where the greater complexity of having to choose from a larger set of options leads to errors and potentially inferior outcomes. Importantly, however, these errors are often assumed to be random – caused by limitations in people's attention and computational abilities (Sims, 2005).

This paper offers a new behavioral perspective on how restricting choice can potentially lead to better outcomes: constraints may prompt individuals to make psychologically painful decisions earlier rather than later. We provide evidence for this claim by examining the effects of borrowing constraints on investment decisions. Personal investing is the ideal venue to test how constraints interact with painful decisions because of the real, salient stakes involved and the well-documented tendency to delay realizing losses relative to gains (Shefrin and Statman, 1985; Weber and Camerer, 1998; Odean, 1998). The phenomenon known as the "disposition effect" – corresponding to the relative avoidance of selling losing assets while letting winners go – has been documented across a wide range of markets and populations (see Kaustia (2010) for review). There is also evidence that the disposition effect is suboptimal, leading to lower earnings (Shumway and Wu, 2005). One of the most parsimonious explanations for the disposition effect stems from people's reluctance to make a psychologically painful decision. Barberis and Xiong (2012) argue that investors derive negative (positive) realization utility from selling an asset at a loss (gain).[1] Within their framework, the disposition effect is generated in part by positive discounting, with

[1] Frydman et al. (2014) provides neural support for realization utility: realized outcomes produce greater activation in brain regions associated with utility shocks than paper outcomes.

investors systematically putting off the painful realization of a loss in favor of realizing a gain. Moreover, depending on the extent to which investors discount the future, they may defer realizing losses until prompted by some exogenous event (e.g., a liquidity shock).

In this paper, we demonstrate that borrowing restrictions in the form of leverage constraints can actually improve outcomes by spurring people to realize losses sooner rather than later. The intuition is as follows. Suppose an investor considers an attractive prospective purchase while her portfolio contains a considerable stake in a depreciated asset. Absent the ability to borrow in the form of leverage, she would be unable to make the prospective purchase unless she sells the depreciated asset and bears the costs of realizing a loss. If the expected returns of the prospect are higher than the expected returns of the depreciated asset plus the psychological costs of selling it, she sells the suboptimal asset and makes the purchase. On the other hand, when given greater access to leverage, the investor can make the purchase without having to realize a loss; she can put off the realization costs by borrowing to fund her new purchase. Access to leverage is not predicted to have a similar effect on the gains side: the investor is already motivated to sell winners, and expanding her ability to borrow will not increase this motivation. In turn, restricting leverage is predicted to have an asymmetric effect of increasing the tendency to realize losses relative to gains, generating a smaller disposition effect.

We exploit multiple data sources to provide evidence for this prediction. First, we examine the trading of retail investors in the market for foreign exchange (forex) before and after regulation that restrict their access to leverage. Second, we explore the effect of leverage on investment behavior in an incentivized laboratory experiment. The two studies are complimentary: results from the forex market offer insight from a more naturalistic environment, while the findings from the experiment replicate the same behavioral patterns in a more controlled setting. The consistency in the observed effects of leverage on investment decisions and performance increases confidence in the generalizability of the behavioral results.

To identify how leverage affects trading behavior in a natural setting, we exploit a 2010 CFTC regulation that restricts brokerages' provision of leverage to traders in the retail market for foreign exchange at a cap of 50:1 per-trade. Prior to the regulation, most brokerages set leverage limits well above the 50:1 constraint. Crucial for identification, most brokerages have both U.S. and European clients trading the same assets. These European traders have similar characteristics (e.g., demographics, trading strategies) as their U.S. counterparts but are not subject to the regulation. Moreover, the trading performance of European and U.S. traders co-moves prior to the regulation, making the former a suitable control group to study the effect of leverage on trading.

Using a data set that includes around 270,000 trades made by 1,000 traders within the three months that surround this legislation, we document a robust negative correlation between the amount of leverage used and traders' market timing per-trade. We provide evidence of a causal relationship by estimating difference-in-difference regressions that compare U.S. traders subject to restrictions on leverage to unregulated European traders. The leverage constraint improves U.S. traders' performance by 1.9 basis points per-trade, a substantial increase that is equal to half of a standard deviation increase. Consistent with the results being caused by the leverage constraint, the effect is strongest when the constraint is binding – amongst traders who used at least 50:1 leverage prior to the regulation – and there are no preexisting trends prior to the regulation.

We attribute traders' improved performance to reductions in their disposition effect. The reduction in available leverage directly reduces traders' disposition effect by about 13 percent. Consistent with our prediction, this decrease is driven primarily by a greater willingness to realize losses earlier; the regulation had no effect on the propensity to realize gains. Moreover, the gains in performance are largest for traders with greater levels of the disposition effect prior to the regulation. We examine heterogeneity in traders' responses to the leverage restriction as a function of their disposition effect before the restriction took effect. We find that traders who were most reluctant to realize losses relative to gains before the regulation benefited most from it — those with the highest disposition effect experienced the largest improvements in trading performance after the regulation was imposed. Importantly, the decrease in the disposition effect is confined to traders' market orders and not their limit orders. Investors manually issue market orders to immediately execute. In contrast, they set limit orders to execute automatically at a predetermined price; limit orders act as a sort of commitment device to trade at a pre-specified gain or loss. Based on the results of Imas (2016) and Fischbacher et al. (2017), the differential effect of the regulation depending on the type of order provides further evidence that procrastination in making painful decisions drives the disposition effect, and that constraining the ability to borrow partially ameliorates this tendency.

To complement the findings from the forex market, we conduct a laboratory experiment where individuals make a series of investment decisions over thirty periods, either with access to leverage or not. Participants are endowed with 2000 units of experimental currency and allocate these funds between six different risky assets. Participants are told that each asset has a probability of either going up or down in price that remains constant throughout the experiment. Some assets have a higher probability of going up in price than others but the exact probabilities are not revealed to the participants. In each period, the participant observes the new price of each asset and decides which to buy and which to sell. She can take as long as she wants to rebalance her portfolio subject to her budget constraint before continuing to the next period and making the same decision again. In the "No Leverage" treatment, each participant's buying decisions are constrained by her portfolio's value and any outstanding balance in her account. The "Leverage" treatment offers participants the opportunity to borrow 500 more units of currency to either purchase more assets or leave deposited in their account. The borrowed amount is subtracted from their final earnings at the end of the experiment, which are then converted to US dollars.

Results from the experiment replicate our findings from the forex market. Participants with access to leverage earn lower returns in the experiment than those without it. Those with leverage earn nearly 150 fewer units of currency relative to a simple benchmark of a $1/N$ investment strategy, and end up with 200 fewer units of currency as their final wealth.[2] Access to leverage increased participants' disposition effect, which had a direct negative impact on earnings. The mechanism through which access to leverage affected the disposition effect was also the same as in the forex market: for those who used leverage, the ability to borrow decreased the propensity to realize losses without changing the propensity to realize gains. Together, our findings suggest that access to leverage can exacerbate the propensity to put off making painful decisions such as the realization of losses, and lead to worse investment outcomes.

This paper contributes to a growing literature at the intersection of behavioral economics and finance. This literature identifies a host of cognitive shortcomings that cause investment biases and reduce individuals' welfare. These biases include overconfidence (Barber and Odean, 2001), loss aversion (Barberis and Huang, 2001), present-biased preferences (Laibson, 1997), mis-calibrated expectations (Bordalo et al., 2013), and social contagion (see the review in Hirshleifer, 2015). Research has also considered the limits to attention and how individuals make decisions when facing large choice sets (e.g., Huberman and Jiang, 2006; Iyengar and Kamenica, 2010; Goldreich and Hałaburda, 2013). Theories in this space suggest that constraints on cognitive capacity lead consumers to develop heuristic models of decision-making but are otherwise fully rational (e.g., Gabaix, 2014). This may lead them to select simpler, less complicated options (Iyengar and Kamenica, 2010), make dominated choices (Bhargava et al., 2017), and sometimes prefer to avoid making a choice altogether (Iyengar and Lepper, 2000). Our contribution differs from these findings in that we consider how expanding an individual's choice set can actually exacerbate existing behavioral biases such as the reluctance to realize losses.

Our paper has a more specific application to the role of financial leverage in individual decision-making. Research in this area is important, because of the well-established connection between consumer leverage and aggregate outcomes, with the substantial rise in housing prices

[2] A $1/N$ investment strategy splits the endowment evenly between assets and and holds this portfolio for the duration of the experiment.

during the mid-2000s being a notable example (Geanakoplos, 2010). The literature tends to assign a specific role for leverage: it facilitates risk-taking by the most optimistic individuals. And there is both theoretical (e.g., Scheinkman and Xiong, 2003; Simsek, 2013) and empirical support for this channel (e.g., Ben-David, 2011; Koudijs and Voth, 2016; Bailey et al., 2018). We contribute to this literature by showing that financial leverage leads individuals to delay making painful decisions, resulting in worse investment outcomes than if they were prompted to liquidate depreciated holdings.

Other research considers the effect of leverage or margin constraints on market characteristics, such as liquidity or asset prices (e.g., Kahraman and Tookes, 2017; Jylhä, 2018; Boguth and Simutin, 2018). Some specifically focus on the levered trading by retail investors (Bian et al., 2018a,b). Most closely related to our paper, Heimer and Simsek (2018) use the CFTC's 2010 leverage regulations to study the effects on trading volume, the performance of the brokerage sector, and the prices that brokerages charge to traders in the form of bid-ask spreads. They find that the leverage regulation reduced trading volume by approximately 25 percent over the subsequent six months, which reduced brokerages' profits by a similar amount. However, Heimer and Simsek (2018) find no evidence that brokerages changed their bid-ask spreads as a result of the regulation. This result is useful to our analysis, because it enhances our confidence that our findings are not due to differences in prices before and after the leverage regulation was imposed.

Finally, the findings contribute to our understanding of the disposition effect by providing evidence that dynamics in mental accounting can play a crucial role in explaining this heavily-studied bias. The differential effect of the leverage constraint on market and limit orders suggests that some individuals take on risk but have trouble sticking to their dynamic plans – a hallmark of dynamic inconsistency; they escalate commitments to their trading mistakes, which exacerbates the disposition effect. Consistent with the theoretical predictions outlined in Barberis (2012), Imas (2016) provides experimental evidence that a dynamic inconsistency in people's propensity to realize losses generates the disposition effect. Individuals plan to realize losses earlier than gains *ex ante*, but deviate from this plan and postpone realizing losses *ex post*.[3] Ploner (2017) obtains similar results. In line with these findings, Fischbacher et al. (2017) show that individuals display a reverse disposition effect in their limit orders (which are placed *ex ante*), but deviate from non-binding limit orders *ex post*. Recent work argues that investors use distinct mental accounts to construct "episodes" that are used to evaluate outcomes. Frydman et al. (2017) find that there is no disposition effect when traders reinvest their holdings in new positions. The authors conjecture that reinvesting losses into a similar position allows traders to "roll over" the associated mental account, avoiding closing it at a loss and deriving negative realization utility. The opportunity to reinvest in a similar position acts analogously to leverage in our setting, giving traders the opportunity to procrastinate in making painful decisions.

This paper is organized as follows. Section 2 describes the retail foreign exchange market and the CFTC regulation, and tests the relation between leverage and trading behavior. Section 3 outlines the experimental paradigm and demonstrates the effect of increased leverage on investment performance. Section 4 provides a discussion of the results and concludes.

2 Evidence from Restricting Retail Traders' Leverage

2.1 The Retail Forex Market and the CFTC Regulations

The retail forex market has experienced substantial growth for more than a decade. The size of the market was almost negligible in the early 2000s; by 2010, the forex market saw volume between 125 and 150 billion USD per day, which is roughly equivalent to the daily turnover on the entire NYSE family of stock exchanges (King and Rime, 2010).

[3] Several papers have offered explanations for *why* people are reluctant to realize losses relative to gains. For example, Chang et al. (2016) propose cognitive dissonance as a parsimonious mechanism. For the purposes of this paper, we are agnostic as to the specific mechanism as long as realized losses are perceived to be more painful than paper losses or realized gains.

The role of retail forex brokerages is to act as a market-making system for retail clients. Clients use a domestic bank account to make deposits into their brokerage account. Brokerages do not provide currency exchange services, as customers cannot withdraw funds in a foreign currency. The brokerages have proprietary algorithms that are used to generate bid and ask quotes for their customers. These algorithms are based on each brokerage's inventory and a data-feed from the interbank market. Quotes are offered to all clients in terms of the currency pair (e.g., EUR/USD) using the nomenclature designated by standard ISO 4217 from the International Standards Organization. The pair is expressed in terms of a "base" and "quote" currency. For example, in the EUR/USD pair, EUR is the base and USD is the quote. Traders decide how much of the pair to buy or to short in terms of the base currency.

Similar to other market-making systems, brokerages off-load assets into the interbank market and acts as counterparties on all transactions. Brokerages generate revenue by charging a spread over interbank prices when offering bid and ask quotes to their clients, and brokerages do not charge additional fees per transaction. In turn, trading costs are a function of the transaction size and the bid-ask spread charged by the brokers (relative to the spreads in interbank markets). Retail brokerages offer the opportunity to use leverage at no additional costs. A client (U.S. or European) can, for example, take a 500,000 position in the EUR/USD using 50,000 of her own funds in domestic currency (USD or Euro). This client would then own a position that is levered 10:1.

The Commodity Futures Trading Commission (CFTC) is largely responsible for overseeing the U.S. retail forex market. The market was subject to few regulations in the 2000s. Unlike mature markets where leverage is tightly regulated (for example, at most 2:1 leverage is permitted on long positions of U.S. stocks), brokerages did not face external restrictions on the amount of leverage they could offer. Brokerages determined their own capital requirements and positions with over 100:1 leverage were regularly observed. Oversight of this market changed significantly when the Financial Crisis spurred concerns over the welfare of consumers participating in financial markets. The Dodd Frank Wall Street Reform and Consumer Protection Act, passed on July 21, 2010, included reforms targeting a wide array of financial industries. As part of the act, the CFTC's authority over the U.S. retail forex market was increased. In anticipation of Dodd-Frank's passage, the agency released a proposal on January 20, 2010 to restrict leverage at 10:1 per trade on all currency pairs available to retail customers.[4]

The CFTC provided a rationale for the 10:1 leverage restriction it proposed. Specifically, the CFTC expressed concern that the amount of leverage available to retail forex traders exposed them to more downside risk than the agency was comfortable with. They were particularly worried about trader sophistication, noting that forex traders may be subject to counterparty risk which they might not be aware of. The proposed leverage restriction was an attempt to mitigate the traders' direct and indirect (counterparty) risks.[5] Given these concerns, the leverage restriction can be interpreted as a paternalistic policy intended to protect traders from losses.

After the proposal was released, the CFTC received several comments from traders who mostly objected to the policy.[6] The final policy document was released in September 10, 2010 and outlined the set of rules for all retail brokerages that had U.S. accounts. The CFTC summarized in the document the comments it received and explained how, after careful consideration, the agency restricted the leverage of U.S. clients to 50:1 on all major currency pairs and 20:1 on all others (Table A.1 provides a complete list of currency pairs).[7] All brokerages were required to comply with the regulations by October 18, 2010. Some began complying with the new leverage cap prior to the deadline. One high volume brokerage failed to comply with the regulation for several months after the date; it ended up paying a heavy fine for this noncompliance. Meanwhile, such regulations

[4] www.cftc.gov/LawRegulation/FederalRegister/ProposedRules/2010-456a

[5] Specifically, on page 3291 the document states: "The Commission's proposed regulation regarding security deposits is intended both to mitigate the risk to which customers are exposed and to provide some capital to cover customer funds held by a failing firm."

[6] The comments to the proposal can be found at the following link on the CFTC's website: https://comments.cftc.gov/PublicComments/CommentList.aspx?id=748

[7] The final document can be found here: http://www.cftc.gov/LawRegulation/FederalRegister/FinalRules/2010-21729. It states: "The Commission's proposed leverage restriction was conservative and was proposed in an effort to provide maximum customer protection . . . Nevertheless, after considering the concerns expressed and arguments made in the comments, the Commission has determined to adopt a revised security deposit requirement . . . "

were not under consideration in Europe. Domestic regulators continued to allow brokerages full discretion in the amount of leverage available to European clients. As a result, the maximum available leverage almost always exceeded 50:1 for traders with E.U. bank accounts.

Our identification strategy relies on several unique features of the retail forex market. Forex brokerages often serve a global clientele. European and U.S. traders can be clients of the *same* brokerage but there is no overarching regulatory body overseeing these institutions; regulations are country-specific and target only those with domestic bank accounts. Brokerages are responsible for complying with these regulations – for example, by making sure that U.S. traders cannot open positions with leverage exceeding 50:1 – under threat of heavy fines and further legal actions. In order to open an account, a client is required to verify their country of origin by providing government-issued identification such as a passport and a link to a domestic bank account. This structure is advantageous for research studying the effects of regulation because it is possible to compare restricted U.S. clients to their less restricted E.U. counterparts within the *same* brokerages. This controls for brokerage-specific institutional factors. Additionally, it is difficult and costly to switch between groups because doing so would require the retail client to obtain new foreign identification (e.g., a passport).

A related paper, Heimer and Simsek (2018), studies the effects of the CFTC regulations on the retail forex market. They find that the constraint has no effect on the market's liquidity or the bid-ask spreads charged by retail brokerages. Hence, their findings suggest that the CFTC leverage constraint is well-suited to identify the effect of leverage on trading behavior, because concurrent changes in the forex market are unlikely to confound estimates of the leverage constraints' effect on trading performance and trading biases. While Heimer and Simsek (2018) study the regulation's effect on the supply-side of the market and on equilibrium market outcomes (bid-ask spreads), they do not study the leverage constraint's effect on the demand-side. Thus, we depart from Heimer and Simsek (2018) by investigating how the reduction in available leverage affects trading behavior.

2.2 Trading Data

Our analysis uses a data set containing the trade and portfolio level transactions of retail forex trades compiled by a social networking platform. For privacy purposes, we refer to this platform as myForexBook. Registration with the platform is free. In order to register, the trader must be an active client at a retail-specific forex brokerage; at the time of regulation, approximately 45 brokerages (out of 70 total) had directly partnered with myForexBook. Registration allowed the platform complete access to the trader's transactions at the brokerage, which still executed all trades. Additionally, each transaction was automatically recorded and timestamped by myForexBook so that reporting bias is not a concern.

That the data comes from a large sample of brokerages is a clear advantage for our analysis, because brokerages may have different responses to the regulations and the traders that choose a given brokerage may be unrepresentative of the population of retail traders. Yet, a possible drawback of our data is that the trading records are compiled by a social networking website, and traders that use social networks could be idiosyncratic. Fortunately, prior work show that myForexBook traders are not dissimilar from other retail traders studied by the literature, and myForexBook traders are representative of retail forex traders more generally. Heimer (2016) documents that myForexBook traders exhibit trading biases that are similar to those of common stock traders on a large discount brokerage, that since its first use in Odean (1998), has been seminal to the behavioral finance literature. Heimer and Simsek (2018) show that myForexBook traders and the complete set of traders on one of the largest retail forex brokerages have similar performance, which provides evidence that social networked traders are similar to the broader population. Furthermore, the trading volume on myForexBook mirrors that of the aggregate U.S. retail forex market. Heimer and Simsek (2018) find high covariance between myForexBook trading volume and retail forex obligations provided by brokerages' filings at the CFTC.

The complete dataset contains over five million trades made by roughly 9,000 traders between early-2009 and April 2012. However, because our analysis focuses on the effects of the October 2010 leverage restrictions, we restrict the data to transactions made between September 1 and December 1, 2010. Including a larger sample period would potentially expose such an analysis to shocks that are unrelated to the leverage regulations. Focusing on the narrow event window also concentrates the analysis on the set of traders who actively traded before and after the leverage regulation. This sample restriction leaves us with 480 U.S. traders and 589 European traders, and just over 270,000 trades.

2.3 Comparing U.S. to European Traders

We run a series of analyses to test the suitability of European traders as a control group for estimating the effect of leverage restrictions on U.S. traders. To do so, we use information on trader characteristics, such as demographics and self-identified trading strategies, that is provided by the traders when they register for myForexBook. We find that the two groups are similar on nearly every dimension, including demographics, trading strategies, the types of assets they trade and when they trade them.

We present results comparing the means of these variables in Table 1, Panel A. European and U.S. traders have similar levels of experience: most (around 50 percent) have 1-3 years of experience and a minority (around 12 percent) have more than 5 years of experience. Trading styles are also similar, with the majority (around 60 percent) using technical trading strategies. U.S. traders are slightly older than their European counterparts (38.3 vs. 36.4 years old, respectively). Importantly, both groups have similar trading characteristics. In the sample period before the leverage restriction took effect (September 1 - October 17, 2010), U.S. and European traders had approximately 170 trades per account and averaged 7 transactions on days they traded. They traded

7 different currency pairs at least once. Approximately 40 percent of both U.S. and European traders used leverage that exceeded 50:1 at least once during our pre-restriction sample period.

Table 1, Panel B uses a probit model to test the probability of being a U.S. trader as a function of these observable characteristics. The regression estimates confirm that these personal and trading characteristics do not differ across locations. Almost all of the coefficient estimates are statistically indistinguishable from zero. Furthermore, the regression's pseudo-R^2 is small (0.018), suggesting that these observable characteristics do a poor job of explaining which traders are from the U.S. In other words, whether a trader is in the control or treatment group is as good as random with respect to trader characteristics – characteristics that could be relevant to the relationship between leverage and trading outcomes.

2.4 Measurement of Trading Performance

Table 2 presents summary statistics on trader's transactions. We measure trading performance by calculating per-trade returns excluding the trade's leverage and fees. Specifically, *unlevered returns* equal

$$\text{unlevered returns} = \begin{cases} \frac{s_{\tau+l}-s_{\tau}}{s_{\tau}} & \text{, if long position} \\ \frac{s_{\tau}-s_{\tau+l}}{s_{\tau+l}} & \text{, if short position} \end{cases}$$

where s_{τ} is the spot price when the position is opened and $s_{\tau+l}$ is the spot price when the position is closed. The measure captures how good a trader is at timing the market. Both the mean and median of *unlevered returns* is positive, which suggests that traders have some ability to time the market.

Table 2 also includes relevant trader and trade level control variables, such as the amount of leverage used in a given trade, the trade's size in USD, and the trade's holding period. We note that 45% of all trades are made by our treatment group of U.S. traders and 48% of all trades come after the regulation was imposed. Moreover, we categorize some traders as having more demand for leverage. We classify 45% of all trades as being made by traders that used at least 50:1 leverage on at least one trade prior to the regulation.

2.5 Leverage Constraints and Market Timing Performance

2.5.1 Empirical relation between leverage and performance

We test traders' market timing performance using the following regression

$$\text{unlevered returns}_{jit} = \gamma_i + \gamma_t + \beta_1 \cdot \log(\text{leverage})_{jit} + \beta_2 \cdot F_{pt} + \beta_3 \cdot \text{Trade}_{jit} + \varepsilon_{jit} \quad (1)$$

where j is a trade made by trader i at time t (trades are recorded at the second, but we tend to set γ_t as a daily fixed effect). *Log(leverage)* is the natural logarithm of the amount of leverage used on a given trade. The variable $F_{p,t}$ is a cross-country interest rate differential, that captures the expected return to holding a safe asset in the currency-pair p's base currency. *Trade* is a vector of trade characteristics that includes the size of the trader's stake in the position and the position's holding period. Sometimes we include brokerage-currency pair fixed effects in this specification in order to capture potential differences across brokerages in the fees and liquidity of different currencies across different brokerages. We double-cluster standard errors to account for correlated residuals by trader and day.

There is a robust negative correlation between traders' market timing performance and the amount of leverage they use per trade (Table 3). Doubling a trade's leverage is associated with about a one basis point increase in market timing performance, which is between one-third and one-quarter of a standard deviation in per-trade performance. The result is robust to using trader and day fixed effects, as well as brokerage-currency pair fixed effects. Columns 3 includes the trade's size and column 4 includes the length of its holding period. Controlling for the trade's holding period dampens the negative relation between leverage and trading performance, which could be consistent with the relationship being related to traders' disposition effect. Lastly, we show that the negative correlation between the use of leverage and trading performance is not an artifact of the sample of trades that occur around the time of the CFTC regulation. Appendix Table A.2 uses the same set of specifications and finds a similarly sized negative relationship between leverage and performance in the complete myForexBook data set, which includes approximately 5 million trades mostly executed between early-2009 and April 2012.

2.5.2 Difference-in-difference estimates

To credibly estimate the causal effect of leverage on trading performance we use the following difference-in-difference specification:

$$\text{unlevered returns}_{jit} = \gamma_i + \gamma_t + \beta_1 \cdot \text{US trader}_i \times \text{post constraint}_t + \beta_2 \cdot F_{p,t} + \beta_3 \cdot \text{Trade}_{jit} + \varepsilon_{jit}. \quad (2)$$

The variable *US trader* equals one if the trader is from the U.S, and equal to zero if they are from Europe. *Post constraint* equals one if the trade is opened after October 18, 2010, the date by which brokerages needed to comply with the CFTC's mandate to cap the provision of leverage at 50:1, and zero otherwise (few trades are open before the leverage constraint and closed afterwards). The coefficient β_1 estimates the average treatment effect of the CFTC regulation on traders' market timing performance.

There are a few reasons why we are confident that equation 2 identifies the effect of leverage on trading performance. First, we provide evidence that European traders are a good control group for U.S. traders. Table 1 shows that U.S. and European traders have similar characteristics – they have similar levels of trading experience, use similar trading styles, and have similar activity in the social network. We also present visual evidence that the difference-in-difference test satisfies the parallel trends assumption. Figure 1 plots time-series of average daily *unlevered returns* for U.S. and European trades. Their *unlevered returns* move in concert prior to the leverage constraint.

After the constraint, their *unlevered returns* decouple, with U.S. traders outperforming European traders by at least a basis point per average trade thereafter.

Estimates of the difference-in-difference regression confirm that the leverage constraint improves the performance of U.S. traders. In Panel A of Table 4, columns 1 and 2, the estimate of β_1 is equal to about 1.9 basis points and is statistically significant at the 10 percent error level.

A potential limitation of these tests is that, though U.S. traders are constrained by the CFTC regulations, not all traders use the same amount of leverage when they trade. This means that our estimates capture the intent-to-treat effect of the leverage restriction, but not necessarily the treatment-on-the-treated effect, which could understate the impact of the leverage constraint.

To address this limitation, we divide the sample into traders for whom the restriction is likely to bind (those who used at least 50:1 leverage on one or more trades prior to the regulation) and traders are not likely to use much leverage in the first place (those who never reach the 50:1 leverage limit prior to the regulation). We find that the leverage constraint has the strongest effect on the former group — precisely those who are most likely to be restricted by the regulation. Table 4, column 3 and 4 estimate equation 2 for the high leverage traders. For these traders, the estimates of β_1 equal between 2.5 and 3.6 basis points and is significant at the 5 percent level. Column 5 and 6 present results for the low leverage traders; the estimates of β_1 equal between 1.2 and 1.9 basis points and loses statistical significance. Because the estimates get larger as our tests focus on the traders who are most likely to be affected by the leverage restriction, this suggests that our estimates could understate the effect of leverage on trading performance. Notably, only 10 percent or so of trades exceeded the 50:1 leverage cap prior to the regulation. If the CFTC would have imposed more stringent leverage restrictions – as it had originally planned – our estimates would likely be much larger.[8]

[8] Analyses that exploit the imposition of discreet thresholds will sometimes search for bunching below the threshold and estimate effects in the narrow window around the threshold. Our setting is not well-suited to this approach because of the way that orders are placed in the forex market. Traders order currency "lots", which are fixed sized amounts of the currency pair, often 1,000 or 10,000 units of the base currency. To purchase a "lot," traders use their own money and then borrow the rest from the brokerage. Because of these discreet sizes, minimums imposed on traders' capital,

Panel B of Table 4 provides a formal test for parallel trends. This panel restricts the sample to the set of trades made prior to the CFTC leverage regulation. It estimates a regression similar to equation 2, except that it defines the variable *placebo constraint* as being equal to one if the trade is opened after September 26, 2010. September 26 is approximately the median start-of-week date between the start of our main sample (September 1) and the actual CFTC regulation date (October 18). The interaction between *US trader* and *placebo constraint* measures the difference between U.S. and European trading performance after September 26, relative to the difference in their performance prior to September 26. We find that the coefficient estimates are not statistically different from zero and tend to be an order of magnitude smaller than the corresponding specifications in Panel A. Because these estimates are not different from zero, we are confident that the relative performance of U.S. and European traders does not diverge prior to the actual restriction on leverage.

Finally, we examine heterogeneous treatment effects by testing whether traders are differentially affected by the leverage restriction depending on their disposition effect before the regulation. We find that traders who are most prone to postponing painful choices – those with the highest disposition effect in the pre-treatment period – experience the largest gains in performance as a result of the leverage restriction. Panel C of Table 4 presents these results. We sort the sample of traders according to how much of a disposition effect they have prior to the CFTC regulation. We create a trader-level disposition effect measure by taking the difference between the holding periods of the traders' median winning and losing trades divided by the holding period of their median winning trade. We sort these traders such that those with the longest relative holding periods on their losing trades are in the top quartile of the disposition effect. We then estimate equation 2 on the full sample period after sorting the sample according to these disposition effect quartiles. We find that the relative increase in trading performance as a result of the leverage constraint is largest

and a fixed number of decimal places in the quoted price, the amount of leverage a brokerage's trading platform offers the trader will often look more like a step-function. In addition, many brokerages' trading platforms simplify the choice of leverage into a few discreet values.

for traders in the top quartile of the disposition effect. For this group of traders, the coefficient estimate on the interaction between *US trader* and *post constraint* equals 0.036 and is statistically significant at the five percent level. The heterogeneity analysis implicates the disposition effect as a potential driver of the performance increase in response to the leverage restriction. The next section investigates whether the disposition effect changed as a result of the restriction.

2.6 Leverage Constraints and the Disposition Effect

We use linear probability models to estimate traders' disposition effect, because most traders in our data do not have multiple positions open at the same time. This differs from the original tests of the disposition, developed by Odean (1998), which compares the ratio of realized gains to paper gains to the ratio of realized losses to paper losses. The Odean (1998) methodology makes it difficult to control for relevant characteristics of the trade, and to address this shortcoming, most of the subsequent literature uses linear probability regressions similar to ours (e.g., Grinblatt and Keloharju (2001); Chang et al. (2016)). The other weakness of the Odean (1998) method is that the magnitude of the estimate of the disposition effect is significantly affected by the number of assets in the trader's portfolio.

We use the following linear probability regression estimated using OLS to test the relation between leverage constraints and the disposition effect:

$$\text{sale}_{ijt} = \gamma_i + \gamma_t + \beta_1 \cdot \text{gain}_{ijt} + \beta_2 \cdot \text{gain}_{ijt} \times \text{post constraint}_{ijt} + \varepsilon_{ijt}. \quad (3)$$

The regressions include multiple observations per each trade j, one for every 10-minute holding period t until the position closes. The dependent variable *sale* equals one in the period the position is closed by trader i, zero otherwise. The independent variable *gain* equals one if the current market price is above the currency's purchase price and equals zero otherwise. In addition to trader and calendar time fixed effects (γ_i and γ_t, respectively), the regressions include indicators for the trade's holding period, one for every 10-minute interval until the position is closed.[9] To interpret the regression, the coefficient on *gain* reflects the change in the hazard rate when the position is a paper gain. A positive estimate of β_1 implies that traders are more likely to sell positions at a gain than at a loss, which indicates a disposition effect. The coefficient on the interaction term between *gain* and *post constraint*, β_2, measures the change in the disposition effect as a result of having less available leverage.

Table 5 presents estimates of equation 3. We estimate the regressions separately for market and limit orders (Panel A and Panel B, respectively). Market orders execute manually immediately when requested by the trader.[10] Limit orders in the retail forex market are stop-loss or take-profit orders, which set the position to close when the price hits a threshold that the trader sets in advance. As a consequence, we conjecture that the use of limit orders help traders stick to a plan and maintain their commitment to closing a trade. The emotional effects of leveraged trading would have more of an effect on traders' market orders and not their limit orders.[11] Also, we separately estimate the disposition effect for U.S. (columns 1 and 2, with and without trader fixed effects, respectively) and European traders (columns 3 and 4).

Estimates of equation 3 provide evidence that reduced leverage lessens traders' disposition effect. The estimates of β_2 are between -0.007 and -0.009 for U.S. traders' market orders and is statistically significant at the five percent level (columns 1a and 2a). These coefficient estimates indicate that the leverage constraint causes an economically significant reduction in traders' disposition effect. The unconditional propensity to sell gains relative to losses is approximately equal to 0.055 (the estimate of β_2). Hence, the leverage constraint reduces traders' disposition effect by about 15 percent.

[9] We set the maximum holding period at two hours, because closing positions becomes increasingly less frequent at longer time horizons (the mean and median trade is held for just a little more than an hour).

[10] Technically, market orders execute as soon as the brokerage can locate a counter-party for the trade, and any delay between the order to execute and completing the transaction is called slippage. In practice in the foreign exchange market, there is little concern about slippage due to the market's tremendous liquidity.

[11] Linnainmaa (2010) and Fischbacher et al. (2017) provide further motivation for distinguishing between traders' market and limit orders when measuring the disposition effect.

Consistent with an emotional response to the reduction in leverage, the constraint does not statistically significantly affect the disposition effect for traders' limit orders (Panel B, columns 1b and 2b). The constraint also does not affect European traders' disposition effect (columns 3(a, b) and 4(a, b)), suggesting that the results are caused by the reduced availability of leverage and not by variation in market conditions before and after the CFTC regulation.

Furthermore, Figure 2 lets us examine whether the reduction in the disposition effect is due to traders holding on to gains for longer or selling losers more quickly, or both. The figure presents hazard rates for the amount of time to execution of the trade conditional on whether the trade is paper gain or paper loss. We find that the reduction in disposition effect due to traders being more willing to part with losing assets. The hazard rate on realized losses falls after the constraint, while there is no difference in the hazard rate for gains before or after the constraint.

3 Experimental Evidence on Trading With Leverage

There are a few limitations to the analysis of the retail forex market that motivate us to conduct a controlled laboratory experiment on trading with leverage. Notably, the experiment can help address potential shortcomings of our identification strategy, such as the fact that we have only a single event from which to test the effect of a leverage constraint. Also, most of the traders in our retail data do not have multiple positions open at the same time. This limits our measurement of the disposition effect to tests that rely on the timing of sell and buy decisions, without having a concurrent portfolio of unrealized assets from which to compare. Most crucially, we cannot determine precisely what aspect of access to leverage decreases traders' performance and increases their disposition effect. The experiment that follows tests whether access to leverage decreases performance through the disposition effect mechanism in a controlled environment that allows participants to trade multiple assets simultaneously, and holds constant the assets' potential returns in each trading period.

3.1 Experimental Design

We designed a portfolio choice experiment to test the effect of leverage on decision-making in a risky environment. Our design was based on the experiment of Fischbacher et al. (2017) who examines the effect of stop-loss and take-profit orders on the disposition effect. Investors made a series of investment decisions over the course of multiple periods, choosing which assets to hold, sell, or buy given their budget constraint. Investors formed portfolios of up to six different tests. As a result, our experimental test of the disposition effect will be better able to handle the idea of "selling winners, holding losers." The forex data does accommodate that sort of test, because traders tend to hold one asset at a time.

Investors ($N = 84$) were recruited from Amazon Mechanical Turk for a base payment of $1. Each was endowed with 2000 experimental currency units (ECU). Each investor's earnings in ECU were converted to dollars at the end of the experiment at a rate of 500 ECU to $2 USD, and delivered to her as a bonus payment. In the experiment, investors traded shares in six different assets labeled Goods 1-6. In total, the experiment consisted of 34 periods (Period -3 to 30). In period -3 the investor received the endowment but could not trade through period -1. Instead they observe the price development for the assets to facilitate learning. From period 0 onwards the investor could buy and sell shares. In period 0, she used all of her endowment to purchase different quantities of asset shares; after period 0, she was able to buy and sell asset shares at will depending on the balance in her account and the value of her portfolio. Investors were told that in each period, the price of each asset either went up by six percent or went down by five percent. In order to ensure that investor behavior was not affected by strategic considerations, the probability of a price increase or decrease was determined by a probability that was specific to each asset. The probability that the price would increase in any given period was different across the six Goods. For example, take Goods 1 and 4. In any given period, Good 1 had a 40 percent probability that its price would go up by six percent (and a 30 percent probability that its price will go down by five percent), while Good 4 had a 70 percent probability that its price would go up (and a 30 percent probability that its price will go down). Investors were told that the probability of a price increase for each good did not change from period to period. It was not affected by outcomes in previous periods nor by the trader's investment choices. Price paths were determined by a computerized randomization device according to the Good-specific probability.[12] Investors were not told the exact probabilities of price increases (or decreases) for the different goods. They could learn about the probabilities by watching price movements.

Each of the six Goods had a starting price of 100 in period -3. Afterwards the price of each Good changed according to its respective probability. In period 0 the prices reset back to 100 to allow investors to fully allocate their endowment. They could then begin trading. In each period, investors saw how many shares of each good they owned, the current price of each good and the last purchase price of each good. They also saw a table that contained the prior prices of each good in every previous period, as well as how many shares of each good they bought or sold in the past.[13]

Investors could buy additional units of goods so long as the money on their account exceeds the price for one unit of the respective good. The investor could sell any of the goods in her portfolio at the prevailing price; the earned currency would be deposited into the account and could be used to either make purchases in the same period or be carried over to the next.

In the Leverage treatment, the investor also had the opportunity to borrow 500 additional ECU. If she chose to borrow the points, they would be added to her account balance in that period and used to make additional purchases or be carried over to the next period. The investor would have to pay back these 500 ECU by the end of the experiment. Paying back the borrowed currency could happen at any time by clicking a button on the screen. If the investor had not paid back the currency by the end of the experiment, they would be deducted from her earnings. Leverage could

[12]Each participant was asked a series of comprehension questions on these points and could not continue before getting them right.

[13]See Appendix (Appendix Screenshots.pdf) for screenshots of the paradigm.

only be used if the net worth of the investor's portfolio exceeded 500 ECU. In the No Leverage condition, the investor could not borrow additional currency.

At the end of the experiment, all Goods were sold at the final prices. The earnings were then converted to USD and paid to the investor. Investors then filled out a short survey that asked for their gender, age, and elicited measures of patience and risk tolerance. The patience measure asked investors to indicate their general level of patience, in the form of "How patient are you in general? (on a scale from 1 'extremely impatient' to 7 'extremely patient')." This measure has been validated to predict real-world intertemporal choice behavior in several representative samples (Vischer et al., 2012). The risk tolerance measure asked investors to choose their general tolerance of risk, in the form of "How willing are you to take risks in general? (on a scale from 1 'unwilling' to 7 'fully prepared')." This measure has also been validated to predict real-world risk-taking behavior across representative samples (Dohmen et al., 2011).

3.2 Measuring the Disposition Effect

We followed Fischbacher et al. (2017) in measuring the disposition effect in our experiment. Their measurement is analogous to Odean (1998) where the propensity to realize gains and losses is calculated in relation to the opportunity set. Given the importance of a salient last purchase price in driving the disposition effect (Frydman and Rangel, 2014), goods were classified as winners or losers whether their current prices were above or below the last purchase price. The proportions of winners realized (PWR) and losers realized (PLR) corresponded to the following:

$$PWR = \frac{sales\ of\ a\ winner}{possibilities\ of\ selling\ winners} \tag{4}$$

$$PLR = \frac{sales\ of\ a\ loser}{possibilities\ of\ selling\ losers} \tag{5}$$

The disposition effect (DE) is calculated as the difference between these two proportions: $DE = PWR - PLR$. The range of the DE measure goes from -1 to 1, with 1 corresponding to an extreme disposition effect (keeping losers and selling winners), 0 corresponding to no disposition effect, and -1 corresponding to a reverse disposition effect (keeping winners and selling losers).

The proportions were calculated in each period. They depend on the possibilities of selling winners or losers in that period, which corresponds to the number of winners and losers in the investor's portfolio. For example, take an investor who held 5 units of Good 1 and 5 units of Good 2 in the second period. She had bought Good 1 and 2 for 100 ECU per share; in the third period, the price of Good 1 was 106 and the price of Good 2 was 95. The possibilities of selling winners in that period was equal to 5, the same as the possibilities of selling losers. Suppose the investor sells 3 shares of Good 1 and 2 shares of Good 2. Her $PWR = 3/5$ and her $PLR = 2/5$, corresponding to a positive disposition effect of $1/5$.

3.3 Results of Trading Experiment

We report summary statistics on the demographics of our sample in Table 6. There were no significant differences on observables such as gender, age and proxies for risk and patience between the two conditions. Since the purpose of the experiment is to replicate the forex trading results in a more controlled environment, we attempt to follow the analyses reported in the previous section as closely as possible. To that end, Section 3.3.1 presents analyses analogous to those in Section 2.4, and Section 3.3.2 presents analyses analogous to those in Section 2.5.

3.3.1 Leverage Restrictions and Performance

We begin by examining the effect of access to leverage on performance. Because we are interested in how access to leverage impacts investment behavior, we first consider performance relative to a simple buy-and-hold strategy. Specifically, since price movements vary randomly between periods, we first calculate how well the investor would have done if she had split her endowment evenly between the goods in the first period and held that portfolio for the rest of the experiment. This $1/N$ holding strategy is a conservative benchmark for performance since it does not allow for learning about the underlying success probabilities of the goods. In the analysis that follows, investor performance is calculated by subtracting final earnings under the $1/N$ holding strategy from the investor's actual final earnings. Positive numbers correspond to the investor outperforming the strategy; negative numbers correspond to the investor underperforming the strategy.

We replicate the effects of leverage on investment performance. Figure 3 shows performance relative to the $1/N$ holding strategy by condition. Similar to our findings from retail forex investors, not having access to leverage leads to substantially better performance in terms of earnings relative to the $1/N$ holding strategy, compared to the Leverage condition. Table 7 shows results from OLS regressions of performance on a treatment dummy (0=Leverage, 1=No Leverage) confirming the significant difference in performance. While investors in the No Leverage treatment significantly outperformed the $1/N$ holding strategy, suggesting a positive effect of learning, investors in the Leverage treatment performed only as well as the benchmark. Performance relative to the benchmark is significantly lower for those with access to leverage compared to those without it, and the effect is robust to the inclusion of control variables such as age, gender and proxies for risk tolerance and patience.

We also examine the effect of leverage on absolute performance. Figure 3 and Table 7 present those results as well. Given that investment in the market has a net positive return, we see that investors in both treatments end up with more total points than the 2000 ECU endowment. Importantly, however, investors without access to leverage end the experiment with higher absolute earnings than those with leverage. As shown in Table 7, this difference is robust to the inclusion of control variables. Additionally, the effect of access to leverage on performance is similar in size to the effect from the retail forex market – approximately one half to two fifths of one standard deviation, depending on the specification.

3.3.2 The Effect of Leverage on the Disposition Effect

Having established the negative effect of leverage on performance, we examine the behavioral channel that could have led to this effect. Based on our hypotheses and results from the forex market data, we expect that access to leverage exacerbates investors' disposition effect. Specifically, the ability to borrow allows investors to hold on to losing goods for longer while still taking taking advantage of buying opportunities.

As in the analysis of the forex market, we now examine whether access to leverage increased the disposition effect. We regress our disposition effect measure on whether participants had access to leverage or not. The results presented in Table 8 mirror the findings from the forex market: restricting access to leverage in our setting resulted in a lower per-period disposition effect. Restricting access to leverage leads to a six percent average reduction in the disposition effect, which corresponds to approximately one fifth of one standard deviation of the mean. We then proceed to examine whether the constraints on leverage decrease the disposition effect by increasing the propensity to realize losses or decreasing the propensity to realize gains. As in the retail forex setting, we restrict our attention to those who used leverage when it was available to them. Figure 4 reproduces the effects captured in Figure 2 in the forex market: leverage decreases the proportion of realized losses while not affecting the proportion of realized gains. Regression results are presented in Table 9.[14]

Lastly, we examine whether changes in the disposition effect drove the effects of leverage on performance. Note that the disposition effect is particularly detrimental to performance in our setting; assets that have gone down in price are more likely to keep going down in price, so a psychological friction that precludes the realization of losses should lead to lower earnings. We

[14]Looking at the whole sample, the effect of having access to leverage had a (directionally) similar negative effect on the propensity to realize losses (effect on PLR: $\beta = -.02, p = .31$). It also had a positve effect on the propensity to realize gains (effect on PWR: $\beta = .05, p = .03$). The increase in the propesity to realize gains was driven by those who had access to leverage but chose not to use it. The reason for why the option to use leverage would prompt those who do not use it to sell winners is beyond the scope of the current paper.

regress per period earnings on the investor's disposition effect in the previous period, which is normalized as a proportion of the standard deviation. Standard errors are clustered at the participant and period level, with period and investor fixed effects, depending on the specification. Results from this analysis are presented in Table 10. We see that indeed, a larger disposition effect in the previous period corresponds to lower earnings in the next. A one standard deviation increase in the disposition effect corresponds to a decrease in per-period earnings of between 50 and 100 ECU, depending on the specification. These effects are significant at either the 1 or 5 percent level, depending on the specification.

4 Conclusion

This paper studies how leverage affects decision-making under uncertainty. The option to use leverage lets individuals enter new positions without liquidating prior holdings. Using regulation that restricts the provision of leverage to retail forex traders, as well as an incentivized laboratory experiment, we find that access to leverage impairs decision-making. Traders and experiment participants have worse trading performance and a higher disposition effect when they have access to leverage. These results suggest that leverage lets individuals delay the costs of negative realization, which is consistent with a dynamic model of prospect theory with realization utility. All in all, *traders do less with more*.

Our findings have important implications for both aggregate prices of financial assets, and for consumer financial protection. With respect to the former, consider an individual that purchases an asset with at least some leverage. The price of the asset rises, but then the fundamental value of the asset is revealed to be below the asset's price. Because the individual used leverage to purchase the asset, she can use her unspent capital to finance other purchases, while avoiding the realization disutility that would come with liquidating the asset. Clearly, this has the potential to sustain prices that deviate from fundamentals, even without limits to arbitrage (Shleifer and Vishny, 1997). It can also cause larger run-ups in prices, because it reduces downward price-pressure. Indeed, the link between leverage and irregular asset price movements is well documented (Geanakoplos, 2010).

Our findings also provide justification for paternalistic regulations in consumer financial markets. The debate in the consumer financial protection literature tends to center on the "tension between laissez faire and interventionist tendencies" (Campbell 2016, pg. 1). We show that expanding choice sets can cause consumers to escalate commitments to financial mistakes when they are personally responsible for managing their financial decisions. This suggests that regulations that constrain financial decisions can improve personal welfare. We suspect that our findings generalize across markets that are subject to consumer financial protections.

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Table 1: **Balancing test comparing U.S. and European traders**

Description: This table compares traders in the myForexBook data set from the United States to traders from Europe. Panel A includes a comparison of means. Panel B estimates a Probit model in which the dependent variable US equals one if trader i is from the U.S., zero otherwise. The sample is from 1st September 2010 to 1st December 2010.

	Panel A: Difference in means test			**Panel B: Probit estimates (dep var = US)**		
	US	EU	t^a		coef	(s.e.)
Personal characteristics						
experience (years)				*experience* (years)		
0 - 1	0.277	0.332	*1.90*	0 - 1	-0.165	(0.14)
1 - 3	0.473	0.466	*0.22*	1 - 3	-0.00549	(0.13)
3 - 5	0.110	0.091	*1.05*	3 - 5	0.0436	(0.17)
5 +	0.140	0.106	*1.72*	5 + (omitted)		
trading.approach				*trading.approach*		
momentum	0.0570	0.0514	*0.41*	momentum	0.308	(0.26)
news	0.0285	0.0240	*0.47*	news	0.402	(0.31)
technical	0.631	0.639	*0.25*	technical	0.259	(0.20)
not specific	0.242	0.229	*0.50*	not specific	0.276	(0.21)
fundamentals	0.0407	0.0564	*1.19*	fundamentals (omitted)		
age	38.33	36.41	*3.02*	log(age)	0.346	(0.14)**
number of social network friends	29.22	23.98	*0.88*	log (1 + number of friends)	0.0410	(0.028)
Trading characteristics (pre-CFTC regulation)						
trades per account	173.8	169.9	*0.10*	trades per account	0.000153	(0.00021)
trades per account/day, conditional on $\geq$ 1 trade in day	6.67	6.88	*0.20*	trades per account/day, conditional on $\geq$ 1 trade in day	-0.00718	(0.0080)
distinct currency pairs traded at least once per account	6.95	6.54	*1.22*	distinct currency pairs traded at least once per account	0.00776	(0.0080)
fraction traders w/ leverage 50:1 > on at least one trade	0.417	0.395	*0.74*	fraction traders w/ leverage 50:1 > on at least one trade	0.0788	(0.083)
Number of traders	480	589		Number of traders	1069	
				pseudo-R^2	0.013	

[a] test of equality of means between US and EU

Table 2: **Trade-level summary statistics**

Description: This table presents summary statistics from the myForexBook database trimmed according to the criteria described in Section **??**. The sample includes trades executed by U.S. and European retail forex traders between September 1 and December 1, 2010. *Leverage* is denominated as X:1. *Holding period* is the length of time in hours between when the position is opened and when it is closed. *US trader* equals one if the trader is located in the U.S. and equal to zero if located in Europe. *Post constraint* equals one if the trade was opened after the October 18, 2010 CFTC regulation limiting the leverage available to U.S retail forex traders at 50:1, zero otherwise. *High leverage trader* equals one if trader i uses more than 50:1 leverage on at least one trade prior to the CFTC regulation, zero otherwise. The sample is from 1st September 2010 to 1st December 2010.

variable	mean	std dev	10^{th} %tile	25^{th} %tile	median	75^{th} %tile	90^{th} %tile
unlevered returns	0.0080	0.52	-0.30	-0.060	0.036	0.14	0.31
log(leverage)	0.81	2.89	-2.75	-0.69	1.24	2.71	3.68
US trader (=1)	0.45						
post constraint (=1)	0.48						
high-leverage trader (=1)	0.45						
log(trade size, *USD*)	0.57	2.23	-2.30	0	0.69	2.30	3.00
log(holding period, *hours*)	0.17	2.43	-2.91	-1.51	0.086	1.84	3.42
Number of trades	270,051						

Table 3: **Correlation between Leverage and Market Timing Performance**

Description: This table reports OLS estimates of the following regression in Panel A

$$unlevered\ returns_{j,i,t} = \gamma_i + \gamma_t + \beta_1 \cdot log(leverage)_{j,i,t} + \beta_2 \cdot F_{p,t} + \beta_3 \cdot Trade_{j,i,t} + \varepsilon_{j,i,t}$$

Unlevered returns equals (for long positions) the spot price when the position in the currency is closed minus the spot price when the position opened, divided by the spot price when it is opened (visa versa for short positions). The variable *leverage* is the amount of leverage used in each trade. Cross-country interest rate differentials are $F_{p,t} = \triangle i_{b,t} - \triangle i_{q,t}$, where $\triangle i$ is the daily change in the risk-free rate for the currency of the base country b and quote country q. $Trade$ is a vector that includes the trade's size and holding period. Trader and day fixed-effects are γ_i and γ_t, respectively. Standard errors are double-clustered by day and trader, and *, **, and *** denote the following significance levels $p < 0.10$, $p < 0.05$, and $p < 0.01$, respectively.

dep var: unlevered returns	(1)	(2)	(3)	(4)
log(leverage)	-0.00798***	-0.0107***	-0.0115***	-0.00798***
	(0.0022)	(0.0023)	(0.0027)	(0.0024)
log(trade size)			0.00283	-0.00477
			(0.0037)	(0.0032)
log(holding period)				-0.0241***
				(0.0033)
trader FE	x	x	x	x
day FE	x	x	x	x
currency risk-free rate differential	x	x	x	x
broker-pair FE		x	x	x
number of trades	270,051	269,995	269,995	269,995
R^2	0.036	0.048	0.048	0.056

Table 4: **Leverage and market timing performance**

Description: This table reports OLS estimates of the following regression

$$unlevered\ returns_{j,i,t} = \gamma_i + \gamma_t + \beta_1 \cdot US\ trader_i \times post\ constraint_t + \beta_2 \cdot F_{p,t} + \varepsilon_{j,i,t}.$$

Unlevered.returns equals (for long positions) the spot price when the position in the currency is closed minus the spot price when the position opened, divided by the spot price when it is opened (visa versa for short positions). *US trader* equals one if the trader is located in the U.S. and equals zero if located in Europe. *Post constraint* equals one if the trade was opened after the CFTC regulation went into effect on October 18, 2010, zero otherwise. **Panels A** and **C** use the sample of trades opened between September 1 and December 1, 2010. **Panel B** uses the sample of trades opened between September 1 and October 17, 2010. This panel sets *placebo constraint* equal to one if the trade is opened after September 26, 2010. **Panel C** sorts traders by the intensity of their disposition effect prior to the regulation. Per-trader disposition effect intensity is calculated by taking the difference between the holding periods of the traders' median winning and losing trades divided by the holding period of their median winning trade. Trader and day fixed-effects are γ_i and γ_t, respectively. Standard errors are double-clustered by day and trader, and *, **, and *** denote the following significance levels $p < 0.10$, $p < 0.05$, and $p < 0.01$, respectively.

Panel A: Leverage constraints and market timing performance

sample:	all traders		high-leverage traders		low-leverage traders	
dep var: unlevered returns	(1)	(2)	(3)	(4)	(5)	(6)
US trader (=1) × post constraint (=1)	0.0185*	0.0192*	0.0360**	0.0248*	0.0121	0.0193
	(0.010)	(0.011)	(0.014)	(0.013)	(0.014)	(0.015)
trader FE	x	x	x	x	x	x
day FE	x	x	x	x	x	x
currency risk-free rate differential	x	x	x	x	x	x
brokerage - currency pair FE		x		x		x
number of trades	270,051	269,995	120,645	120,586	145,502	145,456
R^2	0.035	0.048	0.039	0.053	0.035	0.053

Panel B: Parallel trends tests using placebo leverage constraint

pre-regulation sample:	all traders		high-leverage traders		low-leverage traders	
dep var: unlevered returns	(1)	(2)	(3)	(4)	(5)	(6)
US trader (=1) × placebo constraint (=1)	0.000631	0.00186	0.00988	0.00865	-0.00122	0.00218
	(0.014)	(0.014)	(0.023)	(0.026)	(0.019)	(0.018)
trader FE	x	x	x	x	x	x
day FE	x	x	x	x	x	x
currency risk-free rate differential	x	x	x	x	x	x
brokerage - currency pair FE		x		x		x
number of trades	140,937	140,878	62,718	62,667	78,219	78,165
R^2	0.064	0.085	0.068	0.086	0.063	0.095

Panel C: Leverage constraints, market timing performance, and the role of traders' disposition effect

quartile of traders' disp. effect:	top	3rd	2nd	bottom
dep var: unlevered returns	(1)	(2)	(3)	(4)
US trader (=1) × post constraint (=1)	0.0358**	0.00750	0.0198	0.00730
	(0.017)	(0.0096)	(0.021)	(0.028)
trader FE	x	x	x	x
day FE	x	x	x	x
currency risk-free rate differential	x	x	x	x
brokerage - currency pair FE	x	x	x	x
number of trades	101,912	75,707	45,807	33,722
R^2	0.10	0.036	0.055	0.060

Table 5: **Leverage constraints and the disposition effect**

Description: This table presents OLS estimates of the following linear probability model:

$$sale_{ijt} = \gamma_i + \gamma_t + \beta_1 \cdot gain_{ijt} + \beta_2 \cdot constraint_{ijt} + \beta_3 \cdot gain_{ijt} \times constraint_{ijt} + \varepsilon_{ijt}.$$

The regression includes multiple observations per each trade j, one for every 10-minute holding period until the position closes. The dependent variable $sale$ equals one if trader i closes position j in period t. The independent variable $gain$ equals one if the position is a paper gain in period t. Trader and calendar time fixed effects are γ_i and γ_t, respectively. The regressions include holding period fixed effects, which is a set of indicator variables for every 10-minute interval starting after the position opens. Standard errors are double-clustered by day and trader, and *, **, and *** denote the following significance levels $p < 0.10$, $p < 0.05$, and $p < 0.01$, respectively.

Panel A:

	sample: market orders			
	U.S. traders		European traders	
dep var: sale (=1)	(1a)	(2a)	(3a)	(4a)
gain (=1)× post constraint (=1)	-0.00896**	-0.00768**	-0.00438	-0.00389
	(0.0038)	(0.0038)	(0.0075)	(0.0070)
gain (=1)	0.0543***	0.0577***	0.0330***	0.0376***
	(0.016)	(0.016)	(0.0050)	(0.0051)
holding period FE	x	x	x	x
day FE	x	x	x	x
trader FE		x		x
N (trade - holding period)	278,800	278,799	295,687	295,678
N (trades)	35,690	35,690	36,614	36,614
adj. R^2	0.030	0.065	0.025	0.069

Panel B:

	sample: limit orders			
	U.S. traders		European traders	
dep var: sale (=1)	(1b)	(2b)	(3b)	(4b)
gain (=1)× post constraint (=1)	0.00148	-0.000394	-0.00419	-0.00277
	(0.0026)	(0.0028)	(0.0051)	(0.0051)
gain (=1)	0.0166***	0.0192***	0.0323***	0.0373***
	(0.0038)	(0.0037)	(0.0047)	(0.0044)
holding period FE	x	x	x	x
day FE	x	x	x	x
trader FE		x		x
N (trade - holding period)	288,561	288,558	448,896	448,893
N (trades)	34,366	34,366	59,700	59,700
adj. R^2	0.017	0.060	0.028	0.077

Table 6: **Balancing Test for Leverage Choice and Trading Experiment**

Description: This table reports summary statistics on the demographics of investors in our experiment. We collected data on four variables: gender (male=1, female=0), age, patience (1-7 scale) and risk tolerance (1-7 scale). The patience measure asked investors their general level of patience: "How patient are you in general? (on a scale from 1 'extremely impatient' to 7 'extremely patient')." The risk tolerance measure asked investors their general tolerance for risk: "How willing are you to take risks in general? (on a scale from 1 'unwilling' to 7 'fully prepared')."

sample:	No Leverage Group			Has Leverage Group			diff. in means test	
	mean	median	std. dev.	mean	median	std. dev.	difference	t-stat
male (= 1)	0.56			0.61			-0.06	0.55
age	35.04	33	9.37	36.36	35	9.00	-1.31	0.65
patience (1-7 scale)	4.27	4	1.60	4.01	4	1.52	0.27	0.76
risk tolerance (1-7 scale)	3.64	4	1.98	3.54	4	1.62	0.11	0.26
number of traders	45			39				

Table 7: **Experimental Evidence of Leverages' Effect on Performance**

Description: This table reports OLS estimates of the following regressions

$$performance.benchmark_i = \beta_0 + \beta_1 \cdot no.leverage_i + \beta_2 \cdot controls_i + \varepsilon_i$$

$$performance.absolute_i = \beta_0 + \beta_1 \cdot no.leverage_i + \beta_2 \cdot controls_i + \varepsilon_i$$

The performance relative to benchmark variable measures earnings relative to the $1/N$ and hold investment strategy. The Absolute Earnings variable corresponds to each investor's final earnings at the end of the experiment. The trader cannot use no.leverage (=0) variable corresponds to being in the Leverage treatment (if = 0) or the No Leverage treatment (if = 1). The age^2 variable corresponds to the age variable squared. The constant, β_0, is the unconditional average of the dependent variable. The stars *, **, and *** denote the following significance levels $p < 0.10$, $p < 0.05$, and $p < 0.01$, respectively.

dep var:	Perfrormance Relative to Benchmark		Absolute Performance	
	(1)	(2)	(3)	(4)
trader cannot use leverage (= 1)	143.14**	165.88***	173.73*	204.68**
	(64.58)	(61.89)	(89.05)	(82.64)
male (= 1)		149.42**		163.63*
		(62.44)		(91.19)
age		-10.19		-58.77**
		(18.63)		(28.04)
age^2		0.15		0.75**
		(0.24)		(0.38)
patience		-46.03**		-57.93**
		(22.96)		(28.46)
risk tolerance		24.33		-9.34
		(16.98)		(24.33)
constant	11.41	176.16	2,216.84***	3442.86***
	(45.13)	(383.33)	(57.43)	(510.98)
number of traders	84	83	84	83
R^2	0.05	0.23	0.04	0.19

Table 8: **Experimental Evidence of Leverages' Effect on the Disposition Effect**

Description: This table reports OLS estimates of the following regression

$$disposition.effect_{it} = \gamma_t + \beta_1 \cdot no.leverage_i + \beta_2 \cdot controls_i + \varepsilon_i$$

The *disposition.effect* in t variable corresponds to the investor's per-period disposition effect in the end of period t. The trader cannot use no.leverage (=0) variable corresponds to being in the Leverage treatment (if = 0) or the No Leverage treatment (if = 1). t. Period fixed effects are included in the regressions. Standard errors, clustered at the participant level, are in parenthesis, and *, **, and *** denote the following significance levels $p < 0.10$, $p < 0.05$, and $p < 0.01$, respectively.

dep var:	disposition effect (per period)		
	(1)	(2)	(3)
trader cannot use leverage (= 1)	-0.06**	-0.06**	-0.07**
	(0.03)	(0.03)	(0.03)
male (= 1)		0.02	0.02
		(0.03)	(0.03)
age		-0.01	-0.01
		(0.01)	(0.01)
age^2		0.00	0.00
		(0.00)	(0.00)
patience			-0.00
			(0.01)
risk tolerance			-0.01
			(0.01)
constant	-0.02	0.23	0.29
	(.04)	(.14)	(.16)
period FE	x	x	x
trader-period observations	1,558	1,558	1,528
R^2	0.02	0.03	0.04

Table 9: **Effect of Leverage on Realizing Losses and Gains**

Description: This table reports OLS estimates of the following regressions

$$PLR_{it} = \gamma_t + \beta_1 \cdot no.leverage_{it} + \beta_2 \cdot controls_i + \varepsilon_i$$

$$PWR_{it} = \gamma_t + \beta_1 \cdot no.leverage_{it} + \beta_2 \cdot controls_i + \varepsilon_i$$

The PLR variable corresponds to the number of losses realized per period as a proportion of the total assets sold; the PWR variable corresponds to the number of winners realized per period as a proportion of the total assets sold. The trader cannot use no.leverage (=0) variable corresponds to being in the Leverage treatment (if = 0) or the No Leverage treatment (if = 1). The age^2 variable corresponds to the age variable squared. The constant, β_0, is the unconditional average of the dependent variable. Mirroring the forex analysis, the analysis is restricted to those in the Leverage treatment who use the leverage. Period fixed effects are included in the regressions. Standard errors, clustered at the participant level, are in parenthesis. The stars *, **, and *** denote the following significance levels $p < 0.10$, $p < 0.05$, and $p < 0.01$, respectively.

dep var:	Proportion of Losers Realized		Proportion of Winners Realized	
	(1)	(2)	(3)	(4)
trader cannot use leverage (= 1)	0.06**	0.04*	.01	.01
	(.02)	(.02)	(.03)	(.03)
male (= 1)		-0.02		0.00
		(.03)		(.02)
age		0.01		-0.00
		(.01)		(.01)
age^2		-0.00		0.00
		(.00)		(.00)
patience		0.02*		-0.01
		(.01)		(.01)
risk tolerance		0.01		-0.01
		(.01)		(.01)
period FE	x	x	x	x
number of observations	1,139	1,139	1,339	1,339
R^2	0.05	0.07	0.02	0.04

Table 10: **Experimental Evidence: Effect of Disposition Effect on Performance**

Description: This table reports OLS estimates of the following regression

$$performance.absolute_{i,t+1} = \gamma_t + \beta_1 \cdot disposition.effect(Z)_{i,t} + \beta_2 \cdot controls_i + \varepsilon_i$$

The $performance.absolute_{i,t+1}$ variable corresponds to each investor's per period earnings at the beginning of period *t+1*. The *disposition.effect (Z)* in *t*variable corresponds to the investor's per-period disposition effect in the end of period *t*, normalized such that a one unit increase corresponds to a one standard deviation increase in the disposition effect. Period fixed effects are included in the regressions. Standard errors are in parenthesis, clustered at the participant level and period level. *, **, and *** denote the following significance levels $p < 0.10$, $p < 0.05$, and $p < 0.01$, respectively.

dep var:	earnings in $t+1$		
	(1)	(2)	(3)
Disposition Effect in *t*	-97.81***	-105.50***	-54.56**
	(32.40)	(32.40)	(22.35
male (= 1)		134.51	
		(102.38)	
age		-8.42	
		(30.94)	
age^2		0.04	
		(.41)	
patience		-50.90	
		(30.15)	
risk tolerance		0.53	
		(25.07)	
period FE	x	x	x
investor FE			x
trader-period observations	1,516	1,487	1,516
R^2	0.05	0.09	0.65

Figure 1: **Market Timing Performance and Leverage Constraints**

Description: This figure plots the daily average return on investment per trade by U.S. and European traders in the trimmed sample described in Section 2 and a 5-day moving average of each time series. Weekends are excluded from these calculations.

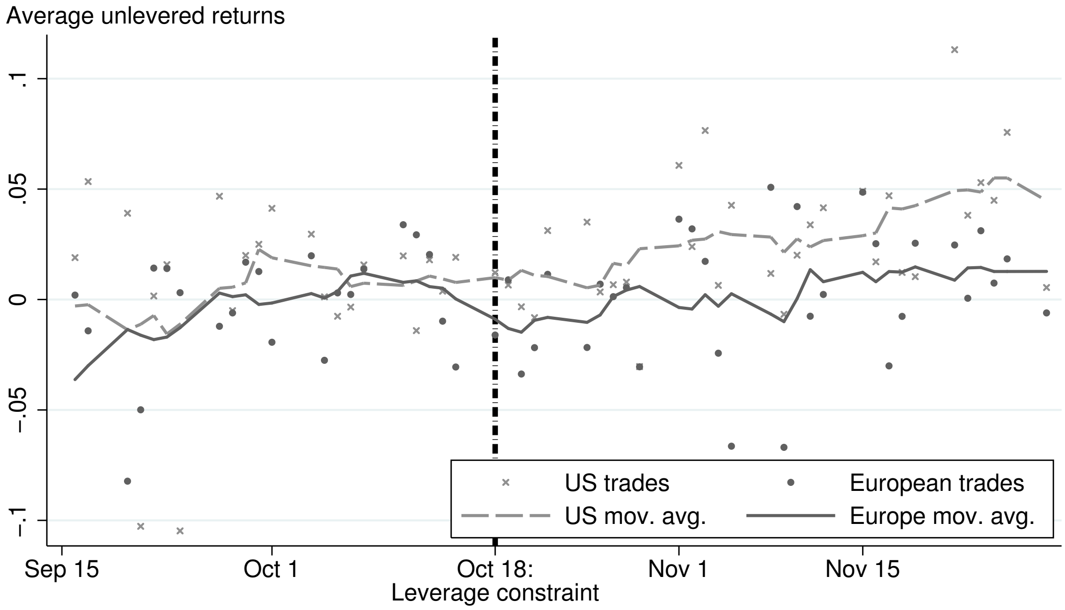


Figure 2: **Holding Period of Gains/Losses and Leverage Constraints**

Description: This figure plots estimates of a Kaplan-Meier survival function in which the outcome of interest is an indicator variable for closing a position. The graphs separate the survival function by paper gains and paper losses. The data only includes market orders and is restricted to traders that use at least 50:1 leverage prior to the CFTC regulation limiting the provision of leverage.

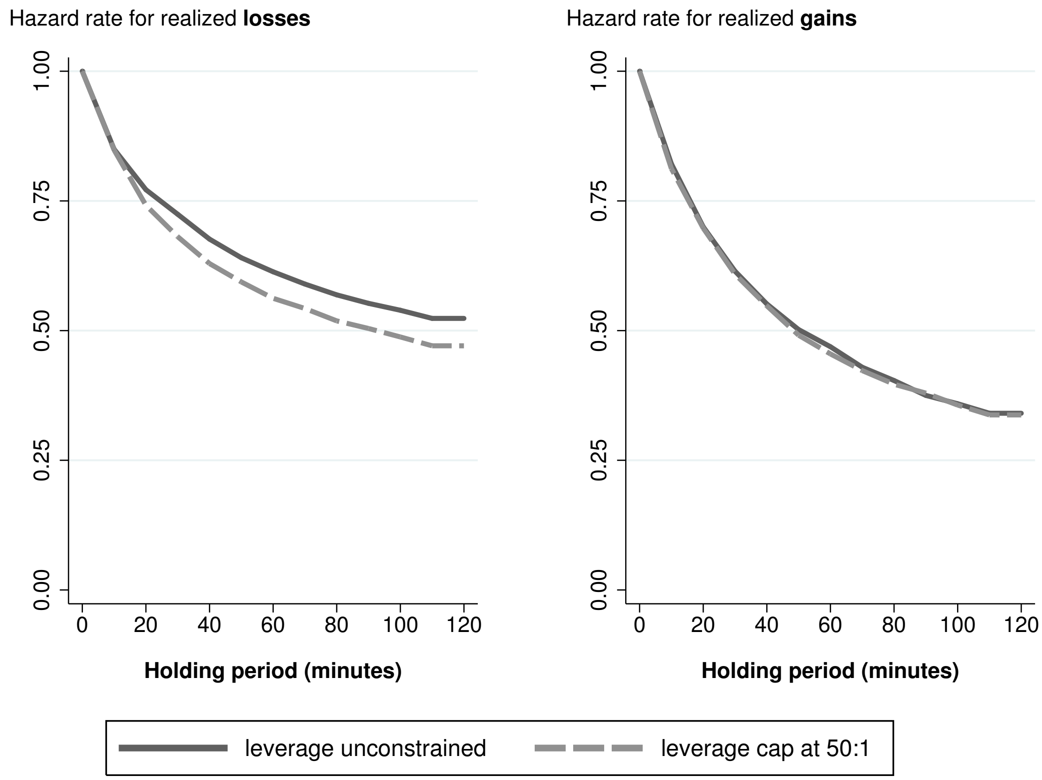
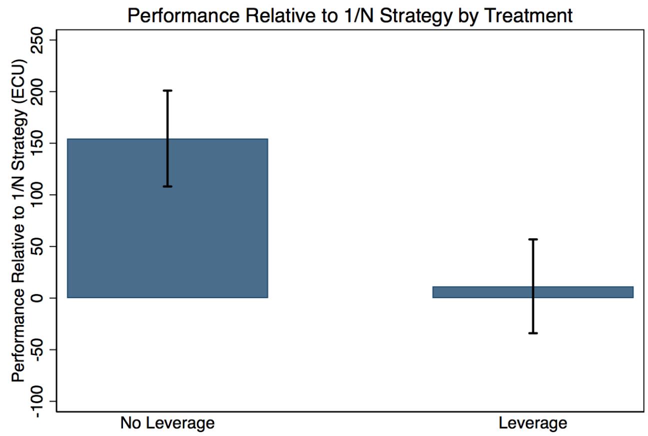
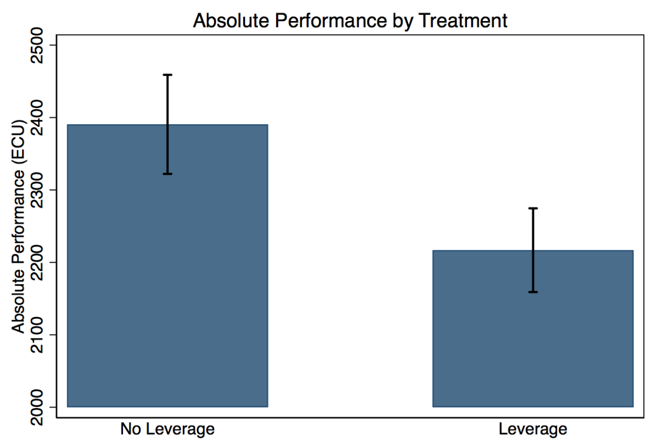


Figure 3: **Experimental Evidence of Leverage on Performance**

Description: This figure illustrates the effect of leverage on mean performance relative to a $1/N$ and hold investment strategy (on top) and on final earnings in the experiment (on bottom). Error bars represent standard errors.



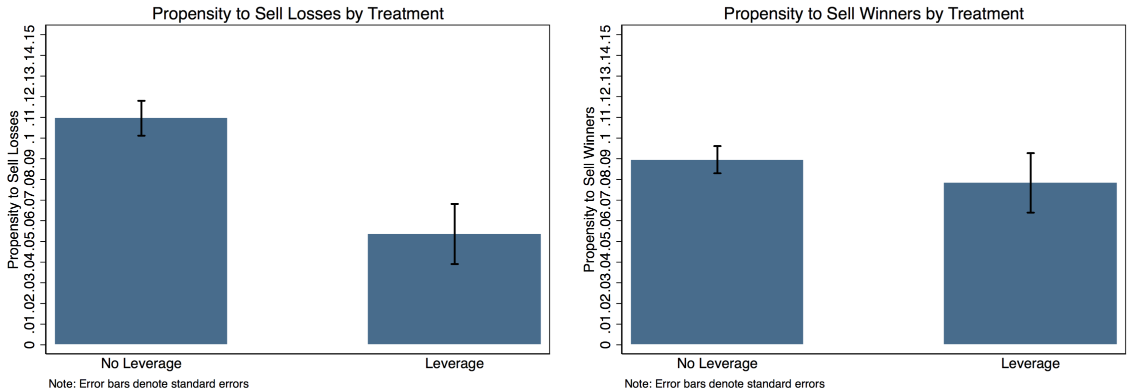
Note: Error bars denote standard errors



Note: Error bars denote standard errors

Figure 4: **Experimental Evidence of Leverage and Propensity to Realize Losses and Gains**

Description: This figure illustrates the effect of leverage on the propensity to sell losing assets (on left) and winning assets (on right). The figure mirrors Figure 2, which uses the forex data, and includes only those who use leverage when it is available to them.



Appendix to:

Doing Less With More

(intended for online publication)

Table A.1: **The CFTC regulation and Leverage Constraints across Currency Pairs**

Description: This table lists the currency pairs affected by the CFTC trading rule restricting the amount of leverage at 50:1 or 20:1.

50:1 leverage				
USD/JPY	AUD/NZD	NZD/CAD	EUR/GBP	GBP/USD
USD/CHF	USD/SEK	CHF/JPY	EUR/JPY	GBP/JPY
AUD/USD	USD/DKK	CAD/JPY	EUR/AUD	GBP/CHF
USD/CAD	USD/NOK	CAD/CHF	EUR/CAD	GBP/CAD
NZD/USD	AUD/CHF	CHF/SEK	EUR/SEK	GBP/NZD
AUD/CAD	NOK/JPY	CHF/NOK	EUR/NOK	GBP/AUD
AUD/JPY	SEK/JPY	EUR/USD	EUR/NZD	GBP/SEK
NZD/JPY	NZD/CHF	EUR/CHF	EUR/DKK	

20:1 leverage				
USD/MXN	USD/CZK	USD/HKD	USD/RUB	ZAR/JPY
EUR/PLN	USD/ZAR	SGD/JPY	EUR/HUF	
USD/PLN	USD/SGB	USD/TRY	USD/HUF	
EUR/CZK	HKD/JPY	EUR/TRY	TRY/JPY	

Table A.2: **Leverage and Market Timing Performance: Complete Data Set**

Description: This table reports OLS estimates of the following regression in Panel A

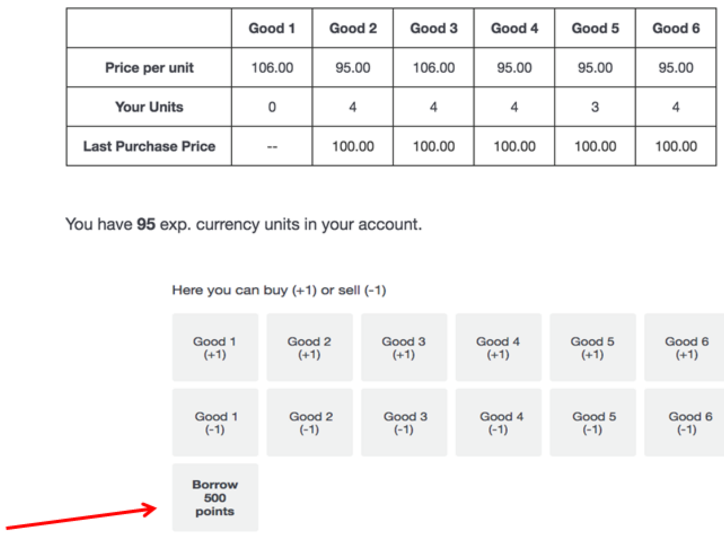
$$unlevered\ returns_{j,i,t} = \gamma_i + \gamma_t + \beta_1 \cdot log(leverage)_{j,i,t} + \beta_2 \cdot F_{p,t} + \beta_3 \cdot Trade_{j,i,t} + \varepsilon_{j,i,t}$$

Unlevered returns equals (for long positions) the spot price when the position in the currency is closed minus the spot price when the position opened, divided by the spot price when it is opened (visa versa for short positions). The variable *leverage* is the amount of leverage used in each trade. $Trade$ is a vector that includes the trade's size and holding period. Trader and day fixed-effects are γ_i and γ_t, respectively. This table uses all of the trades in the myForexBook data set. The data includes transactions from January 19, 2003 to April 24, 2012; however, the majority of transactions occur between 2009 and 2012. Standard errors are double-clustered by day and trader, and *, **, and *** denote the following significance levels $p < 0.10$, $p < 0.05$, and $p < 0.01$, respectively.

sample:	complete myForexBook data set			
dep var: unlevered returns	(1)	(2)	(3)	(4)
log(leverage)	-0.00361***	-0.00424***	-0.00512***	-0.00530***
	(0.00045)	(0.00054)	(0.00057)	(0.00061)
log(trade size)			0.00167***	-0.000915
			(0.00062)	(0.00062)
log(holding period)				-0.0132***
				(0.00071)
trader FE	x	x	x	x
day FE	x	x	x	x
currency risk-free rate differential	x	x	x	x
broker-pair FE		x	x	x
number of trades	5,083,091	5,082,928	5,039,709	4,854,087
R^2	0.054	0.058	0.058	0.065

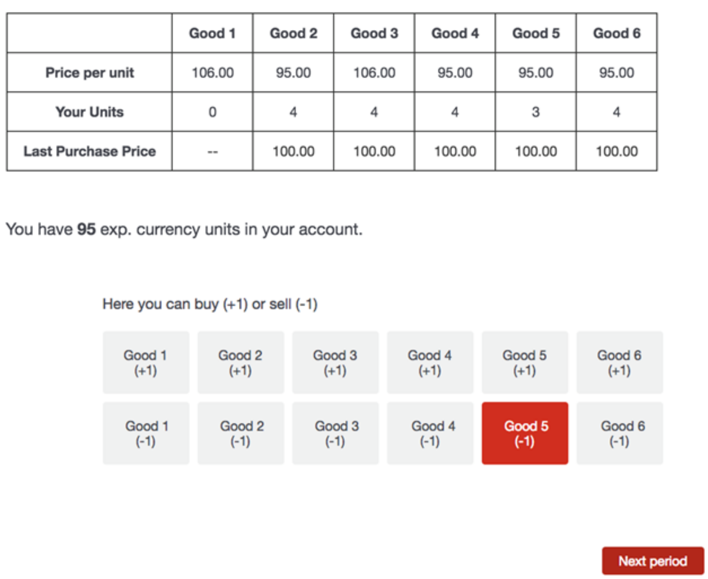
Figure A.1: **Trading Screen For Leverage and No Leverage Treatments**
Description: This figure shows the trading screen for our experimental setting. The top shows the Leverage group and the bottom shows the No Leverage group.

Leverage Treatment:



	Good 1	Good 2	Good 3	Good 4	Good 5	Good 6
Price per unit	106.00	95.00	106.00	95.00	95.00	95.00
Your Units	0	4	4	4	3	4
Last Purchase Price	--	100.00	100.00	100.00	100.00	100.00

No Leverage Treatment:



	Good 1	Good 2	Good 3	Good 4	Good 5	Good 6
Price per unit	106.00	95.00	106.00	95.00	95.00	95.00
Your Units	0	4	4	4	3	4
Last Purchase Price	--	100.00	100.00	100.00	100.00	100.00

Figure A.2: **Display of Assets for Treatment and Control Groups**

Description: This figure is from our experimental setting. It shows how the history of prices are displayed for both the treatment and control groups.

Period 3 out of 30

Periods -3 to 30

	Period -3	Period -2	Period -1	Period 0	Period 1	Period 2	Period 3
Price Good 1	100.00	106.00	112.36	100.00	106.00	112.36	**119.10**
+ (bought) /- (sold)	--	--	--	--	+0 / -0	+0 / -0	/
Price Good 2	100.00	95.00	100.70	100.00	106.00	100.70	**106.74**
+ (bought) /- (sold)	--	--	--	--	+0 / -0	+0 / -0	/
Price Good 3	100.00	106.00	112.36	100.00	106.00	112.36	**119.10**
+ (bought) /- (sold)	--	--	--	--	+0 / -0	+0 / -0	/
Price Good 4	100.00	95.00	90.25	100.00	95.00	100.70	**95.66**
+ (bought) /- (sold)	--	--	--	--	+0 / -1	+1 / -0	/
Price Good 5	100.00	106.00	112.36	100.00	95.00	100.70	**106.74**
+ (bought) /- (sold)	--	--	--	--	+0 / -1	+0 / -1	/
Price Good 6	100.00	106.00	112.36	100.00	95.00	100.70	**95.66**
+ (bought) /- (sold)	--	--	--	--	+0 / -0	+0 / -0	/