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Too Much “Skin in the Game” Ruins the Game: Evidence From Managerial Capital Gains Taxes

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Co-investment, often seen as a remedy for agency problems, may incentivize managers to cater to own preferences. We provide evidence that mutual fund managers with considerable co-investment stakes alter risk-taking decisions to prioritize their own tax interests. By exploiting the enactment of the American Taxpayer Relief Act 2012 as an exogenous shock of managerial capital gains taxes, we observe that co-investing fund managers increase risk-taking by 8%. Specifically, these managers adjust their portfolios by investing in stocks with higher beta. The observed effect appears to be driven by agency incentives, particularly for funds with a more convex flow-performance relationship and for managers who have underperformed. Such tax-induced behavior is associated with negative fund performance. We highlight the role of co-investment in transmitting managerial tax shocks to mutual funds.

Keywords: co-investment, risk-taking, taxation, mutual funds

JEL: G11, G18, G23, H24

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1 Introduction

"In short, we eat our own cooking. ...[N]o other testimonial means more."
— Warren E. Buffett, 2009 Shareholder letter of Berkshire Hathaway Inc.

It is a notion widely acknowledged, that a fiduciary manager in possession of a significant co-investment stake, must be in want of outperformance as investors do. An early articulation of this viewpoint in financial economics is Jensen and Meckling (1976), who shed light on how co-investment mitigates agency problems. Subsequent empirical work supports this view (Khorana et al., 2007; Agarwal et al., 2009; Cremers et al., 2009; Fu and Wedge, 2011; Ma and Tang, 2019; Agarwal et al., 2022). However, once fund managers have significant skin in the game, they may view their fund portfolio as an extension to their private portfolio and thus introduce personal considerations into their professional decision-making. For instance, an increase in personal capital gains taxes for fund managers, which presumably affects only their private portfolios, can now also affect their fund portfolios.

Recent studies have also drawn attention to the role of fund managers in transmitting personal tax shocks to their funds.[1] As fund managers are pivotal decision-makers for their funds, the influence of personal capital gains taxes on their individual behavior can potentially extend to their investment decisions within the funds. This spillover effect can be intensified when fund managers have considerable co-investment stakes. With over 70% of U.S. actively-managed equity funds having co-investment (Ma and Tang, 2019), understanding how co-investment facilitates the transmission of managerial tax shocks to mutual funds remains of great interest for academics, regulators, practitioners, and individual investors.

Ex ante, it is unclear how co-investing fund managers adjust investment decisions in response to personal capital gains tax changes. We develop a simple model to disentangle it. To begin, we consider that a mutual fund manager with co-investment assumes dual roles as both a manager and an investor of the fund. While an increase in capital gains taxes may not directly affect their payoff as a manager, it does have an impact on their payoff as an investor. The impact can be modeled based on the prediction put forth in the tax literature:[2] As capital gains taxes increase, risk-averse investors tend to undertake greater investment risk if they can effectively offset losses. The underlying intuition is as follows. When capital gains taxes increase, co-investing managers encounter a trade-off in deciding whether to take an additional unit of risk. In the case of gains, they face a higher marginal cost due to increased tax payments. However,

[1] In the hedge fund literature, Agarwal et al. (2021) find that personal income taxes distort the work incentives of hedge fund managers, leading to a decline in investment performance. In the corporate finance literature, Yost (2018) and Armstrong et al. (2019) provide evidence that CEOs adjust corporate risk-taking decisions in response to personal tax changes.

[2] See the seminal work of Domar and Musgrave (1944), the subsequent studies of Richter (1960) and Penner (1964), and the literature review of Dammon and Spatt (2012).

in the case of losses, they also experience a higher marginal benefit as they can offset a greater proportion of capital losses against capital gains. A risk-averse fund manager will appreciate the ability to reduce investment losses during bad times, even if it means paying higher taxes during good times, and therefore increases risk-taking. To a certain extent, this risk-sharing effect can be seen as insurance against downside risk, with the insurance protection being more pronounced under a higher tax regime compared to a lower one.

Motivated by the prediction of our theoretical model, we empirically test whether co-investing fund managers exhibit a tendency to pursue a riskier portfolio allocation as their capital gains taxes increase, with a specific focus on U.S. actively-managed domestic equity mutual funds. This investigation raises several follow-up questions that merit empirical exploration. For instance, what adjustments do these managers make to their portfolios? Is the effect primarily driven by agency incentives? Do fund investors experience negative consequences as a result? More generally, how do equity incentives shape mutual fund managers' responses to personal tax shocks?

Investigating the empirical association between managerial co-investment, personal capital gains taxes, and fund risk-taking is complex due to at least three factors. First, conventional risk measures fail to capture the ex-ante risk choices of fund managers. These measures, often constructed based on the standard deviation of fund returns, are heavily affected by the underlying volatility of holdings stocks, which prevents them from isolating managers' intended risk-taking decisions. Second, personal capital gains taxes have an effect on both fund *managers* and *investors*. In certain instances, fund managers may react to tax changes not only because of their private incentives but also because of their clientele considerations (Sialm and Starks, 2012), making it challenging to differentiate between these two channels. Third, managerial incentives may simultaneously react to tax changes. For instance, fund companies may adjust managers' compensation contracts when taxes change. In this paper, we aim to address these potential confounding effects and establish causal explanations.

To isolate ex-ante risk choices, we leverage the changes in portfolio holdings as a means to uncover the intended portfolio actions undertaken by fund managers. More specifically, we follow Kempf et al. (2009) and Huang et al. (2011) and construct a holdings-based risk-shifting measure. This measure is defined as the difference in volatility that exclusively comes from managers' active portfolio allocation in weightings, while keeping the underlying stock volatility constant. Unlike realized risk measures, this measure better captures the ex-ante risk choices of fund managers.

To rule out the impact of tax clienteles, we focus on the enactment of the American Taxpayer Relief Act 2012 (ATRA) as an event that represents an exogenous tax shock to fund managers. A noteworthy feature of the ATRA is that it increases only the tax rates of top earners, while leaving the tax code unchanged for the majority of taxpayers. Mutual fund investors, who are typically middle-income households, are unlikely to be affected by the ATRA.[3] In contrast, portfolio managers, known for their well-compensated occupation, are likely to experience a tax hike as a result. Therefore, we see the ATRA as a tax shock primarily affecting fund managers rather than fund investors.

We employ a difference-in-differences (DiD) analysis around the ATRA during the period of 2009 to 2015. We assign treatment and control groups based on a manually-collected dataset of managerial co-investment. The treatment group comprises funds whose managers have positive co-investment stakes prior to the ATRA event, while the control group consists of funds whose managers have no pre-event co-investment. We assume that treated managers are incentivized to respond to capital gains tax shocks by adjusting their fund portfolio, as their investment payoff is tied to fund performance through co-investment. In contrast, the controlled managers, who lack co-investment stakes, do not have the same incentives to respond. The treatment-control comparison in the DiD setting accounts for the underlying factors that drive the trends of both treatment and control groups. For instance, if fund companies have incentives, if any, to change managers' compensation contracts due to tax changes, this effect would apply to both treatment and control groups. Assuming both groups move in parallel in the absence of treatment, the post-treatment difference can potentially indicate the treatment effect of having co-investment. We test for common trends in an event study to alleviate the concern about violating the parallel trend assumption.

The baseline result of the DiD analysis confirms our hypothesis. Following the ATRA tax hike, co-investing fund managers increase risk-taking by 8%, relative to the standard deviation. The observed effect is both statistically and economically significant, compared to the 5-15% magnitude reported in other settings (Ma and Tang, 2019; Pool et al., 2019). In addition, the magnitude of this effect varies with the size of managers' co-investment stakes, with larger stakes leading to more pronounced risk-taking reactions. Our baseline findings remain robust across various specifications, including different choices of fixed effects, alternative risk-taking measures, event indicators, treatment indicators, and sample periods.

We further shed light on the timing of managers' risk-taking response. Our DiD event study shows that treated co-investing managers respond to the tax hike in 2014, one year after the enactment of the ATRA. In addition, we observe no significant pre-trends prior to the ATRA, confirming the absence of pre-treatment effects that are necessary for the internal validity of our DiD setting.

We proceed to investigate the portfolio adjustments made in response to increased capital gains taxes. Under a higher tax regime, co-investing managers tend to increase the share of equity holdings and actively reallocate their portfolios for higher exposure to systematic risk. Specifically, they prefer stocks with

[3] According to Burham (2013) and Bogdan and Schrass (2013), 72% of household investors earn less than $150,000 a year, far lower than the threshold of $400,000 required to be placed in the top tax bracket.

higher market beta and downside beta, while avoiding stocks with lottery-like features. The increase in portfolio beta may be associated with the characteristics of mutual funds as liquidity-constrained investors. Due to the restrictions on leverage, most mutual funds are unable to adjust their risk levels along the Capital Market Line in the Capital Asset Pricing Model (CAPM) framework. Instead, they increase their risk-taking by investing in high-beta assets, as documented in the study by Frazzini and Pedersen (2014).

Agency incentives appear to be important drivers to explain managers' risk-taking behavior in response to taxation. Our analysis shows that this behavior is primarily driven by fund managers who face a stronger convex flow-performance relationship and by those who have underperformed peers in the past two years. We attribute this finding to the interplay between the dual roles of co-investing fund managers. Perceiving greater risk-sharing under a higher tax regime as *investors* may amplify the existing agency considerations as *managers*. With insurance reducing the fear of negative outcomes of risk-taking, managers who can derive greater agency benefits are thus encouraged to take excessive risk. It seems that under a higher tax regime, co-investment may not be as effective an incentive alignment tool compared to when it is under a lower tax regime.

Such tax-induced risk-taking behavior is costly to mutual fund investors. We find a significant reduction in subsequent fund performance. For instance, co-investing fund managers experience a drop in their cumulative twelve-month returns by 11%, relative to the standard deviation, following the tax hike. Similar patterns are observed for fund alphas. The adverse performance consequence can be associated with managers' portfolio decisions to invest in higher-beta stocks, as the "betting-against-beta" behavior suggests that high-beta assets tend to have low alpha (Frazzini and Pedersen, 2014). In addition, the deteriorating performance can also be related to the amplified agency incentives, which motivates fund managers to optimize their profits even at the expense of overall fund performance (Huang et al., 2011).

Our study contributes to several strands of literature. First, we contribute to the literature on spillover effects of personal taxes on managerial risk-taking decisions. Previous studies have extensively documented the direct effect of personal taxes on individuals' investment decisions (see Dammon and Spatt, 2012, for a literature review). However, only recently have studies explored the spillover effects of personal taxes on professional managers. For instance, Armstrong et al. (2019) and Yost (2018) focus on the context of CEOs and find that they adjust corporate risk-taking in response to the changes in personal income and capital gains taxation. We are the first to extend the discussion to the context of mutual fund managers. Given that mutual funds play a key role in the wealth accumulation of more than half of U.S. households,[4] it is important for policymakers to consider the tax response of mutual funds when

[4]See "Mutual Funds Are Key to Building Wealth for Majority of US Households." (2022, October 31). Investment Company Institute. https://www.ici.org/news-release/22-news-ownership.

formulating optimal tax policies.

Second, we expand the literature on the roles of co-investment in mutual fund governance. Previous research has interpreted co-investment as an effective tool to align incentives and mitigate agency problems (Jensen and Meckling, 1976): it reduces disposition effect (Fu and Wedge, 2011), excessive risk-taking (Ma and Tang, 2019), and the tendency to hold lottery-like stocks (Agarwal et al., 2022), leading to an improvement in fund performance (Khorana et al., 2007; Agarwal et al., 2009; Cremers et al., 2009). Recent research has offered an alternative interpretation of co-investment, suggesting that it can serve as a mechanism through which fund managers incorporate their private considerations.[5] Our finding complements this literature by showing that co-investing fund managers take into account private tax considerations when determining fund risk-taking. These two interpretations are not mutually exclusive. For instance, Ma and Tang (2019) argue that co-investment can effectively mitigate agency-related risk-taking. Our study further adds that a higher tax regime can reverse this mitigating effect, making co-investment a less effective tool to temper excessive risk-taking.

Finally, we add to the asset management literature by examining the agency problems that arise from tax considerations. Previous studies have highlighted that implicit incentives, such as flows-based compensation, can lead to a variety of tax-induced agency problems (Barclay et al., 1998; Dickson et al., 2000; Harris et al., 2015). Yet, little attention has been paid to the explicit incentives of fund managers, such as compensation and equity incentives. A recent study by Agarwal et al. (2021) focuses on the context of compensation incentives and finds that higher income taxes for hedge fund managers are associated with reduced work incentives and worse fund performance. Our study adds to this literature by considering equity incentives and focusing on capital gains taxes. We find that higher capital gains taxes, coupled with co-investment, can incentivize agency-prone mutual fund managers to increase risk-taking, leading to a suboptimal performance. Together, both studies underscore the profound impact of personal taxation on fund management, revealing the complex dynamics between personal taxation, managerial incentives, and fund investment decisions.

2 Theoretical Background

The tax impact on individual portfolio decisions has been comprehensively established since the first investigation in Domar and Musgrave (1944) and subse-

[5] Orlov et al. (2022) share a similar spirit, as they interpret co-investment as a manifestation of the revealed beliefs of fund managers toward specific investment decisions in the context of ESG investing. In addition, Agarwal et al. (2022) show that a higher co-investment stake is associated with lower risk-taking in lottery stocks, indicating that fund managers have no preference over such stocks when betting with their own money. Their finding is in line with our interpretation of co-investment—it measures how much fund managers take into account their private considerations.

quent discussions in Feldstein (1969) and Stiglitz (1969). One conclusion is that investors take greater risk as tax increases under the assumption of full loss offset and risk aversion. Risk-averse investors—characterized by concave von Neumann-Morgensterm utility functions—appreciate an increase in investment payoff to a larger extent in bad times than in good. As a result, their utility gains in bad times, when they use capital losses to offset future taxable income, are much greater than the utility losses in good times due to tax payment. Put differently, risk-averse investors perceive the loss offset rule as an insurance contract with the government: they are insured against full loss in bad times, while paying a premium in good times. A higher tax regime thus implies that the government assumes more downside risk, motivating risk-averse investors to take on greater risk.

Fund managers who have co-investment stakes respond to personal tax changes in a way similar to individual investors. Figure 1 visualizes how co-investing fund managers respond to a tax hike. Suppose that managers have a concave utility function $U(\pi)$, i.e., $U' > 0$ and $U'' < 0$, where π is the payoff they derive from fund performance. Fund performance, $f_i(\sigma)$, is a function of risk-taking, σ, and is dependent on market conditions, $i \in \{good, bad\}$. In good times, with probability $p \in \{0, 1\}$, the investment delivers a gain, $f_g(\sigma) > 0$, that follows $f_g' > 0$ and $f_g'' < 0$. In bad times, with probability $(1 - p)$, it incurs a loss, $f_b(\sigma) < 0$, that follows $f_b < 0'$ and $f_b'' < 0$. In a world of full loss offset with tax $\tau \in \{0, 1\}$, the net payoff of co-investment takes the form:

$$\pi^{INV}(\sigma, \tau) = \begin{cases} (1-\tau)f_g(\sigma) > 0, & \text{in good times} \\ (1-\tau)f_b(\sigma) < 0, & \text{in bad times} \end{cases}$$

Notably, $-\tau f_g < 0$ is the capital gains tax payment and $-\tau f_b > 0$ is the tax savings due to loss offset. As seen in Figure 1, when tax increases from 0 to τ, the magnitude of utility gains in bad times, $MB = |U(f_b) - U((1-\tau)f_b)|$, are greater than that of utility losses in good times, $MC = |U(f_g) - U((1-\tau)f_g)|$, given that the utility function is concave, $U'' < 0$. As a result, fund managers are motivated to increase risk-taking.

So far, we have disregarded compensation incentives of fund managers and assumed that they behave similarly to individual investors. Now we further consider this aspect. Fund managers' total payoff associated with portfolio management can now come from two sources: the performance-linked compensation from their incentive contracts, π^0, and the investment payoff from their co-investment, π^{INV}.

$$\pi = \pi^0(\sigma) + \pi^{INV}(\sigma, \tau)V$$

where $V = \mathbb{1}(co - investment > 0)$ is a dummy variable indicating whether fund managers have co-investment. Note that π^0 is not a function of managers' personal taxes τ. Whether or not fund managers are rewarded by their incentive contracts should be independent of their own tax status.[6] For convenience, we specify the performance-linked compensation as $\pi^0 = zf(\sigma)$ with $z \geq 0$.[7]

$$\pi(\sigma, \tau) = \begin{cases} \pi_g = (z + (1-\tau)V)f_g(\sigma) > 0, & \text{in good times} \\ \pi_b = (z + (1-\tau)V)f_b(\sigma) < 0, & \text{in bad times} \end{cases}$$

With this payoff structure, fund managers make risk-taking decisions following a von Neumann-Morgensterm utility optimization. Their objective function is of the form:

$$\max_{\sigma(w)} EU\{\pi[\sigma(w)]\} = pU(\pi_g) + (1-p)U(\pi_b)$$

where total risk-taking, $\sigma(w)$, is a function of portfolio weightings, w, a variable that fund managers determine during portfolio management. To simplify the analysis, we examine fund managers' optimal risk-taking decisions (σ), instead of analyzing their optimal portfolio weightings (w), while still maintaining the insights obtained from our model. The optimal risk-taking, σ^*, satisfies the first order condition:[8]

$$\begin{aligned} FOC \equiv \frac{\partial EU}{\partial \sigma(w)} &= p[U'(\pi_g)\pi'_g] + (1-p)[U'(\pi_b)\pi'_b] \\ &= p[U'(\pi_g)(z + (1-\tau)V)f'_g] + (1-p)[U'(\pi_b)(z + (1-\tau)V)f'_b] \\ &= 0 \end{aligned}$$

The first order condition characterizes fund managers' risk-taking decision dynamics. With an additional unit of risk taken, the investing payoff increases in good times, $\pi'_g > 0$, but decreases in bad times, $\pi'_b < 0$; fund managers increase their risk-taking until their expected utility reaches zero. In addition, the decision dynamics have a second implication for co-investing fund managers, whose $V = 1$. Due to tax payment, $-\tau f_g < 0$, the co-investing fund managers have fewer utility gains in good times, but they also have fewer utility losses in bad times due to tax savings after offsetting losses, $-\tau f_b > 0$. Fund managers' ultimate risk-taking choice then depends on their risk attitudes, or as shown in Figure 1, the concavity of utility functions.

[6] Although compensation contracts may sometimes relate to after-tax performance metrics due to tax clienteles, the contracts are designed to induce optimal portfolio management based on *clients'* taxes, rather than *fund managers'* taxes.

[7] If we consider z a coefficient related to performance pay sensitivity (delta), we can set it as a function of fund performance and therefore sigma, $z(\sigma)$. The insights derived from this alternative model align with those of our current model.

[8] We check the sign of the second order condition, $SOC = p\{U''(\pi'_g)^2 + U'\pi''_g\} + (1 - p)\{U''(\pi'_b)^2 + U'\pi''_b\} < 0$, ensuring that σ^* derived from the first order condition maximizes the objective function.

By implicit function theorem, we can derive how fund managers change their optimal risk-taking with respect to personal tax changes:

$$\frac{d\sigma^*}{d\tau} = -\frac{\frac{\partial FOC}{\partial \tau}}{\frac{\partial FOC}{\partial \sigma}} = \frac{\frac{\partial FOC}{\partial \tau}}{-SOC} \tag{1}$$

where SOC is the second order condition.[9] Since $SOC < 0$, whether co-investing fund managers take greater risk then depends on the sign of the numerator in Equation (1). After rearrangement,[10] we show that

$$\frac{\partial FOC}{\partial \tau} = pU'(\pi_g)\pi'_g(R^A_g \pi_g - R^A_b \pi_b)(\frac{V}{z + (1-\tau)V}),$$

where the Arrow-Prat coefficient of absolute risk aversion, $R^A_i \equiv -\frac{U''(\pi_i)}{U'(\pi_i)}$, is greater than 0 for $i \in \{g, b\}$ under the assumption of utility concavity. Since U', π'_g, R^A_g, R^A_b, $\pi_g > 0$ and $\pi_b < 0$, we obtain

$$\frac{d\sigma^*}{d\tau} = \frac{\frac{\partial FOC}{\partial \tau}}{-SOC} \quad \begin{array}{l} > 0, \text{ if } V = 1, \text{ and} \\ = 0, \text{ if } V = 0. \end{array}$$

This comparative statics provides several implications. First, the magnitude of tax-induced risk depends on whether or not there is a co-investment stake. Fund managers who co-invest ($V = 1$) and those who do not ($V = 0$) behave differently: co-investing fund managers take on greater risk while their peers do not react to rising taxes. In addition, the magnitude of tax-induced risk depends on managerial risk aversion, R^A_i. The more risk-averse the fund managers are, the more risk they take on as taxes increase, as long as $R^A_i > 0$. Put differently, our analysis can apply to any concave utility functions without imposing further restrictions on risk aversion R^A_i.

Thus, under the assumption of loss offset and risk aversion, if managerial taxes increase, ceteris paribus, fund managers who have co-investment will increase fund risk-taking.

3 Data

We collect data from various sources, including the Center for Research in Security Press (CRSP), Morningstar Direct (MSD), the Electronic Data Gathering, Analysis, and Retrieval system (EDGAR), Thomson Reuters Mutual Fund

[9]The prerequisite of implicit function theorem, $\frac{\partial FOC}{\partial \sigma} \neq 0$, is by construction satisfied because $SOC < 0$.

[10]We show details of the rearrangement in Appendix A.1.

Holdings (TRH) database, and NBER TAXSIM (Feenberg and Coutts, 1993).[11] Following prior literature (Chen et al., 2004; Busse and Tong, 2012; Ferson and Lin, 2014; Busse et al., 2021), we screen actively managed U.S. domestic equity funds and compute fund-level variables by aggregating across different share classes based on lagged total net assets.[12]

We focus on the period from 2009 to 2015 around our event, the American Taxpayer Relief Act of 2012 (ATRA). We chose this sample period for several reasons. First, we include symmetric 3-year event windows before and after 2012, when the ATRA was passed. Second, as Trump's Tax Cuts and Jobs Act was announced in 2017 and led to substantial changes afterward, we omit the years after 2016 to avoid biases from other significant concurrent tax changes and potential anticipation effects—our major event, the ATRA, represents the only sizable federal-level tax change during the sample period.

3.1 Holdings-based risk shift measures

Although many previous studies measure risk-taking with the standard deviation of fund returns, such measures fail to isolate the intended change in fund risk from the realized one (Kempf et al., 2009; Huang et al., 2011). As Kempf et al. (2009) point out, "intended risk changes can deviate substantially from realized changes in fund risk because risk changes of stocks affect the change of funds' volatility dramatically"(p. 96), indicating that it may be inappropriate to measure intended risk changes by using return-based measures. To rule out the unexpected market risk, we follow Kempf et al. (2009) and Huang et al. (2011) and construct our holdings-based intended risk shift measure as follows:

$$\begin{aligned} \text{RS}_{i,t} &= \sigma^H_{it} - \sigma^R_{i,t-1} \\ &= stdev(w_t r_{t-1}) - stdev(w_{t-1} r_{t-1}) \\ &= \sqrt{w_t' \Sigma_{t-1} w_t} - \sqrt{w_{t-1}' \Sigma_{t-1} w_{t-1}} \end{aligned} \tag{2}$$

where $w_{i,t}$ refers to the portfolio weights of fund i at period t, and Σ_{t-1} refers to the covariance of stock holdings at the previous period $t-1$. Note that the numerator and denominator of Equation (2) share the same source of stock volatility, Σ_{t-1}, suggesting that the difference in volatility is solely driven by the changes in portfolio weights between period t and $t-1$, after controlling for the underlying stock volatility. As portfolio weighting allocation is the primary means by which fund managers achieve desired risk levels, changes in portfolio weights can thus reflect their ex-ante risk choices. For instance, an increase in $\text{RS}_{i,t}$ indicates that the managers of fund i have changed the portfolio weightings

[11]To merge CRSP Mutual Fund and TRH databases, we use the MFLINKS tables of Wermers (2000). To merge CRSP Mutual Fund and MSD, we apply the algorithm of Pástor et al. (2015) to reconcile the data discrepancies between MSD and CRSP Mutual Fund databases (Berk and van Binsbergen, 2015; Pástor et al., 2015).

[12]Details of screening criteria are shown in Appendix A.2. We use wficn as the portfolio-level identifiers.

at period t in a way that would result in a higher risk level at period t, assuming the underlying stock volatility remains unchanged from period $t-1$.

In our empirical analysis, we measure the $\mathrm{RS}_{i,t}$ at each quarter of year t by setting the base period to be the previous quarter and then taking a yearly average. The covariance of stock holdings is calculated by using the standard deviation of the prior 52 weekly returns. We annualize intended risk changes by multiplying them by the square root of 52. This measure is computed using equity holdings data from TRH and security price data from CRSP.

3.2 Co-investment data and summary statistics

We manually collect a dataset of managerial co-investment from the "Statement of Additional Information" in the annual fund prospectus filed to SEC EDGAR. Since 2005, fund managers have been obliged to disclose their personal investments of the funds they manage. This co-investment information is reported not as an absolute amount but within seven dollar ranges: \$0, \$1-\$10,000, \$10,001-\$50,000, \$50,001-\$100,000, \$100,001-\$500,000, \$500,001-\$1,000,000, or over \$1,000,000. Following prior studies (Khorana et al., 2007; Ma and Tang, 2019), we first appoint the midpoint of each reported range as an exact dollar amount to each manager. We then construct the fund-level co-investment by adding up each manager's stake in the fund.[13] Figure 2 displays the amount of managerial co-investment across different investment styles. Note that the co-investment stakes are similar across investment styles, alleviating selection concerns.

Summary statistics for managerial co-investment data as well as for risk-taking measures and control variables are provided in Table 1. We provide a detailed description of all variables in Appendix A.3. All data are available and analyzed at a yearly frequency. We winsorize all variables at the 1% level. The average fund in our sample increases the intended fund risk by 0.19%, with a standard deviation of 0.59%. It has about 1.87 billion USD in total net assets, a 19-year history, and 1.7% fund flows. More than 70% of our sample funds have at least one manager holding co-investment, and the average co-investment per manager amounts to \$289,280.

4 Empirical strategy and results

We use the American Taxpayer Relief Act 2012 (ATRA) as a natural experiment that led to a substantial tax increase in the U.S. in 2013. The ATRA was enacted to address the expiration of temporary tax provisions, including the Economic Growth and Tax Relief Reconciliation Act of 2001 (known as "Bush tax cuts"). To determine whether to extend these tax provisions, the legislation drafted the

[13]To address potential measurement errors, we use a binary indicator to represent the presence or absence of co-investment stakes, a variable that can be accurately constructed even when precise co-investment information is not available.

bill of the ATRA in late December 2012 and swiftly passed it on January 1st, 2013.[14] Under the ATRA, the top federal tax rate for long-term (short-term) capital gains increased from 15% to 20% (35% to 39.6%[15]) for high-income earners with an annual income exceeding $400,000,[16] while the tax code for other taxpayers remained unchanged. In addition, the Patient Protection and Affordable Care Act introduced a 3.8% net investment income tax.[17] Overall, this leads to a long-term (short-term) capital gains tax rate of 23.8 percent (43.4 percent) for top earners, which represents a staggering 58% (24%) increase in 2013 compared to the tax rates in 2012. Figure 3 visualizes the substantial increase in the long-term capital gains taxes experienced by top earners across all US states, resulting in a noticeable shift in the distribution of marginal tax rates toward higher levels.[18]

The ATRA presents a desirable research setting to distinguish between the tax effects driven by investor clienteles and those driven by managerial incentives, as it only affects top earners with an annual income greater than $400,000. Notably, mutual fund investors are unlikely to be high-earning taxpayers. According to Burham (2013) and Bogdan and Schrass (2013), the annual household income of a median mutual fund investor was $80,000 and only 18% of household investors earn more than $150,000 a year, far less than the threshold of $400,000 a year. In contrast, portfolio managers, commonly considered a high-paying occupation, are more likely to be placed in the top income bracket and subject to the tax shock than their investors. Thus, the ATRA tax hike can be seen as a tax shock that is more likely to affect fund managers than fund investors. If managers adjust fund risk-taking following the ATRA tax shock, it is unlikely that they respond to the tax changes for their investors' tax interests; instead, fund managers may do so for their own tax benefits.

We then employ a difference-in-differences (DiD) analysis around 2013, when the ATRA was enacted. We use the level of co-investment stakes in 2012, the year prior to the enactment of the ATRA, as the foundation for assigning treatment and control groups, in order to avoid variations in co-investment affecting our results. Specifically, the treatment group comprises funds whose managers had non-zero co-investment in 2012, while the control group consists of funds whose managers had no co-investment in 2012.[19] Notably, only the treated fund managers are motivated to respond to the tax shock by adjusting their fund portfolio, as their investment payoff is tied to fund performance through

[14] The Internet Appendix presents more details on the legislative history of the ATRA. Table IA.1 displays the legislative progress, and in Figure IA.1, Google Search Trend indicates that public attention to the tax increase only started to rise toward the end of 2012.

[15] Short-term capital gains, i.e., the capital gains from investments held for one year or less, are taxed at the same rate as ordinary income.

[16] The threshold amounts $450,000 for joint filers in 2013.

[17] The threshold amounts to $200,000 ($250,000) for single (joint) filers in 2013.

[18] State-level deduction rules lead to slight variations in the magnitude of tax changes across states.

[19] Median co-investment stakes per manager remain stable around the ATRA, mitigating the concern that taxes drive the changes in co-investment.

co-investment stakes. The treatment-control comparison in the DiD setting accounts for the underlying factors that drive the trends of both treatment and control groups, mitigating concerns about confounding factors. Assuming that the compensation structure of treated managers does not change systematically compared to controlled managers after the ATRA tax hike, we can identify the relationship between managerial capital gains taxes and fund risk-taking by comparing behavioral changes between the groups.[20]

4.1 Baseline: do co-investing managers increase risk-taking?

Our hypothesis posits that co-investing fund managers take on more risk as taxes increase. To test this hypothesis, we estimate the following DiD regression:

$$\begin{aligned} \mathrm{RS}_{i,t} = \beta_1 \mathrm{Post}_t + \beta_2 \mathrm{Treat}_i + \beta_3 \mathrm{Post}_t \times \mathrm{Treat}_t + \Gamma_1 \mathrm{Z}_{i,t-1} \\ + \mu_i + v_t + \epsilon_{i,t} \end{aligned} \tag{3}$$

where the dependent variable $\mathrm{RS}_{i,t}$ is fund i's across-year risk shift across quarters of year t. We measure $\mathrm{RS}_{i,t}$ at period t while independent variables at period $t-1$ so as to mitigate potential reverse causality concerns. $\mathrm{Post}_{s,t}$ is a binary variable equal to 1 after 2013, when the ATRA was enacted and led to a significant tax increase in the U.S. Treat_i is a binary variable indicating that fund i held non-zero co-investment, prior to the enactment of the ATRA. Alternatively, we define Treat_i as a continuous variable of the logarithm of the pre-event co-investment. The coefficient of $\mathrm{Post}_t \times \mathrm{Treat}_i$, β_3, is of primary interest to us. It captures the relationship between changes in taxes and changes in risk-taking conditional on co-investment. According to our hypothesis, we expect β_3 to be positive, implying that the treated fund managers, who have co-investment stakes prior to the ATRA, take on more risk when experiencing a positive tax shock in 2013.

To account for other factors that may influence managerial risk-taking decisions, we follow Ma and Tang (2019) and include a set of additional variables to control for manager-, fund-, and family-specific characteristics, including the team management dummy, the logarithm of maximum tenure among the management team, the logarithm of fund size, the logarithm of fund age, fund flows, expense ratio, the logarithm of turnover ratio, fund activeness, and the logarithm of fund family size.[21] We include both year and fund fixed effects, which capture any pre-existing time-invariant differences between the two groups. To enable

[20] As the tax increase in 2013 was rather unexpected (Table IA.1 of the Internet Appendix), it is unlikely that managers anticipated the tax changes and negotiated a different compensation structure in the short run. Furthermore, there is little evidence that CEOs engage in compensation negotiations due to the changes in top marginal tax rates (Goolsbee, 2000; Hall and Liebman, 2000; Frydman and Molloy, 2011). Considering that CEOs typically have more bargaining power over compensation than mutual fund managers, it is unlikely that mutual fund managers negotiate compensation arrangements in response to higher taxes.

[21] Kempf and Ruenzi (2008), Kempf et al. (2009), and Huang et al. (2011) suggest that funds with certain characteristics take more risk; for instance, funds with a higher expense ratio,

comparison with Ma and Tang (2019), we also present results using year and investment style fixed effects as they do. To address the autocorrelation within the same fund over time, we cluster standard errors at the fund level.

Table 2 presents the results of our baseline regression as specified in Equation (3). We begin by analyzing the setting of Ma and Tang (2019) and then proceed to analyze our specifications with more stringent fixed effects. Column 1 and Column 3 report the regression results using Ma and Tang (2019)'s settings. We observe statistically significant negative estimates of β_2 for the co-investment variables, I(pre-coinvestment > 0) and log(pre-coinvestment), at the 5% significance level. These findings confirm the findings of Ma and Tang (2019), demonstrating that managerial co-investment stakes effectively reduce agency-induced risk-taking.

As predicted by our hypothesis, we observe statistically significant positive estimates of β_3 for our primary variables of interest, the interaction terms Post $\times$ I(pre-coinvestment > 0) and Post $\times$ log(pre-coinvestment), with significant levels of at least 5% in Column 1 and Column 3, where year and style fixed effects are used. We find similar results when employing more stringent year and fund fixed effects in Column 2 and Column 4. The inclusion of fund fixed effects absorbs the treatment assignment variables and provides an estimate of β_3 similar in magnitude and significance levels.

The effects are also of economic significance. On average, the dependent variable, RS, has a mean of 0.19% with a standard deviation of 0.59% over our sample period. Therefore, the 0.046 coefficient of the estimated β_3 in Column 2 indicates that after the ATRA tax hike, the co-investing fund managers increase risk-taking by 8% (=0.046 / 0.59 $\times$ 100), relative to the standard deviation. Similarly, the 0.005 coefficient of the estimated β_3 in Column 4 indicates that an average fund manager with log(co-investment) equal to 9.38 subsequently increases risk-taking by 8% (=9.38 $\times$ 0.046 / 0.59 $\times$ 100), relative to the standard deviation. Our observed effect is considerable when compared to the 15% decrease in fund risk-taking reported in Ma and Tang (2019).[22] While co-investment is often seen as an incentive alignment mechanism to mitigate agency-related risk-taking, our study demonstrates that capital gains taxes can partially reverse this mitigating effect. Overall, our findings support the hypothesis that co-investing fund managers take on more risk in the year following a tax hike.

Although co-investing fund managers are affected by the ATRA tax shock, their reactions may vary depending on the size of their co-investment stakes. If managers have minimal investments in the funds they manage, they may be less concerned about the additional impact of the tax shock and thus may not alter

funds managed by a single manager, funds affiliated with larger families, funds with worse performance, funds that are younger, funds managed by managers with shorter tenure, and funds with higher activeness.

[22] Other settings provide a comparable magnitude of effect on the holdings-based risk difference. For example, Pool et al. (2019) report that a fund manager who experiences a wealth shock decreases the holdings-based risk difference by 8% relative to the standard deviation.

fund risk-taking in response. For example, when using I(pre-coinvestment $>$ 0) as a treatment assignment variable, we may include managers who invest only $1 in the funds they manage in the treatment group; presumably, they are barely affected by the tax shock through such a tiny co-investment. Including managers with a small amount of co-investment can substantially bias our estimates toward zero.

To investigate how much it affects our estimate, we define two alternative treatment assignment variables: (1) I(pre-coinvestment $>$ Q50) and (2) I(pre-coinvestment $>$ Q75). The former is a binary variable indicating that the fund held a stake larger than the 50th percentile of the co-investment prior to the enactment of the ATRA, while the latter uses the 75th percentile as the cutoff. Both treatment variables exclusively assign managers with a significant amount of co-investment stakes to the treatment group. We display the estimates of β_3 using the 50th percentile and the 75th percentile cutoffs in Column 5, and Column 6 of Table 2. Compared to the estimated β_3 in Column 2 using zero as the cutoff, the 0.084 coefficient in Column 5 using the 50th percentile is 2 times larger and amounts to 14% increase in risk-taking relative to the standard deviation. The number increases to 19% when we use the 75th percentile to assign treatment, as shown in Column 6. Both coefficients are significant at the 1% level. Clearly, the coefficient of the estimated β_3 becomes more pronounced in magnitude and statistical significance as we raise the cutoff for the treatment assignment. Fund managers with larger co-investment stakes can be more exposed to the capital gains tax shock following the ATRA. This is due to their increased likelihood of accruing higher taxable investment income from their co-investment stakes. As a result, the coefficient β_3 in Column 2, where I(pre-coinvestment $>$ 0) is used, can be seen as a conservative estimate and serves as a lower bound for the impact of managerial capital gains tax shocks on fund risk-taking through co-investment stakes.

In the Internet Appendix, we show that our baseline findings remain robust across various specifications, including different choices of fixed effects (Table IA.2), alternative risk-taking measures (Table IA.3), event indicators (Table IA.4), treatment indicators (Table IA.5), and sample periods (Table IA.6). In addition, we find similar results when using an alternative state-level identification strategy proposed by Card (1992) (Table IA.7).

4.2 Dynamics: when do co-investing managers increase risk-taking?

We continue to discuss the validity of the parallel trend assumption and the timing of when fund managers increase fund risk-taking by employing a DiD event study analysis.

The validity of our DiD baseline results relies on the parallel trend assumption, i.e., in a counterfactual world where the ATRA were not implemented, the difference in underlying risk-taking behavior between the treatment and control groups would remain constant over time. To confirm, we employ a DiD event study design:

$$\begin{aligned}\text{RS}_{i,t} = \Sigma_{k\neq 2012}\beta_k year_k \times \text{I(pre-coinvestment} > 0)_i + \Gamma_1 Z_{i,t-1} \\ +\mu_i + v_t + \epsilon_{i,t}\end{aligned} \quad (4)$$

where the dependent variable $\text{RS}_{i,t}$ is fund i's across-year risk difference of year t, and $year_k$ is a dummy equal to one in year k and zero otherwise; all other variables are defined as in Equation (3). We are mainly interested in the interactions of $year_k$ and $I(pre-coinvestment > 0)$, which capture the development of the treatment group over time. We normalize the coefficient in the period preceding the treatment, β_{2012}, to zero. We interpret the coefficient β_k as the difference in the reaction between fund managers with and without co-investment in year k, relative to the year 2012. Identical to Equation (3), we include the same set of controls and fixed effects, and the standard errors are clustered at the fund level.

Figure 4 visualizes the event study estimation as specified in Equation (4). If the parallel trend assumption were violated, we would expect to observe a significant pre-trend between the treatment and control groups prior to the ATRA. As shown in Figure 4, the coefficients for 2009, 2010, and 2011 do not show significant differences between the treatment and control groups, and the point estimates are close to zero. We do not find direct evidence that would suggest a violation of the parallel trend assumption. Despite that, we fully acknowledge the limitation that the absence of pre-trends in the DiD event study does not guarantee the validity of the parallel trend assumption or a causal interpretation of the baseline results obtained from the DiD analysis. However, we could still claim that we find a variable, co-investment, that effectively identifies a subgroup most likely to increase risk-taking as taxes increase.

Another observation from Figure 4 is that the treated fund managers do not immediately respond to the ATRA tax hike following its enactment. We identify an effect in 2014, one year after the implementation of the ATRA. There are two plausible explanations for this delayed response. First, it may be associated with the timing of the execution of tax-motivated transactions. The literature has documented that the loss offset mechanism incentivizes investors to engage in year-end tax strategies (Dyl, 1977; Givoly and Ovadia, 1983; Keim, 1983). Grinblatt and Keloharju (2004) provide a wash sale example, where investors sell losers in December and repurchase the same stocks in January the next year. Since the ATRA was passed on January 1st and swiftly implemented on January 2nd of 2013, fund managers aiming to leverage the loss offset mechanism must wait until the year-end of 2013 to achieve the optimal execution timing. If tax-motivated transactions predominantly occur around the turn of the year, it is plausible that we only observe the overall effect of risk-taking in 2014 when all tax-relevant transactions are executed. We provide indirect evidence on the timing of tax-motivated transactions in Figure IA.2 and Figure IA.3 of the Internet Appendix. As shown in Figure IA.2, we observe a substantial change in realized capital gains in 2014, suggesting the presence of transactions that lead to changes in the tax liability distribution. We observe a similar, albeit borderline significant, 2014 effect for the unrealized capital gains in Figure IA.3.

Second, limited attention and tax salience may contribute to an underreaction to taxes (Chetty et al., 2009; Finkelstein, 2009; Krishna, 2003). In the U.S., individuals typically file their annual tax returns in the months following the end of the income year. Given that the ATRA was passed on short notice and affected only a specific subgroup of taxpayers, it is plausible that fund managers initially underestimated, or were unaware of, the extent of the ATRA tax changes due to limited attention. However, in 2014 when they filed their tax liability incurred during the previous year, every affected fund manager should have understood the content of the tax shock and consequently reacted to it. Put differently, the delayed response can be explained if we interpret the ATRA as a tax shock that travels slowly.

Our first explanation provides a rational foundation for understanding the delayed response of the affected fund managers, while the second explanation assumes behavioral bias among fund managers. Note that these two explanations are not mutually exclusive.

4.3 Mechanism: how do co-investing managers increase risk-taking?

After establishing the magnitude and the timing of the observed effect, we proceed to discuss the portfolio decisions made by fund managers following the ATRA tax hike. To understand how co-investing fund managers increase risk-taking by portfolio manipulation, we estimate the following regression:

$$\begin{aligned} \text{PortfolioDecision}_{i,t} = \beta_1 \text{Post}_t + \beta_2 \text{Treat}_i + \beta_3 \text{Post}_t \times \text{Treat}_t \\ + \Gamma_1 \text{Z}_{i,t-1} + \mu_i + v_t + \epsilon_{i,t} \end{aligned} \tag{5}$$

where we control for the same set of variables, include the same fixed effects, and cluster standard errors at the fund level, as the specification specified in the baseline analysis. The dependent variable, $\text{PortfolioDecision}_{i,t}$, includes a set of variables associated with portfolio decisions that fund i can make in year t. Following the prior literature, we explore various dimensions of portfolio decisions, including the allocation between cash and equity holdings, the number of portfolio stocks, exposure to systematic as well as idiosyncratic risk, market beta, downside beta, and lottery-like stock holdings (Huang et al., 2011; Agarwal et al., 2022). Our primary focus lies in the estimated β_3, which represents the divergent portfolio decisions made by managers with and without co-investment after the ATRA tax hike. Table 3 presents the results obtained by estimated Equation (5) and provides an overview of various portfolio decisions potentially made by fund managers following a tax hike.

The first set of portfolio decisions is associated with the allocation between risk-free and risky assets. If fund managers attempt to increase fund risk-taking, they can reduce the weighting on cash holdings and increase the weighting on risky assets. To investigate whether the co-investing fund managers undertake these actions, we estimate Equation (5) for the following dependent variables: the percentage of equity holdings, the percentage of cash holdings, and the number of stocks in the fund portfolio. We observe a positive and statistically significant β_3 in the regression of equity holdings in Column 1, while insignificant β_3 in the regressions of cash holdings in Column 2. These suggest that when co-investing managers experience a tax hike, they respond by allocating more capital to equity holdings. In addition, they do not decrease cash holdings, possibly because most mutual funds need cash holdings to meet daily redemption requirements. We further examine whether co-investing fund managers increase equity holdings by including more stocks in the portfolio. Column 3 shows that they do not include more stocks in the portfolio, suggesting that they may instead allocate more weight to the existing portfolio stocks.

The second set of portfolio decisions is associated with the allocation of risky assets. If fund managers aim to increase risk-taking by allocating more to equity holdings, they can increase either their exposure to systematic risk or to idiosyncratic risk. To investigate this mechanism, we construct two variables to capture the systematic risk shift and the idiosyncratic risk shift. First, we estimate a Carhart (1997) four-factor model based on daily returns for fund i in year t.

$$R_{i,t} - R_{f,t} = \alpha_i + \beta_i^m (R_{m,t} - R_{f,t}) + \beta_i^s SMB_t + \beta_i^h HML_t + \beta_i^u UMD_t + \epsilon_{i,t} \quad (6)$$

Then we decompose daily fund returns into two components: the return component attributable to bearing systematic risk, $R_{i,t}^{sys}$, and the other return component attributable to bearing idiosyncratic risk, $R_{i,t}^{idio}$, based on the estimated betas from Equation (6).

$$R_{i,t}^{sys} = \hat{\beta}_i^m (R_{m,t} - R_{f,t}) + \hat{\beta}_i^s SMB_t + \hat{\beta}_i^h HML_t + \hat{\beta}_i^u UMD_t$$
$$R_{i,t}^{idio} = R_{i,t} - R_{i,t}^{sys}$$

We proceed to construct the systematic risk shift by using $R_{i,t}^{sys}$ in Equation (2). Similarly, we construct the idiosyncratic risk shift by using $R_{i,t}^{idio}$. The higher the systematic (idiosyncratic) risk shift, the more actively fund managers reallocate the portfolio toward stocks with higher systematic (idiosyncratic) risk. To examine the source of risk shift, we estimate Equation (5) for the systematic risk shift and the idiosyncratic risk shit. We observe a positive and statistically significant β_3 in the regression for the systematic risk shift in Column 4, while an insignificant estimate for the idiosyncratic risk shift in Column 5. These results suggest that the risk shifts of co-investing managers are mainly driven by the systematic risk component, rather than the idiosyncratic one.

The final set of variables we explore is associated with the characteristics of holdings stocks. If fund managers aim to increase systematic risk-taking, we would expect to observe a higher level of beta in the portfolio. We observe a positive and statistically significant β_3 in the regression for market beta in Column 5 of Table 3. In Column 6, we show a similar estimate for downside beta, which is an alternative beta calculated using return data conditional on the below-mean market factor (Ang et al., 2006). The increase in portfolio beta is consistent with the observed increase in managers' systematic risk shifts, as shown in Column 4. Moreover, the increase in portfolio beta may be associated with the characteristics of mutual funds as liquidity-constrained investors. Due to the restrictions imposed by their charters, many mutual funds are prohibited from utilizing leverage, preventing them from adjusting their risk levels along the Capital Market Line (CML) in the Capital Asset Pricing Model (CAPM) framework. As documented in the study by Frazzini and Pedersen (2014), they instead increase their risk-taking by investing in high-beta assets. This "betting-against-beta" behavior can result in adverse performance consequences, which will be discussed in a subsequent section.

In addition to portfolio beta, we further examine whether fund managers increase lottery holdings. Agarwal et al. (2022) document that fund managers who engage in risk-shifting behavior tend to increase lottery holdings, in order to attract investor flows. To investigate whether it explains the risk-taking behavior of co-investing managers, we construct a portfolio-level measure for lottery features of holding stocks following the prior literature (Agarwal et al., 2022; Bali et al., 2011). We retrieve for each stock s the highest daily return during the previous month, MAX_s, and then compute the holding-weighted average of MAX_s across all stock held by a fund as $\text{MAX}_i^{\text{Hold}}$. We then take a yearly average for each fund. In Column 8 of Table 3, we present the regression result for this lottery-like measure. We observe a negative β_3 significantly at the 10% level. This suggests that co-investing managers do not increase fund risk-taking by investing in lottery stocks, or they may even avoid holding lottery stocks, following the tax hike. Our finding does not contradict that of Agarwal et al. (2022). As highlighted in Agarwal et al. (2022), fund managers tend to invest less in lottery stocks when they have a higher co-investment stake, indicating a reverse revealed preference for such stocks. In our scenario, if co-investing fund managers take risk for their own benefit, it is unlikely that they would invest in stocks that go against their own preferences.

4.4 Incentive: why do co-investing managers increase risk-taking?

We proceed to explore reasons as to why co-investing fund managers are likely to increase risk-taking following a tax hike. Prior literature documents that fund managers exhibit greater risk-taking incentives when they encounter a convex flow-performance relationship and when they underperform compared to their peers (Brown et al., 1996; Chevalier and Ellison, 1997; Kempf and Ruenzi, 2008; Kempf et al., 2009; Hu et al., 2011; Ma and Tang, 2019). We associate the former with the explicit incentives derived from managers' compensation contracts and the latter with the implicit incentives stemming from managers' employment risk.

To examine whether these incentives are associated with risk-taking decisions made by co-investing managers, we estimate the following triple difference-in-differences (3DiD) analysis:

$$\begin{aligned}\mathrm{RS}_{i,t} = \alpha &+ \beta_1 \mathrm{Post}_t + \beta_2 \mathrm{Treat}_i + \beta_3 \mathrm{Incentive}_{i,t-1} \\ &+ \beta_4 \mathrm{Post}_t \times \mathrm{Treat}_t + \beta_5 \mathrm{Post}_t \times \mathrm{Incentive}_{i,t-1} + \beta_6 \mathrm{Treat}_i \times \mathrm{Incentive}_{i,t-1} \\ &+ \beta_7 \mathrm{Post}_t \times \mathrm{Treat}_t \times \mathrm{Incentive}_{i,t-1} \\ &+ \Gamma_1 \mathrm{Z}_{i,t-1} + \mu_i + v_t + \epsilon_{i,t} \end{aligned} \tag{7}$$

where the definition of $\mathrm{RS}_{i,t}$, Post_t , and Treat_i, the choice of control variables and fixed effects, and the variable used to cluster standard errors are the same as the baseline specification. The key variable of the triple interaction term, $\mathrm{Incentive}_{i,t-1}$, captures the risk-taking incentive related to either fund convexity or fund underperformance. Our primary focus lies in the estimated β_7, which tackles the question of whether co-investing managers' risk-taking decisions are driven by the corresponding incentive. Table 4 presents the results obtained by the estimated Equation (7).

Column 1 shows the results for the risk-taking incentive related to the convex flow-performance relationship. Following the prior literature (Longin and Solnik, 2001; Ang and Chen, 2002; Hong et al., 2007; Ma and Tang, 2019), we construct a proxy of fund convexity, defined as the difference in the correlation between flows and past returns conditional on the returns being positive and negative:

$$\mathrm{Convexity} = \mathrm{corr}(\mathrm{Flows}, \mathrm{Return}^+) - \mathrm{corr}(\mathrm{Flows}, \mathrm{Return}^-)$$

where Return^+ (Return^-) refers to a positive (negative) twelve-month past return and the correlations are measured using monthly data from the past five years. The convexity measure captures the asymmetric response of investors to fund performance: the wider the correlation difference, the more investors reward the stellar performance and the less they penalize the poor performance. Using this convexity measure, we estimate the 3DiD regression and show a significantly positive β_7 on the triple interaction term. This implies that among all the co-investing fund managers, those who face a stronger convex flow-performance relationship exhibit a greater tendency to take on more risk after the tax hike. This is because a stronger convex flow-performance relationship amplifies the benefit of risk-taking: managers can attract greater fund inflows in cases where risk-taking yields positive outcomes.

In addition, Column 2 shows the results for the risk-taking incentive related to underperformance among peers. To proxy for underperforming funds, we construct a binary variable, *Loser*, which takes a value of 1 if the fund's past performance falls within the bottom 25% percentile among peers. We adopt a three-year evaluation window because Ma and Tang (2019) document that most fund managers are evaluated based on this timeframe in their compensation contracts. Using this underperformance proxy, we estimate the 3DiD regression and show a significantly positive β_7 on the triple interaction term. This indicates that among all the co-investing fund managers, those who have the poorest performance are more likely to engage in risk-taking after the tax hike.

Based on the results in Columns 1 and 2, we find agency-related incentives are highly related to post-event risk-taking, and moreover, they seem to be the primary drivers of the risk-taking effects. As shown in Columns 1 and 2, the coefficient of particular interest to us in the baseline analysis, Post × Treat, becomes insignificant after the inclusion of the triple interaction term involving the agency-related incentives. We find similar results when substituting the co-investment dummy with the continuous treatment intensity variable, the logarithm of co-investment, in Columns 3 and 4.

One may argue that a potential agency conflict can arise from the disparity in tax rates between fund managers and investors. With substantial co-investment stakes, fund managers may perceive themselves as the preeminent investors and accord precedence to their own tax interests over those of other investors. If this were the case, positive estimates of β_4 for the Post × Treat variable would be observed, as tax considerations are supposedly independent of fund convexity and managerial underperformance. However, the mostly insignificant estimates of β_4 suggest that tax considerations, from the perspective of investors alone, cannot fully account for the increased risk-taking observed among co-investing fund managers.

Alternatively, we attribute the positive risk-taking effect to the interplay between the dual roles of co-investing fund managers. In their role as investors, they can share more downside risk with the government as taxes increase, which reduces their fear of negative outcomes associated with risk-taking. This, in turn, intensifies the agency considerations in their role as managers. With a lower cost of excessive risk-taking, managers who can derive greater agency benefits are particularly incentivized to take on greater risk. To some extent, the after-tax insurance protection received from the "investor" side fuels the agency incentives from the "manager" side.

Finally, the 3DiD analysis also helps alleviate concerns about an alternative explanation based on managerial traits. One may consider co-investing fund managers less risk-averse and more overconfident, because they are willing to invest their own wealth in the funds where they have locked in substantial human capital. In this case, co-investing fund managers could take on more risk after the tax hike regardless of their agency incentives. However, we do not observe a significant coefficient of Post × Treat. We observe the post-event risk-taking effect only for funds with stronger agency incentives.

4.5 Consequence: fund performance

Finally, we discuss the consequences associated with tax-induced risk-taking behavior. We estimate the following regression:

$$\begin{aligned}\text{Performance}_{i,t} = \beta_1 \text{Post}_t + \beta_2 \text{Treat}_i + \beta_3 \text{Post}_t \times \text{Treat}_t + \Gamma_1 \text{Z}_{i,t-1} \\ + \mu_i + v_t + \epsilon_{i,t}\end{aligned} \quad (8)$$

where the dependent variable, Performance, includes cumulative twelve-month returns, CAPM alpha, Fama-French three-factor alpha, and Carhart (1997) four-factor alpha. Factor alphas are the intercept from the fund-year-level regressions of daily excess fund returns on the daily factors, such as market factor (CRSP value-weight market return minus the one-month Treasury bill rate), SMB (small-minus-big) factor, HML (high-minus-low) factor, and momentum factor (Fama and French, 1993; Carhart, 1997). We control for the same set of variables as in Equation (3). We include year and fund fixed effects and cluster standard errors at the fund level.

Table 5 presents the results obtained by estimating Equation (8). The estimates of the interaction term, β_3, are negative and statistically significant at the 1% level, regardless of the choice of fund performance measures. The effects are also of economic significance. Given the standard deviation of the cumulative twelve-month returns equal to 15.4%, the -1.702 coefficient in Column 1 implies that co-investing fund managers experience a drop in the cumulative twelve-month return by 11% (= $|$-1.702 / 15.4 $\times$ 100$|$), relative to the standard deviation, after the ATRA tax hike. Similarly in Column 4, we observe a drop in four-factor alpha by 23% (= $|$-0.388 / 1.7 $\times$ 100$|$), relative to the standard deviation. Although the magnitude of the estimated β_3 is rather small, the relative magnitude to the standard deviation is sizable. It seems that there are negative performance consequences as co-investing managers increase risk-taking in response to rising taxes.

One plausible explanation for the decreasing performance can be attributed to the "betting-against-beta" behavior of investors. As documented in Frazzini and Pedersen (2014), high-beta assets are associated with low alpha because of leverage constraints. In the ideal world of the CAPM, mean-variance agents invest in the optimal portfolio with the highest Sharpe ratio, and they leverage to reach their desired risk levels. However, some investors are constrained in the leverage they can use; they alternatively overweigh risky assets in order to reach their desired risk levels. The high demand for high-beta assets results in a lower required risk premium for these assets. We show in Section 4.3 that co-investing managers take on more risk by increasing fund beta after the tax hike. Our observed increase in fund beta and the subsequent decrease in fund returns are consistent with the prediction of the "betting-against-beta" story as documented in Frazzini and Pedersen (2014).

In addition, performance deterioration can also be attributed to the amplified agency incentives. As discussed in Huang et al. (2011), when fund managers face a more convex relationship between flows and performance, they tend to prioritize their profits, often at the expense of overall fund performance. Moreover, if underperforming fund managers engage in risk shifting due to their inferior ability, it is reasonable to expect poor performance. In Section 4.4, we show that the primary drivers for risk-shifting are fund convexity and managerial underperformance; as a result, the observed decline in performance is anticipated.

5 Conclusion

This paper examines the complex dynamics between personal taxation, managerial incentives, and fund investment decisions. Exploiting the enactment of the American Taxpayer Relief Act 2012 (ATRA) as a natural experiment, we provide evidence that co-investing fund managers respond to the ATRA tax shock by increasing fund risk-taking, with a significant response one year after the tax hike. They increase equity holdings and actively reallocate their portfolios for higher exposure to systematic risk. Specifically, they increase holdings in stocks with higher market beta and downside beta, while reducing the holdings in stocks with lottery-like features. In addition, this risk-taking effect is driven by funds facing a stronger convex flow-performance relationship and by managers who have underperformed compared to their peers over the past two years, suggesting that agency incentives may be the underlying drivers. Consequently, fund investors experience a negative fund performance. Taken together, we highlight the spillover effect of managerial taxation on mutual fund risk-taking through co-investment, an incentive alignment tool that becomes less effective under a higher tax regime.

This study has implications for mutual fund investors, investment companies, and policymakers. For fund investors, it is crucial to be aware of whether their fund managers hold shares in the funds they manage and how they respond to personal tax shocks, as their reaction can lead to adverse performance consequences. For investment companies, they should consider reevaluating fund managers' compensation contracts whenever there are changes in managerial taxes. It is necessary to design optimal incentive contracts that uphold the fiduciary duty of fund managers. By taking into account how taxes can distort the risk-taking incentives of fund managers, investment companies can ensure the alignment of interests and promote effective risk management within their organizations. Last but not least, policymakers should consider the tax response of mutual fund managers when formulating optimal policies related to personal taxation. This is important because fund managers are influential individuals whose decisions can potentially influence trillions of dollars in assets in the capital market. We argue that it is an important policy consideration because the impact of a personal tax shock may unintentionally go beyond the scope of individual fund managers and spill over, through co-investment, to a broader group of investors. Overall, we call for greater awareness of the interplay between personal taxes and managerial co-investment and urge mutual fund investors, investment companies, and policymakers to consider measures to mitigate its potential adverse effects.

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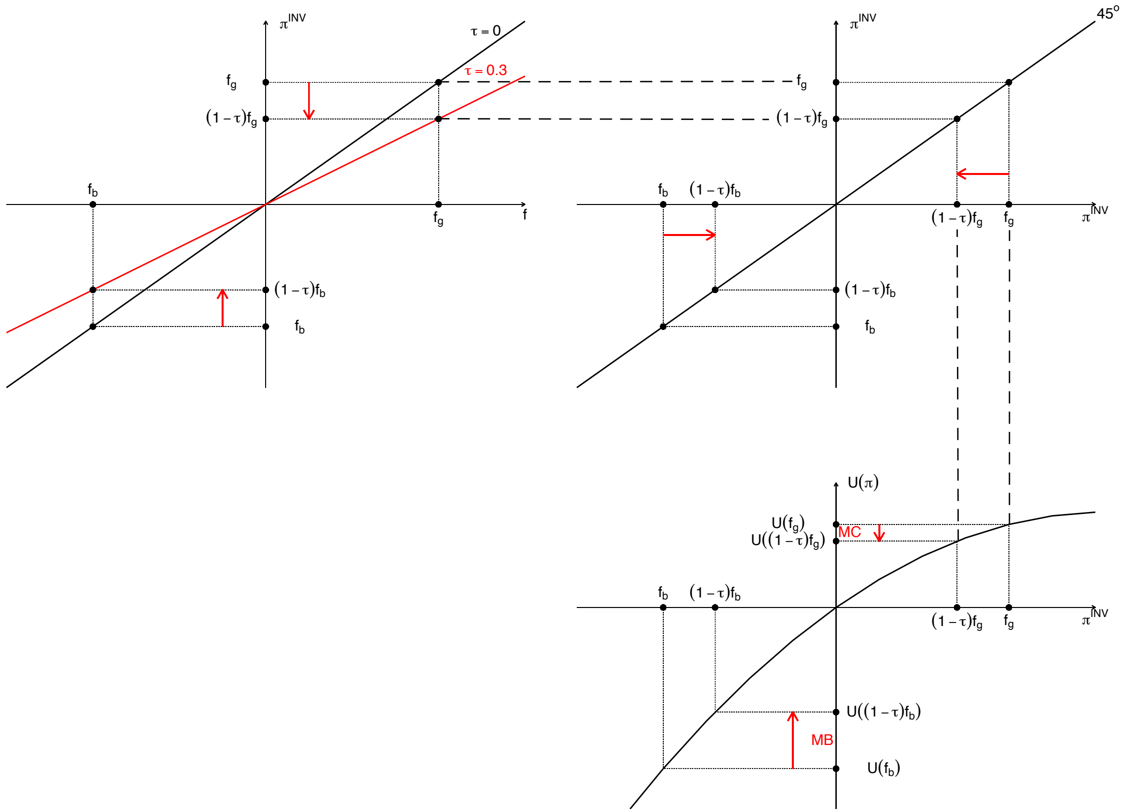
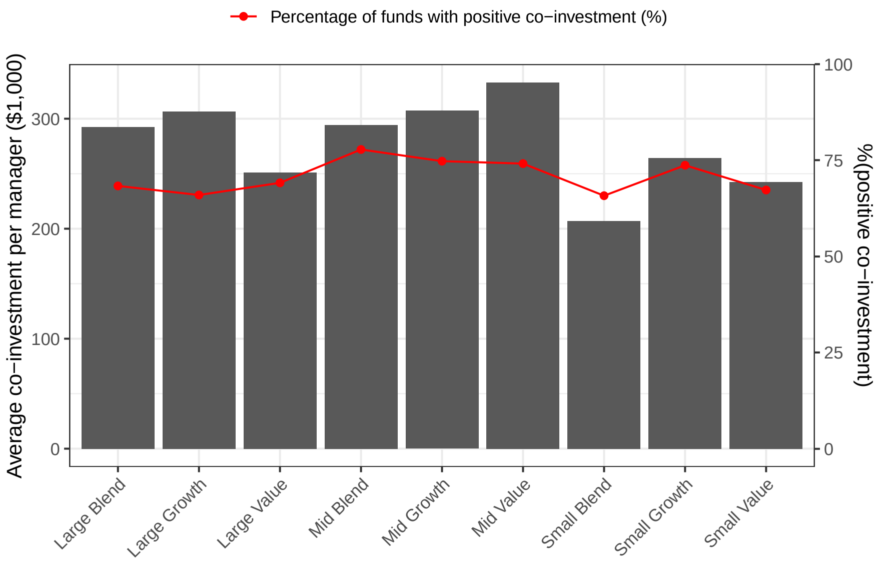
Figures and Tables

Figure 1: The utility function of co-investing fund managers.



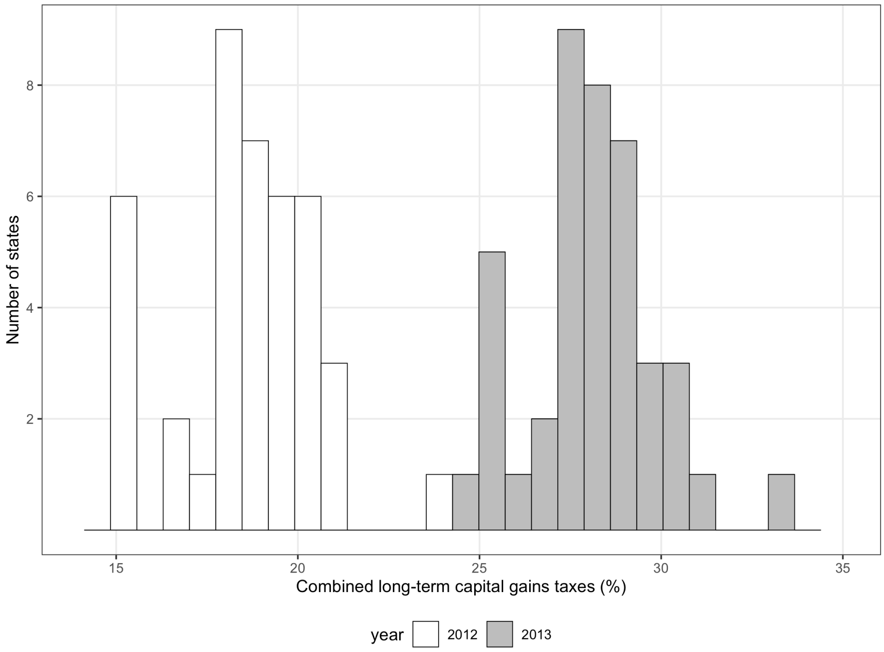
Note: The graph depicts how co-investing fund managers respond to a tax hike. The x-axis represents the co-investing payoff, and the y-axis represents the utility of fund managers.

Figure 2: Fund managerial co-investment across different investment styles



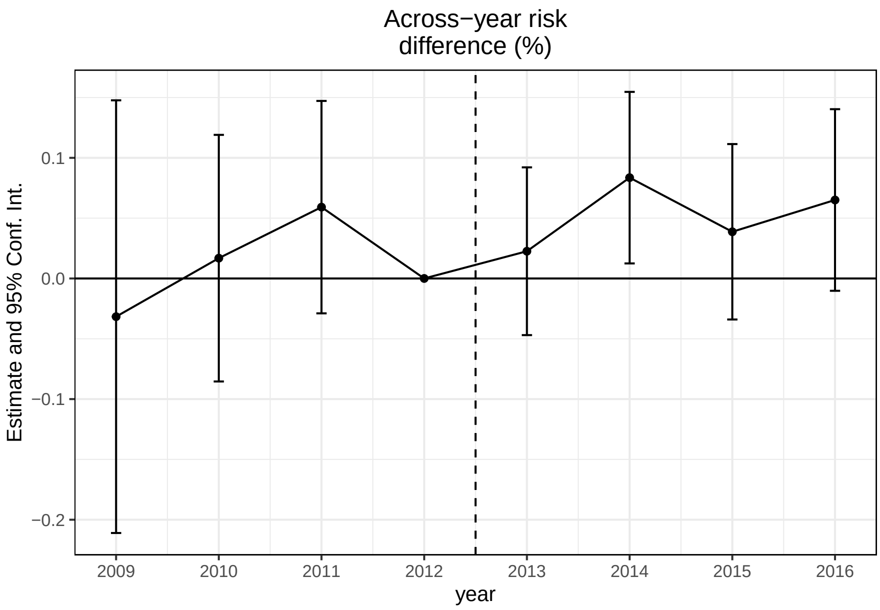
Note: The graph depicts the heterogeneity of co-investment across investment styles. The y-axis refers to the average co-investment per manager($1,000).

Figure 3: Top marginal capital gains tax rates in the U.S. in 2012 and 2013.



Note: The graph depicts the distribution of the combined (state and federal level) top marginal tax rates on long-term capital gains in the U.S. in 2012 (white) and 2013 (gray). Source: NBER TAXSIM.

Figure 4: Difference-in-differences event study: fund risk-taking



Note: This figure displays the results of a difference-in-differences event study on fund risk-taking. The dependent variable, across-year risk difference, is defined as the average of the quarterly risk difference between the hypothetical returns and realized past return, where the hypothetical returns are constructed using current portfolio weightings and past stock returns.

Table 1: Summary Statistics

Variable	N	Mean	SD	1%	Median	99%
Across-year risk difference (%)	4,987	0.19	0.59	-0.90	0.08	2.44
Across-year risk ratio (%)	4,987	0.71	2.43	-4.83	0.47	7.67
CAPM Alpha (bps)	4,987	-0.30	2.18	-5.29	-0.41	6.00
FF3 Alpha (bps)	4,987	-0.24	1.82	-4.34	-0.33	5.10
FF4 Alpha (bps)	4,987	-0.24	1.70	-4.41	-0.29	4.62
Coinvestment	4,610	659,203.46	870,802.72	0.00	310,001.50	3,800,001.50
Coinvestment per manager	4,610	289,279.92	327,546.76	0.00	165,000.50	1,000,000.00
Coinvestment dummy	4,610	0.74	0.44	0.00	1.00	1.00
I(pre-coinvestment > 0)	4,987	0.72	0.45	0.00	1.00	1.00
log(pre-coinvestment)	4,987	9.38	5.95	0.00	12.61	15.19
Cum. 12-month return (%)	4,987	15.82	15.40	-10.57	13.97	51.67
Fund size ($bn)	4,987	1.87	3.87	0.01	0.54	20.76
Fund age (month)	4,987	228.46	164.90	48.00	190.00	934.00
Fund flows 1-year (%)	4,987	1.70	39.51	-57.76	-5.90	189.74
Fund expense (%)	4,987	1.06	0.30	0.18	1.06	1.80
Turnover (%)	4,987	63.76	48.30	0.00	53.00	242.00
Fund activiness (%)	4,987	4.36	3.01	0.60	3.65	15.15
Team-managed	4,987	0.79	0.41	0.00	1.00	1.00
Max manager tenure (month)	4,954	111.73	78.72	5.00	97.00	337.47
Fund family size ($bn)	4,924	214.40	481.44	0.00	39.50	2,152.74

Note: This table shows descriptive statistics of all variables in our sample of the actively-managed U.S. domestic equity funds. The sample ranges from 2009 to 2015. All data are summarized at a yearly frequency and winsorize at the 1% level. Across-year risk difference (ratio) is defined as the average of quarterly risk difference (rato) between the hypothetical returns and realized past return, where the hypothetical returns are constructed using current portfolio weightings and past stock returns. Cum. 12-month return is the cumulative return over the 12-month window in a year; Fund size is the aggregated total net assets (TNA) of all share classes of a fund; Fund age is the number of months that a fund starts trading; Fund flows are the change in TNA excluding growth in TNA as a result of fund returns; Fund expense is the yearly expense ratio; Turnover is the turnover ratio; Fund activeness is defined as 1 minus R-squared from Carhart (1997) four-factor model regression; Team-managed is a dummy indicating that the fund is managed by team; maximum tenure indicates the maximum length of time among managers who currently manage the fund; Family size is the aggregated fund TNA in the family. We provide a detailed description of all variables in Appendix A.3.

Table 2: Baseline - do fund managers increase risk-taking

	(1)	(2)	(3)	(4)	(5)	(6)
I(pre-coinvestment > 0)	−0.035**					
	(−2.064)					
Post ATRA x I(pre-coinvestment > 0)	0.044**	0.046**				
	(1.970)	(1.995)				
log(pre-coinvestment)			−0.003**			
			(−2.526)			
Post ATRA x log(pre-coinvestment)			0.005***	0.005***		
			(2.793)	(2.680)		
Post ATRA x I(pre-coinvestment > Q50)					0.084***	
					(3.513)	
Post ATRA x I(pre-coinvestment > Q75)						0.113***
						(3.854)
Observations	4,740	4,797	4,740	4,797	4,440	4,440
Adj. R2	0.29	0.27	0.29	0.27	0.28	0.28
Year FE	✓	✓	✓	✓	✓	✓
Fund FE		✓		✓	✓	✓
Style FE	✓		✓			

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Note: This table presents the baseline results of a difference-in-differences (DiD) analysis. The dependent variable is the across-year risk difference, defined as the average of the quarterly risk difference between the hypothetical returns and realized past return, where the hypothetical returns are constructed using current portfolio weightings and past stock returns. The treatment indicators of the DiD analysis include I(pre-coinvestment > 0), defined as a dummy indicating that the fund held positive co-investment stakes in 2012, and log(1 + pre-coinvestment), defined as the logarithm of co-investment stakes held in 2012. The event indicator of the DiD analysis, Post ATRA, is a dummy indicating a tax change after 2013. All specifications in this table include the same set of control variables as the baseline results. Detailed definitions of all other variables can be found in Appendix A.3. Standard errors are clustered at the fund level; t-statistics are displayed in parentheses.

Table 3: Mechansim - how do fund managers increase risk-taking

	(1) %(Stock)	(2) %(Cash)	(3) N(Stocks)	(4) Systematic	(5) Idiosyncratic	(6) Beta	(7) Downside beta	(8) Lottery
Panel A: Treat = I(pre-coinvestment > 0)								
Post ATRA x I(pre-coinvestment > 0)	0.482**	−0.086	0.009	0.030*	−0.014	0.007**	0.007*	−0.075*
	(2.305)	(−0.697)	(0.377)	(1.659)	(−0.727)	(2.228)	(1.826)	(−1.834)
Observations	4,264	4,264	4,799	4,805	4,805	4,998	4,998	4,842
Adj. R2	0.48	0.44	0.94	0.23	0.09	0.6	0.52	0.9
Year FE	✓	✓	✓	✓	✓	✓	✓	✓
Fund FE	✓	✓	✓	✓	✓	✓	✓	✓
Panel B: Treat = log(pre-coinvestment)								
Post ATRA x log(pre-coinvestment)	0.038**	−0.006	0.001	0.003**	0.000	0.001**	0.001**	−0.006*
	(2.397)	(−0.574)	(0.795)	(2.197)	(−0.243)	(2.245)	(2.015)	(−1.953)
Observations	4,264	4,264	4,799	4,805	4,805	4,998	4,998	4,842
Adj. R2	0.48	0.44	0.94	0.23	0.09	0.6	0.52	0.9
Year FE	✓	✓	✓	✓	✓	✓	✓	✓
Fund FE	✓	✓	✓	✓	✓	✓	✓	✓

* p < 0.1, ** p < 0.05, *** p < 0.01

Note: This table presents the results of a difference-in-differences (DiD) analysis for the dependent variables associated with fund managers' portfolio decisions. We include the following dependent variables in Column 1 to 8. %(Stock) is defined as the percentage of equity holdings. %(Cash) is defined as the percentage of cash holdings. N(stocks) is defined as number of holding stocks in the portfolio. Systematic risk shift is defined as the holdings-based risk shift derived from the returns attributable to bearing systematic risk in the Fama-French four-factor model. Idiosyncratic risk shift is defined as the holdings-based risk shift derived from the returns attributable to bearing idiosyncratic risk in the Fama-French four-factor model. Beta is defined as the factor loading of market factor in the Fama-French four-factor model. Downside beta is defined as the factor loading of market factor in the Fama-French four-factor model conditional on market factor being less than its yearly average. Lottery is defined as the yearly average of the holding-weighted average of the maximum daily return at the previous month across all portfolio stocks. Panel A presents the regression result using the dummy I(pre-coinvestment > 0) as the treatment assignment variable. Panel B presents the regression result using the continuous variable log(1 + pre-coinvestment) as the treatment assignment variable. The event indicator of the DiD analysis, Post ATRA, is a dummy indicating a tax change after 2013. All specifications in this table include the same set of control variables as the baseline analysis Detailed definitions of all other variables can be found in Appendix A.3. Standard errors are clustered at the fund level; t-statistics are displayed in parentheses.

Table 4: Incentive - why do fund managers increase risk-taking

	(1)	(2)	(3)	(4)
Post ATRA x I(pre-coinvestment > 0)	0.032	0.016		
	(1.257)	(0.583)		
Post ATRA x I(pre-coinvestment > 0) x Convexity	0.185***			
	(2.592)			
Post ATRA x I(pre-coinvestment > 0) x Loser in past 2 years		0.128*		
		(1.668)		
Post ATRA x log(pre-coinvestment)			0.004**	0.002
			(1.986)	(1.045)
Post ATRA x log(pre-coinvestment) x Convexity			0.013**	
			(2.515)	
Post ATRA x log(pre-coinvestment) x Loser in past 2 years				0.011*
				(1.902)
Observations	4,440	4,797	4,440	4,797
Adj. R2	0.27	0.27	0.27	0.27
Year FE	✓	✓	✓	✓
Fund FE	✓	✓	✓	✓

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Note: This table presents the results of the triple difference-in-differences (DiD) analysis. The dependent variable is the across-year risk difference, defined as the average of the quarterly risk difference between the hypothetical returns and realized past return, where the hypothetical returns are constructed using current portfolio weightings and past stock returns. The treatment indicators of the DiD analysis include I(pre-coinvestment > 0), defined as a dummy indicating that the fund held positive co-investment stakes in 2012, and log(1 + pre-coinvestment), defined as the logarithm of co-investment stakes held in 2012. The event indicator of the DiD analysis, Post ATRA, is a dummy indicating a tax change after 2013. Convexity is defined as the difference in the correlation between monthly flows and past twelve-month returns conditional on positive and negative returns. Loser is defined as a dummy variable equal to one if a fund's past two-year performance is in the bottom quartile. All specifications in this table include the same set of control variables as the baseline analysis. Detailed definitions of all other variables can be found in Appendix A.3. Standard errors are clustered at the fund level; t-statistics are displayed in parentheses.

Table 5: Consequence - fund performance

	(1) Return	(2) CAPM	(3) FF3	(4) FF4	(5) Return	(6) CAPM	(7) FF3	(8) FF4
Post ATRA x I(pre-coinvestment > 0)	−1.702***	−0.585***	−0.424***	−0.388***				
	(−3.570)	(−4.156)	(−4.587)	(−4.556)				
Post ATRA x log(pre-coinvestment)					−0.130***	−0.045***	−0.035***	−0.031***
					(−3.607)	(−4.239)	(−4.973)	(−4.804)
Observations	4,998	4,998	4,998	4,998	4,998	4,998	4,998	4,998
Adj. R2	0.85	0.22	0.15	0.12	0.85	0.22	0.15	0.12
Year FE	✓	✓	✓	✓	✓	✓	✓	✓
Fund FE	✓	✓	✓	✓	✓	✓	✓	✓

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Note: This table presents the results of a difference-in-differences (DiD) analysis for the dependent variables associated with fund performance. The dependent variables include cumulative 12-month returns, CAPM alpha, Fama-French three-factor alpha, and Cahart(1997)'s four-factor alpha, defined as the average quarterly percentage change of intended risk-taking. The treatment indicators of the DiD analysis include I(pre-coinvestment > 0), defined as a dummy indicating that the fund held positive co-investment stakes in 2012, and log(1 + pre-coinvestment), defined as the logarithm of co-investment stakes held in 2012. The event indicator of the DiD analysis, Post ATRA, is a dummy indicating a tax change after 2013. All specifications in this table include the same set of control variables as the baseline analysis. Detailed definitions of all other variables can be found in Appendix A.3. Standard errors are clustered at the fund level; t-statistics are displayed in parentheses.

Appendix

A.1 Derivation of the dynamics of optimal risk-taking with respect to tax changes

In this section, we derive the comparative statics of optimal risk-taking with respect to tax changes, i.e., $\frac{d\sigma^*}{d\tau}$, with a particular focus on co-investing fund managers.

Given the first order condition of the optimization problem,

$$FOC \equiv \frac{\partial EU}{\partial \sigma} = p[U'(\pi_g(\sigma))\pi_g'(\sigma)] + (1-p)[U'(\pi_b(\sigma))\pi_b'(\sigma)] = 0$$

where $\pi_g'(\sigma) = (z+(1-\tau)V)f_g'(\sigma)$ and $\pi_b'(\sigma) = (z+(1-\tau)V)f_b'(\sigma)$, we can derive how fund managers change their optimal risk-taking with respect to personal tax changes:

$$\frac{d\sigma^*}{d\tau} = -\frac{\frac{\partial FOC}{\partial \tau}}{\frac{\partial FOC}{\partial \sigma}} = \frac{\frac{\partial FOC}{\partial \tau}}{-SOC}$$

Since $SOC < 0$, the sign then depends on $\frac{\partial FOC}{\partial \tau}$.

$$\frac{\partial FOC}{\partial \tau} = p[\frac{\partial U'(\pi_g)\pi_g'}{\partial \tau}] + (1-p)[\frac{\partial U'(\pi_b)\pi_b'}{\partial \tau}]$$

To simplify the algebraic expression, we define $G \equiv \frac{\partial U'(\pi_g)\pi_g'}{\partial \tau}$ and $B \equiv \frac{\partial U'(\pi_b)\pi_b'}{\partial \tau}$, so that $\frac{\partial FOC}{\partial \tau} = pG + (1-p)B$. We then rearrange G and B, respectively.

$$\begin{aligned}
G &\equiv \tfrac{\partial U'(\pi_g)\pi_g'}{\partial \tau} && \\
&= [U''(\pi_g)\tfrac{\partial \pi_g}{\partial \tau}]\pi_g' + U'(\pi_g)[\tfrac{\partial \pi_g'}{\partial \tau}] && \text{, by the product rule} \\
&= U'(\pi_g)\pi_g'\{\tfrac{U''(\pi_g)}{U'(\pi_g)}\tfrac{\partial \pi_g}{\partial \tau} + \tfrac{\partial \pi_g'}{\partial \tau}\tfrac{1}{\pi_g'}\} && \text{, by taking out } U'(\pi_g)\pi_g' \\
&= U'(\pi_g)\pi_g'\{-R_g^A\tfrac{\partial \pi_g}{\partial \tau} + \tfrac{\partial \pi_g'}{\partial \tau}\tfrac{1}{\pi_g'}\} && \text{, by } R_g^A \equiv -\tfrac{U''(\pi_g)}{U'(\pi_g)} \\
&= U'(\pi_g)\pi_g'\{-R_g^A(-Vf_g) + (-Vf_g')\tfrac{1}{[z+(1-\tau)V]f_g'}\} && \text{, by } \tfrac{\partial \pi_g}{\partial \tau} = -Vf_g \text{ and } \tfrac{\partial \pi_g'}{\partial \tau} = -Vf_g' \\
&= U'(\pi_g)\pi_g'\{R_g^A(z+(1-\tau)V)f_g - 1\}(\tfrac{V}{z+(1-\tau)V}) && \text{, by taking out } \tfrac{V}{z+(1-\tau)V} \\
&= U'(\pi_g)\pi_g'\{R_g^A\pi_g - 1\}(\tfrac{V}{z+(1-\tau)V}) && \text{, by } \pi_g = z+(1-\tau)Vf_g
\end{aligned}$$

$$\begin{aligned}
B &\equiv \tfrac{\partial U'(\pi_b)\pi_b'}{\partial \tau} && \text{, by following the same arrangements} \\
&= U'(\pi_b)\pi_b'\{R_b^A\pi_b - 1\}(\tfrac{V}{z+(1-\tau)V}) && \text{, by } R_b^A \equiv -\tfrac{U''(\pi_b)}{U'(\pi_b)}
\end{aligned}$$

where R_A^i for $i \in \{g, b\}$ is the Arrow-Prat coefficient of absolute risk aversion. Since U is a concave function, both $R_g^A > 0$ and $R_b^A > 0$.

Now we plug in the rearranged G and B to $\frac{\partial FOC}{\partial \tau}$.

$$\begin{aligned}
\frac{\partial FOC}{\partial \tau} &= pG + (1-p)B \\
&= pU'(\pi_g)\pi_g'(R_g^A\pi_g - 1)(\tfrac{V}{z+(1-\tau)V}) + (1-p)U'(\pi_b)\pi_b'(R_b^A\pi_b - 1)(\tfrac{V}{z+(1-\tau)V}) \\
&\text{by setting } M \equiv R_g^A\pi_g \text{ and } N \equiv R_b^A\pi_b \text{ to simplify the algebraic expression} \\
&= \{pU'(\pi_g)\pi_g'(M-1) + (1-p)U'(\pi_b)\pi_b'(N-1)\}(\tfrac{V}{z+(1-\tau)V}) \\
&\text{by adding } (N-N) \text{ in the first term in the bracket} \\
&= \{pU'(\pi_g)\pi_g'[(M-1)+(N-N)] + (1-p)U'(\pi_b)\pi_b'(N-1)\}(\tfrac{V}{z+(1-\tau)V}) \\
&= \{pU'(\pi_g)\pi_g'[(M-N)+(N-1)] + (1-p)U'(\pi_b)\pi_b'(N-1)\}(\tfrac{V}{z+(1-\tau)V}) \\
&\text{by combining the terms with } (N-1) \\
&= \{[pU'(\pi_g)\pi_g' + (1-p)U'(\pi_b)\pi_b'](N-1) + pU'(\pi_g)\pi_g'(M-N)\}(\tfrac{V}{z+(1-\tau)V}) \\
&\text{by } pU'(\pi_g)\pi_g'(\sigma) + (1-p)U'(\pi_b)\pi_b'(\sigma) = 0 \text{ according to FOC} \\
&= pU'(\pi_g)\pi_g'(M-N)(\tfrac{V}{z+(1-\tau)V}) \\
&= pU'(\pi_g)\pi_g'(R_g^A\pi_g - R_b^A\pi_b)(\tfrac{V}{z+(1-\tau)V})
\end{aligned}$$

Given that R_g^A, R_b^A, and $\pi_g > 0$ as well as $\pi_b < 0$, we obtain that

$$\frac{\partial FOC}{\partial \tau} \begin{array}{l} > 0, \text{ if } V = 1, \text{ and} \\ = 0, \text{ if } V = 0. \end{array}$$

and therefore

$$\frac{d\sigma^*}{d\tau} = \frac{\frac{\partial FOC}{\partial \tau}}{-SOC} \begin{array}{l} > 0, \text{ if } V = 1, \text{ and} \\ = 0, \text{ if } V = 0. \end{array}$$

A.2 Screening of actively-managed U.S. equity mutual funds

Following the prior literature (Chen et al., 2004; Busse and Tong, 2012; Ferson and Lin, 2014; Busse et al., 2021), we screen actively-managed U.S. equity mutual funds. An actively-managed US domestic equity fund must satisfy the following criteria: (1) its CRSP Objective Code (crsp_obj_cd) is either EDGY (equity domestic growth fund), EDYI (equity domestic income fund), EDYB (equity domestic blend, newly fund), EDCL (equity domestic cap-based large fund), EDCM (equity domestic cap-based medium fund), EDCS (equity domestic cap-based small fund), or EDCI (equity domestic cap-based micro fund); (2) its percentage of equity holdings (per_com) must be between 85% and 105% for the entire lifespan; (3) it is neither ETF (et_flag), index funds (index_fund_flag), nor variable annuity (vau_fund); (4) its fund name (fund_name) does not contain either "Index," "Ind," "Idx," "Indx," "Mkt," "Market," "Composite," “S&P,” “SP,” “Russell,” “Nasdaq,” “DJ,” “Dow,” “Jones,” “Wilshire,” “NYSE,” “iShares,” “SPDR,” “HOLDRs,” “ETF,” “Exchange-Traded Fund,” “PowerShares,” “StreetTRACKS,” “100,” “400,” “500,” “600,” “1000,” “1500,” “2000,” “’3000,” or “5000”.

To account for the incubation bias (Evans, 2010), we exclude funds with less than three years of history and funds with monthly total net assets of less than 15 million, a threshold also used by Elton et al. (2001), Chen et al. (2004), Yan (2008), and many others.

A.3 Variable description

This table contains a description of all variables used in our empirical analyses. Data sources are as follows: Thomson Reuters Mutual Funds Holdings Database (TRH), CRSP U.S. Stock Database (CRSP Stock), CRSP Survivorship-Bias-Free Mutual Fund Database (CRSP Fund), MSD: Morningstar Direct (MSD), the Electronic Data Gathering, Analysis, and Retrieval system (EDGAR), Data Library on Kenneth French’s website (FF), and variables manually constructed by the authors (MC).

Table A.1: Variable description

Variable	Description	Source
Across-year risk difference	The average of the quarterly differences of the hypothetical volatility of the most recently disclosed fund holdings over the realized volatility of the previous quarter, where the hypothetical volatility is calculated based on the portfolio weights of the current quarter and the stock covariance of the previous quarter (Huang et al., 2011; Ma and Tang, 2019).	TRH, CRSP Stock, MC
Across-year risk ratio	The average of the quarterly percentage change of the hypothetical volatility of the most recently disclosed fund holdings over the realized volatility of the previous quarter, where the hypothetical volatility is calculated based on the portfolio weights of the current quarter and the stock covariance of the previous quarter (Huang et al., 2011; Ma and Tang, 2019).	TRH, CRSP Stock, MC
Across-year systematic risk difference (Sys. FF4 risk change)	It is computed with the same definition of ”Across-year risk difference,” but it uses only the return data attributable to the systematic component of the Fama-French four-factor model.	TRH, CRSP Stock, MC

Table A.1: Variable description *(continued)*

Variable	Description	Source
Across-year idiosyncratic risk difference (Idio. FF4 risk change)	It is computed with the same definition of "Across-year risk difference," but it uses only the return data attributable to the idiosyncratic component of the Fama-French four-factor model.	TRH, CRSP Stock, MC
Market beta	The estimated coefficient of the market factor using the Carhart (1997) four-factor model, which is the fund-year-level regressions of daily excess fund returns on the daily market factor (CRSP value-weight market return minus the one-month Treasury bill rate), SMB (small-minus-big) factor, HML (high-minus-low) factor, and momentum factor (Carhart, 1997).	CRSP Fund, FF, MC
Downside beta	The construction is the same as Market beta except that its estimation is conditional on the data whose market factor is less than its yearly mean (Ang et al., 2006).	CRSP Fund, FF, MC
CAPM Alpha	The intercept from the fund-year-level regressions of daily excess fund returns on the daily market factor (CRSP value-weight market return minus the one-month Treasury bill rate).	CRSP Fund, FF, MC
FF3 Alpha	The intercept from the fund-year-level regressions of daily excess fund returns on the daily market factor (CRSP value-weight market return minus the one-month Treasury bill rate), SMB (small-minus-big) factor, and HML (high-minus-low) factor.	CRSP Fund, FF, MC
FF4 Alpha	The intercept from the fund-year-level regressions of daily excess fund returns on the daily market factor (CRSP value-weight market return minus the one-month Treasury bill rate), SMB (small-minus-big) factor, HML (high-minus-low) factor, and momentum factor (Carhart, 1997).	CRSP Fund, FF, MC
Co-investment	The aggregate dollar amount of the mid-point co-investment interval of all managers in the fund at the year-end, where the original co-investment intervals are reported within seven dollar ranges: $0, $1-$10,000, $10,001-$50,000, $50,001-$100,000, $100,001-$500,000, $500,001-$1,000,000, or over $1,000,000.	EDGAR, MC
Pre-coinvestment	The aggregate dollar amount of the mid-point co-investment interval of all managers in the fund in 2012.	EDGAR, MC
I(Co-investment > 0)	A dummy variable equal to one if the fund holds positive co-investment, and zero otherwise.	EDGAR, MC

Table A.1: Variable description *(continued)*

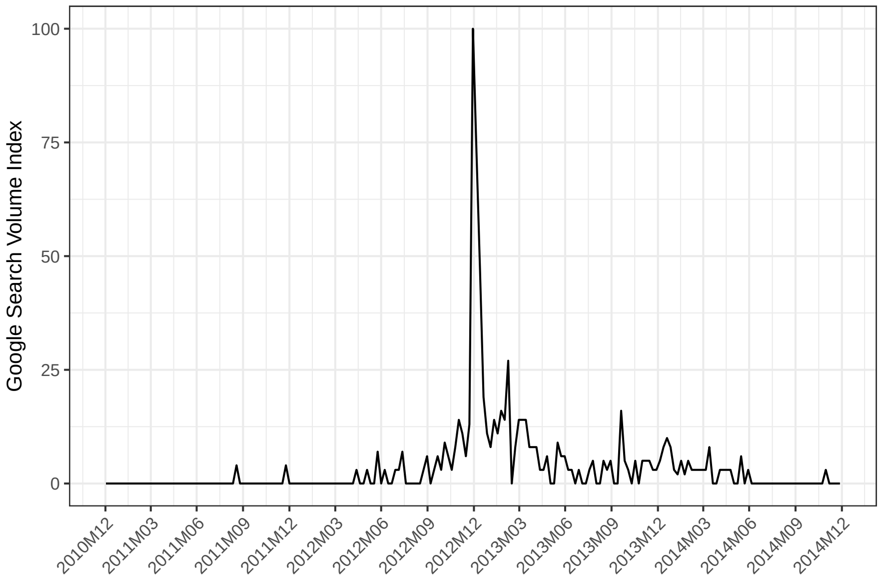
Variable	Description	Source
I(Pre-coinvestment > 0)	A dummy variable equal to one if the fund holds positive co-investment in 2012, and zero otherwise.	EDGAR, MC
I(Pre-coinvestment > Q50)	A dummy variable equal to one if the fund held pre-coinvestment greater than 50th percentile in 2012, and zero otherwise.	EDGAR, MC
I(Pre-coinvestment > Q75)	A dummy variable equal to one if the fund held pre-coinvestment greater than the 75th percentile in 2012, and zero otherwise.	EDGAR, MC
Combined long-term tax rates	The combined federal- and state-level long-term capital gains tax rates.	NBER TAXSIM
Post ATRA	A dummy variable equal to one after 2013, and zero otherwise.	MC
Post ATRA tax increase	A dummy variable equal to one after 2013 multiplied by the magnitude of tax increases during 2012 and 2013, and zero otherwise.	NBER TAXSIM, MC
Fund size	The total net assets of the fund (in billion dollar).	CRSP Fund
Fund age	The number of months since the oldest share class of the fund launched.	CRSP Fund
Fund flows	The change in total net assets (TNA) excluding growth in TNA as a result of fund returns (Sirri and Tufano, 1998).	CRSP Fund
Fund expense	The annual expense ratio of the fund.	CRSP Fund
Turnover	The annual turnover ratio of the fund.	CRSP Fund
Fund activeness	One minus R-squared from Carhart (1997) four-factor regression of the fund (Amihud and Goyenko, 2012).	CRSP Fund, FF, MC
Team-managed	A dummy variable equal to one if the fund is managed by a team, and zero otherwise.	CRSP Fund
maximum tenure	The maximum length of time for which all managers have been at the helm of the fund (in months).	MSD
Family size	The total net assets of the fund family (in billion dollar).	CRSP Fund, MC
Convexity	We calculate the correlations between monthly flows and past returns when past returns are positive and when past returns are negative, using five-year time-series data. We measure convexity by the difference between correlations of positive returns and negative returns.	CRSP Fund, MC
Loser	A dummy variable equal to one if the fund's past two-year performance is in the bottom quartile, and zero otherwise	CRSP Fund, MC
%(Stock)	Percentage of equity holdings (%)	CRSP Fund
%(Cash)	Percentage of cash holdings (%)	CRSP Fund
N(Stocks)	Number of holding stocks in the portfolio	TRH, MC

Table A.1: Variable description *(continued)*

Variable	Description	Source
Lottery	The yearly average of the holding-weighted average of the maximum daily return at the previous month across all stocks held by the fund (Agarwal et al., 2022; Bali et al., 2011).	TRH, CRSP Stock, MC
State GDP growth	The GDP growth rate of a state.	FRED
State income growth	The income growth rate of a state.	FRED
State corporate taxes	The corporate taxes of a state.	NBER TAXSIM

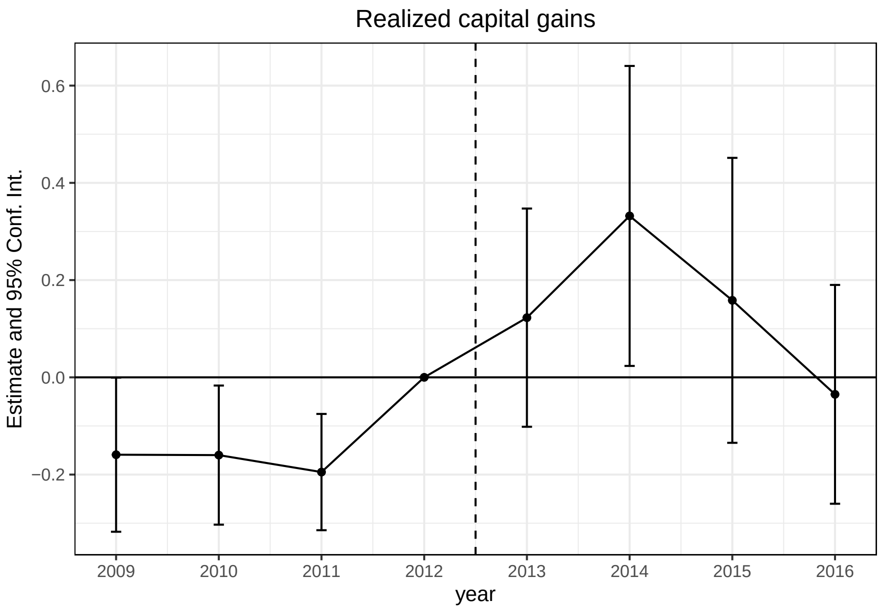
Internet Appendix

Figure IA.1: The American Taxpayer Relief Act of 2012 (ATRA): Google trend analysis



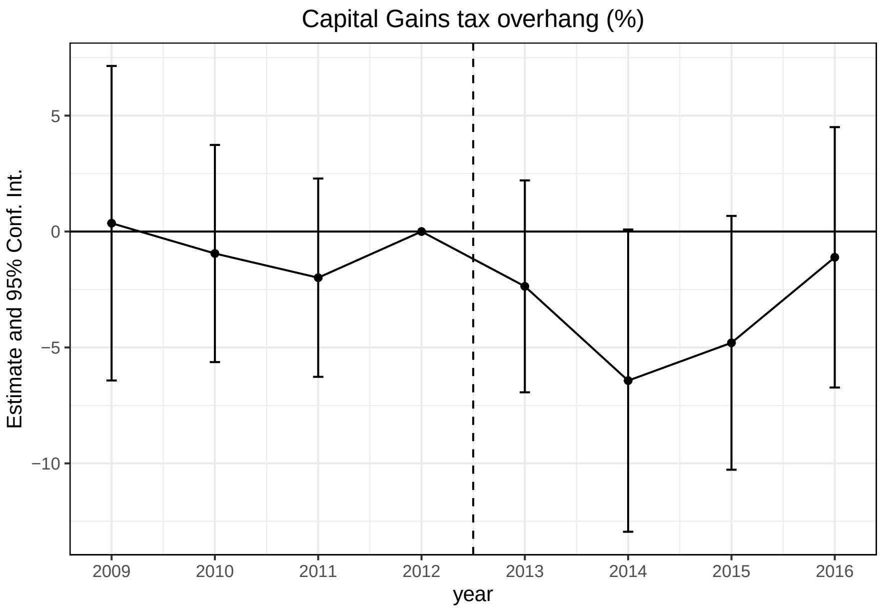
Note: This figure shows the result of the Google Search for the term "Federal Tax Increase 2013." The values indicate search interests relative to the highest point on the chart for the U.S. from 1^st January 2011 to 31^st December 2014. The value 100 represents the highest popularity of the search term. Source: Google Trends.

Figure IA.2: Difference-in-differences event study: Realized capital gains



Note: This figure displays the results of difference-in-differences event study on realized capital gains. Control variables include fund convexity and loser dummy in addition to the control variables of the baseline analysis. Detailed definitions of all other variables can be found in Appendix A.3. We include fund and year fixed effects. Standard errors are clustered at the fund level.

Figure IA.3: Difference-in-differences event study: Unrealized capital gains



Note: This figure displays the results of difference-in-differences event study on capital gains tax overhang (unrealized capital gains). Control variables include fund convexity and loser dummy in addition to the control variables of the baseline analysis. Detailed definitions of all other variables can be found in Appendix A.3. We include fund and year x family fixed effects. Standard errors are clustered at the fund level.

Table IA.1: The American Taxpayer Relief Act of 2012 (ATRA): Legislative history

Date	Regulation
2010-03-23	”Patient Protection and Affordable Care Act” signed into law by Barack Obama
2012-07-24	Introduction of ”Job Portection and Recession Prevention Act” in House
2012-08-01	”Job Portection and Recession Prevention Act” engrossed in House
2012-09-11	”Job Portection and Recession Prevention Act” placed on calendar Senate
2012-12-30	Amendment and rename to ”American Taxpayer Relief Act of 2012”, engrossed in Senate
2013-01-01	”American Taxpayer Relief Act of 2012”, passed in Senate
2013-01-01	”American Taxpayer Relief Act of 2012”, passed in House
2013-01-02	”American Taxpayer Relief Act of 2012”, signed into law by Barack Obama

This table displays the legislative history of tax increases up to the beginning of 2013.

Table IA.2: Robustness checks with the time-varying style fixed effect

	(1)	(2)	(3)	(4)
Post ATRA x I(pre-coinvestment > 0)	0.039*			
	(1.670)			
Post ATRA x log(pre-coinvestment)		0.004**		
		(2.286)		
Post ATRA x I(pre-coinvestment > Q50)			0.082***	
			(3.515)	
Post ATRA x I(pre-coinvestment > Q75)				0.096***
				(3.392)
Observations	4,740	4,740	4,383	4,383
Adj. R2	0.3	0.3	0.31	0.31
Fund FE	✓	✓	✓	✓
Year x Style FE	✓	✓	✓	✓

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Note: This table contains results of difference-in-differences (DiD) analysis using the time-varying style fixed effect. The dependent variables include across-year risk difference and across-year risk ratio. The event indicator of the DiD analysis, Post ATRA, is a dummy indicating a tax change after 2013. The treatment indicators of the DiD analysis include I(pre-coinvestment), a dummy indicating that the fund held positive co-investment in 2012, and log(1 + pre-coinvestment), the logarithm of the co-investment stake in 2012. All other variables are defined in detail in Appendix A.3. Standard errors are clustered at the fund level; t-statistics are displayed in parentheses.

Table IA.3: Robustness checks with alternative risk-taking measures

	(1)	(2)	(3)	(4)
Post ATRA x I(pre-coinvestment > 0)	0.289**			
	(2.209)			
Post ATRA x log(pre-coinvestment)		0.030***		
		(2.955)		
Post ATRA x I(pre-coinvestment > Q50)			0.549***	
			(4.113)	
Post ATRA x I(pre-coinvestment > Q75)				0.658***
				(3.867)
Observations	4,797	4,797	4,440	4,440
Adj. R2	0.21	0.21	0.21	0.21
Year FE	✓	✓	✓	✓
Fund FE	✓	✓	✓	✓

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Note: This table contains results of difference-in-differences (DiD) analysis using alternative risk-taking measures. The dependent variable, across-year risk ratio, is defined as the average percentage change of quarterly risk shift between the hypothetical returns and realized past return, where the hypothetical returns are constructed using current portfolio weightings and past stock returns.. The event indicator of the DiD analysis, Post ATRA, is a dummy indicating a tax change after 2013. The treatment indicators of the DiD analysis include I(pre-coinvestment), a dummy indicating that the fund held positive co-investment in 2012, and log(1 + pre-coinvestment), the logarithm of the co-investment stake in 2012. All other variables are defined in detail in Appendix A.3. Standard errors are clustered at the fund level; t-statistics are displayed in parentheses.

Table IA.4: Robustness checks with alternative event indicators

	(1)	(2)	(3)	(4)	(5)	(6)
Post ATRA x I(pre-coinvestment > 0)	0.046**					
	(1.995)					
Post ATRA tax increase x I(pre-coinvestment > 0)		0.052**				
		(1.995)				
Combined long-term taxes x I(pre-coinvestment > 0)			0.005**			
			(2.022)			
Post ATRA x log(pre-coinvestment)				0.005***		
				(2.680)		
Post ATRA tax increase x log(pre-coinvestment)					0.005***	
					(2.688)	
Combined long-term taxes x log(pre-coinvestment)						0.001***
						(2.658)
Observations	4,797	4,797	4,797	4,797	4,797	4,797
Adj. R2	0.27	0.27	0.27	0.27	0.27	0.27
Year FE	✓	✓	✓	✓	✓	✓
Fund FE	✓	✓	✓	✓	✓	✓

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Note: This table contains results of difference-in-differences (DiD) analysis using alternative treatment indicators. The dependent variable is the across-year risk difference, defined as the average quarterly differeces of intended risk-shifting. The event indicators of the DiD analysis include: Post ATRA tax increase, Post ATRA, and Combined long-term tax rates. The treatment indicators of the DiD analysis include I(pre-coinvestment), a dummy indicating that the fund held positive co-investment in 2012, and log(1 + pre-coinvestment), the logarithm of the co-investment stake in 2012. All other variables are defined in detail in Appendix A.3. Standard errors are clustered at the fund level; t-statistics are displayed in parentheses.

Table IA.5: Robustness checks with alternative treatment indicators

	(1)	(2)	(3)	(4)
Post ATRA x I(pre-coinvestment > 0)	0.046**			
	(1.995)			
Post ATRA x log(pre-coinvestment)		0.005***		
		(2.680)		
Post ATRA x Coinvestment dummy			0.056*	
			(1.873)	
Post ATRA x log(1 + Coinvestment)				0.006**
				(2.469)
Observations	4,797	4,797	4,874	4,874
Adj. R2	0.27	0.27	0.33	0.33
Year FE	✓	✓	✓	✓
Fund FE	✓	✓	✓	✓

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Note: This table contains results of difference-in-differences (DiD) analysis using alternative treatment indicators. The dependent variable is the across-year risk difference, defined as the average quarterly differeces of intended risk-shifting. The event indicator of the DiD analysis, Post ATRA, is a dummy indicating a tax change after 2013. The treatment indicators of the DiD analysis include: High pre-investment, Pre-investment dummy, investment dummy, log pre-investment, and log investment. All other variables are defined in detail in Appendix A.3. Standard errors are clustered at the fund level; t-statistics are displayed in parentheses.

Table IA.6: Robustness checks with alternative sample periods

	(1)	(2)	(3)	(4)	(5)	(6)
	(1) 2008:2016	(2) 2009:2015	(3) 2010:2014	(4) 2008:2016	(5) 2009:2015	(6) 2010:2014
Post ATRA x I(pre-coinvestment > 0)	0.046**	0.046**	0.057**			
	(2.519)	(1.995)	(2.387)			
Post ATRA x log(pre-coinvestment)				0.005***	0.005***	0.005***
				(3.252)	(2.680)	(2.757)
Observations	5,990	4,797	3,512	5,990	4,797	3,512
Adj. R2	0.27	0.27	0.22	0.27	0.27	0.22
Year FE	✓	✓	✓	✓	✓	✓
Fund FE	✓	✓	✓	✓	✓	✓

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Note: This table contains results of baseline difference-in-differences (DiD) analysis using alternative sample periods. The dependent variable is the across-year risk difference, defined as the average quarterly differeces of intended risk-shifting. The event indicator of the DiD analysis, Post ATRA, is a dummy indicating a tax change after 2013. The treatment indicators of the DiD analysis include I(pre-coinvestment), a dummy indicating that the fund held positive co-investment in 2012, and log(1 + pre-coinvestment), the logarithm of the co-investment stake in 2012. All other variables are defined in detai in Appendix A.3. Standard errors are clustered at the fund level; t-statistics are displayed in parentheses.

Table IA.7: Robustness checks using Card(1992) identification

	(1) Across-year risk difference (%)	(2) Across-year systematic risk diff (%)	(3) Across-year idiosyncratic risk diff (%)	(4) FF4 Alpha (bps)
Post ATRA x %(positive-coinvestment funds in 2012)	0.177**	0.143**	0.047	−0.697**
	(2.551)	(2.437)	(1.075)	(−2.332)
State corporate tax	−0.001	−0.001	−0.003	−0.010
	(−0.050)	(−0.327)	(−0.634)	(−0.578)
State GDP growth	0.006	0.005	−0.001	−0.012
	(0.831)	(0.921)	(−0.362)	(−1.083)
State Income growth	−0.008	−0.010	−0.002	−0.002
	(−0.743)	(−1.180)	(−0.435)	(−0.140)
Observations	6,335	6,343	6,343	6,709
Adj. R2	0.28	0.25	0.08	0.06
Year FE	✓	✓	✓	✓
State FE	✓	✓	✓	✓

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Note: Card (1992) investigates the impact of the federal wage increase by exploiting regional variations in the treatment populations. He defines a measure at the state level that quantifies the fraction of teenagers who are expected to be affected by the minimum wage increase. The higher the measure in a state, the more the treatment population in the state. In our analysis, we introduce a state-level measure that captures the fraction of fund managers likely to be affected by the ATRA tax hike based on their co-investment. The measure can be interpreted as treatment intensity, with higher values indicating the tax hike is likely to have had more "bite" in the state. This table contains results of difference-in-differences (DiD) analysis using Card (1992) identification. %(positive-coinvestment funds in 2012) is defined as the percentage of funds having positive co-investment within the state in 2012. The dependent variables include across-year risk difference, across-year systematic risk difference, across-year idiosyncratic risk difference, and Fama-French four-factor alpha. The event indicator of the DiD analysis, Post ATRA, is a dummy indicating a tax change after 2013. The treatment indicators of the DiD analysis include I(pre-coinvestment), a dummy indicating that the fund held positive co-investment in 2012, and log(1 + pre-coinvestment), the logarithm of the co-investment stake in 2012. Control variables include state corproate tax, state GDP growth, and state income growth. All other variables are defined in detail in Appendix A.3. Standard errors are clustered at the fund level; t-statistics are displayed in parentheses.

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