Discontinuities in Returns:
Re-examination of the Misreporting Explanation

Abstract

A discontinuity, or “kink”, at zero in the distribution of fund returns has been attributed to managers overstating returns to avoid reporting losses. Using unique regulatory data that can separate fund returns into capital and income components, I find there is no discontinuity in the capital return distribution. The discontinuity is created by income return, which reflects cash receipts. Income return has an asymmetric contribution: income return does not change with capital gain but increases the greater the capital loss, leading funds to gather above zero. This is a facet of the underlying assets and outside the control of managers.

JEL classification: G20, G23, G30

Keywords: funds, returns manipulation, discontinuity

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Introduction

A long alleged problem is that fund managers manipulate returns. In the absence of direct evidence of manager actions, the approach in literature has been to look for *a priori* suspicious patterns in the end result of those actions: fund returns. One such pattern is the potential discontinuity, or "kink", at zero in the distribution of returns when pooled across funds and over time, in which there are far more slightly positive returns than slightly negative returns. Bollen and Pool (2009) (hereafter, BP) focus on hedge funds and find a discontinuity in the distribution of total returns. However, BP do not have the data to identify what creates the discontinuity and conjecture it is the result of managers overstating returns to avoid reporting losses, such as via opportunistic valuation of illiquid assets. Nonetheless, their conjecture has since been widely embraced. The objective of this paper is to identify what creates a discontinuity in the total return distribution and, thereby, whether the discontinuity can be interpreted as evidence of manipulation.

I focus on another opaque environment where managers have the opportunity to value a large amount of illiquid assets – pension funds. While there is a dearth of data on pension funds worldwide, all fund providers in Australia must submit quarterly confidential filings to the regulator, the Australian Prudential Regulation Authority, in relation to the performance, investments, and operations of their pension funds. Australia uses a market-based defined contribution system whereby employers make mandatory contributions to the employee's chosen fund(s) and employees can make additional voluntary contributions. Contributions vest immediately, accounts are portable, and funds compete for members. The filings substantially expand upon public disclosures and are used internally to support regulatory supervision. The database covers the population of pension funds in Australia which hold over \$1.7 trillion in assets worldwide; tracks all funds since inception of the fund or reporting regime, whichever is later; and includes funds that subsequently close. Thus, it is free from sample selection, self-reporting, backfill, and survivorship biases. Upon lodgment, the data are subject to validation checks. Fund providers face criminal penalties if they do not provide the required information, declare the information is correct, or keep accurate records. Further details are provided in Section I.

In Section II, I identify what creates the discontinuity. One novelty of the database is that funds report the breakdown of total return by income and capital returns (realized and unrealized). Income return refers to cash receipts earned by the fund on its assets, such as dividends, interest, and rent. If the discontinuity is due to managers overstating returns, such as through valuation of assets, then the discontinuity should be in the capital return distribution. Thus, I test for a discontinuity in the pooled distributions of total and capital returns separately. For all tests for a discontinuity throughout the paper, I use both the BP and McCrary (2008) tests. Figure 1 shows there is a discontinuity in the total return but not capital return distribution.[1] The capital return distribution has a smooth bell shape. Removal of income return removes the discontinuity entirely. The discontinuity is created by the income return component.

What is the effect, then, of manager valuation of assets? Funds further report the breakdown of capital returns by, *inter alia*, listing status and asset class. Unrealized capital returns on listed assets arise on changes in the market price of exchange-traded securities, while unrealized capital returns on unlisted assets arise on changes in the valuation by the manager. Valuation of unlisted equities, such as private companies, has been expected to provide substantial opportunity for manipulation. Thus, I test for a discontinuity in the capital return distribution after excluding the portion relating to unrealized capital return on unlisted equities. This conservatively attributes the entire unrealized capital return to opportunistic revaluation, whereas only a part or none of it may be. As robustness, I also exclude the unrealized capital return on other unlisted asset classes. I find the capital return distribution is essentially unchanged and remains a smooth bell shape. The effect of manager valuation of assets is imperceptible.

In Section III, I track how income return creates the discontinuity, or how the addition of income return transforms the smooth capital return distribution into a discontinuous total return distribution. If an equal amount of income return is added to the capital return of all funds, then that would merely shift the capital return distribution to the right while preserving the smooth bell shape. For the capital return distribution to change shape, funds with capital

[1] The instances of negative income return include the effect of foreign currency translations.

loss should have higher income return than funds with capital gain. This would push more funds with capital loss to the right compared to funds with capital gain, leading funds to gather above zero return. Thus, I plot the mean income return of funds in each bin of the capital return distribution. Figure 2 shows that for funds with capital gain, income return is flat and low. However, for funds with capital loss, income return increases the greater the capital loss. Together, the income-capital return relation is convex. For income return to offset a capital loss and move the fund to the positive region, income return must increase by at least as much as the capital return decreases. This is sufficient for funds in the -2% to 0% return region.

To ensure the movement of funds from this narrow region is sufficient to create the discontinuity and identify the funds that moved, I track the migration of each fund as the capital return distribution transforms into the total return distribution on the addition of income return. I find the discontinuity is indeed driven by funds in the -2% to 0% return region moving to the 0% to 2% return region. The discontinuity and convex relation persists within subperiods, indicating results are not idiosyncratic to a period.

In Section IV, I evaluate whether managers could instead manipulate total returns through the income return component. This is not possible. First, managers are not able to manipulate the magnitude of percentage income return. The dollar income return (numerator) reflects cash distributions set by security issuers, including after the fund has purchased the security, and held by independent custodians. The portfolio value (denominator) is as of the beginning of the period. Even if portfolio values are revised retrospectively, the bulk of portfolios are determined by market closing prices rather than manager valuation. To increase the percentage income return would also require revising portfolio values down.

Second, managers are not able to manipulate the timing of income return. Under accounting standards worldwide, while funds can recognize income on an accrual basis – that is, in advance of cash receipts – recognition is allowed only upon declaration of distributions by security issuers. Further, the lengthy quarterly return horizon is often sufficient to close the accrual process and for the recognition to be supported by cash receipts. The median investment income receivable – that is, return yet to be supported by cash receipts – across all fund providers is just 0.07% of assets.

Third, managers are not able to jointly manipulate income and capital return so to sort themselves into the convex relation that creates the discontinuity. Managers are not able to observe a capital loss and then switch into assets that would provide the higher income return to offset it. Capital return is observable only at the end of the period after income return has been recognized during the period, not vice versa. Nor can managers control the capital return. While managers can value some assets, the portfolios are highly diversified and predominately valued by market prices that are subject to change continuously until the period end. To examine the relative scope for market prices and manager valuations to affect capital returns, I plot the mean asset allocation of funds in each bin along the capital return distribution. Figure 3 shows all funds are largely invested in fixed income or equities. Only 10% to 20% of portfolios are allocated to other asset classes.

Fourth, managers who seek to increase returns would be more likely to increase risk, not decrease it by switching into lower risk assets such as fixed income for higher income return (Brown, Harlow, and Starks (1996)). In line with this, Figure 3 also shows that the asset allocation for funds along the capital return distribution is symmetrical around zero. Funds with capital loss do not hold more fixed income than funds with capital gain. The convex relation and bin migration also do not affect only funds slightly below zero, but is part of a systematic trend throughout the distribution. Overall, it is not possible for the convex relation to reflect investment actions by the fund manager.

I investigate whether there is support instead for the alternative explanation that the effect of income return is a facet of the underlying assets. Funds would then passively benefit from holding assets that yield higher income return when the market price falls. Thus, I identify whether a particular asset class drives the convex relation. I break down the sources of income return that make up the convex relation by asset class. Figure 4 shows it is driven by dividends from equities. I also break down the sources of capital return by asset class and find that equities are by far the largest contributor to capital return and the key determinant of the fund's position on the capital return distribution. Funds incur capital loss predominately because of capital loss on equities and equities with capital loss have higher income return on average. The convex relation is driven by equities. I find a discontinuity and convex relation of similar magnitude using only the portion of fund returns relating to listed equities.

If the discontinuity is a facet of the underlying equities rather than the result of manager actions, then it should be apparent in other contexts that involve equities. Thus, I test for a discontinuity in the pooled distribution of US listed equity returns reported by the Center for Research in Security Prices (CRSP). To maintain comparability with BP, I use their sample period of 1994 through 2005. This also provides a falsification test for a discontinuity where misreporting is not possible, since returns are based on market closing prices and collated by independent data vendors. Figure 5 shows there is a discontinuity in US listed equity returns. This differs from BP. Figure 6 shows these equities also have the convex relation. Results are robust to, and stronger, using an extended period of 1926 through 2018, or the first and second half of the extended period. Thus, it is not idiosyncratic to a period but has been a consistent feature of returns.

I also test for a discontinuity in the pooled distribution of US equity mutual fund returns reported in CRSP for 1994 through 2005. This provides a further falsification test for a discontinuity where misreporting is not possible, since the funds predominately invest in US listed equities and net asset values are based on market closing prices as confirmed by independent custodians. Figure 7 shows there is a discontinuity in the distribution of total returns. This differs from BP. Results are robust to, and stronger, using an extended period of 1961 through 2018, or the first and second half of the extended period. Thus, it is not idiosyncratic to a period but has been a consistent feature of returns.

Since CRSP does not report the income and capital components of total returns, I use the price return on the funds' holdings, weighted by actual portfolio weights, to proxy for the capital return. I obtain a capital return distribution with the same distinctive bimodal shape as the total return distribution in Figure 7, indicating that holdings returns can sufficiently reflect the key features of fund returns, except there is no discontinuity.

In Section V, I investigate whether the applicability of income return can be an omitted variable that explains the presence or absence of a discontinuity in return distributions. First, I find the magnitude of the discontinuity has weakened over time and this is related to the decrease in dividend yields. Second, the discontinuity mechanically dissipates the longer the return horizon as the contribution of income return to total return weakens relative to capital return. Whereas the magnitude and volatility of capital returns increases with the return horizon, income returns remain low and consistent. Third, the discontinuity persists notwithstanding mandatory audits of the population of Australian pension funds and US mutual funds, so is independent of monitoring by auditors. Overall, regardless of whether managers manipulate returns, a discontinuity in the total return distribution in itself is not reliable evidence of it.

My findings have implications for methodology, literature, and policy. An increasing number of studies use the regression discontinuity design and the McCrary test has been the *de rigueur* means to satisfy the assumption of no manipulation of a variable around a threshold.[2] That is, if agents cannot manipulate a variable, then the occurrence of the variable around the threshold should be random and the density above and below the threshold should be similar. I demonstrate a rejection of the McCrary test for no discontinuity, thereby giving an inference of manipulation, in three independent contexts – pension funds, listed equities, and mutual fund returns – despite the discontinuity not being created by manipulation. The test is but a preliminary assessment of manipulation or not, need not be applicable universally, and is not conclusive. A discontinuity suggests the possibility of manipulation so to warrant further evaluation but does not prove manipulation, while continuity does not prove lack of manipulation.

My findings also suggest caution against the reliance on *a priori* suspicious patterns to infer manipulation. While BP introduce precision to the measurement of and significance testing for a discontinuity that have wide application in other contexts,[3] these are second order benefits to the first order need of data availability. To the extent that unobservable factors other than manipulation cause a discontinuity, this reduces the power of a discontinuity to detect manipulation. Jorion and Schwarz (2014), the only other paper to investigate an alternate cause of a discontinuity, use simulations to claim the asymmetric effect of performance fees on positive and negative gross returns would create a discontinuity. However, that is only relevant to funds that charge asymmetric fees and relates to the change from gross to net return, whereas

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[2] Cattaneo and Vazquez-Bare (2016) note the test "is by now extremely popular in empirical work." Imbens (2016) recommends it "should be performed any time someone does a rdd analysis."
[3] For example, the BP approach has since been used to test for credit overratings (Badoer, Demiroglu, and James (2019)), earnings management around executive compensation targets (Bennett, Bettis, Gopalan, and Milbourn (2017)), and anchoring on credit spreads (Dougal, Engelberg, and Parsons (2015)).

I show the discontinuity persists in the gross return distribution. To further adjust for the asymmetric effect of income return, use of a discontinuity to infer manipulation should, at the very least, be in the capital not total gross return distribution.

Finally, my findings inform ongoing regulatory and market oversight. Faced with continually limited resources to oversee a fast growing industry, regulators and investors are turning to quantitative screens to identify high risk cases quickly, at low cost, and on a large scale.[4] However, a high rate of false positives directs a high number of cases to costly, time-consuming, and ultimately unwarranted investigations. For example, on the basis of the discontinuity in total returns, BP estimate that manipulation is a "widespread phenomenon" that affects over 20,000 cases in the Center for International Securities and Derivatives Markets (CISDM) database over 1994 through 2005. The CISDM database covers less than 40% of just the hedge funds industry, a small segment of the funds market (Agarwal, Fos, and Jiang (2013)). The number of flagged cases is likely to be several times over if extended to the universe of funds and other years. Yet, in 2006, the SEC was able to examine merely 321 hedge fund managers.[5] It may be fewer in other less resourced jurisdictions. Unreliable screens that consume and misdirect resources create more harm than they prevent.

I. Data

I use data as provided from the Australian Prudential Regulation Authority about the population of institutional pension funds in Australia from fiscal 2013 through 2018. There are 12,412 fund-quarters. The funds hold $1.7 trillion in assets worldwide on behalf of 96% of the labor force as of 2018 (APRA 2018). In the Australian market-based system, employers make mandatory contributions to the employee's chosen fund(s) under a defined contribution arrangement and employees can make additional voluntary contributions.[6,7] Contributions vest

[4] For example, see SEC (2001). Software produced by Riskdata Inc. also uses a discontinuity to flag suspicious returns (Bollen and Pool (2009)).
[5] See the US Government Accountability Office, http://www.gao.gov/assets/280/271478.html
[6] The mandatory contribution rate is 9.5% of gross wages since 2012.
[7] I do not examine defined benefit funds, which are legacy offerings that are closed to new members and account for 5% of benefits (APRA 2018).

immediately, accounts are portable, and switching costs are negligible.[8] Funds are actively managed, compete for members, and subject to uniform regulation nationwide. Funds can be multi-asset class portfolios labeled by the risk level, such as Conservative or Balanced, or sector-specific, such as Bonds or Domestic Equities. In line with literature, I use funds across all styles.

Under the current reporting framework since 2013, all fund providers must submit confidential filings in relation to the performance, investments, and operations of their pension funds within one month of each calendar quarter. These filings substantially expand upon public disclosures and are used internally to support regulatory supervision. The database covers the population of funds, so is free from sample selection bias; covers funds since inception of the fund or reporting regime, whichever is later, so is free from backfill bias; and covers funds that subsequently close, so is free from survivorship bias. The requirements of each filing are set out in dedicated Reporting Standards to ensure comparability across funds and over time. Reporting is further supported by Prudential Standards that require annual audits of the reporting process.[9] Both Reporting and Prudential Standards have the standing of legislative instruments. Upon electronic lodgment, the data are subject to validation checks, such as for calculation errors, negative numbers, and cross-form consistency.[10] Fund providers face criminal penalties if they do not provide the required information,[11] declare the information is correct,[12] or keep accurate records.[13]

The relevant data used is the portfolio value and asset allocation of funds at the end of each calendar quarter and their dollar return from income, unrealized capital gain/loss, and realized capital gain/loss over the quarter. I use percentage gross returns, being the dollar return over a quarter divided by the portfolio value at the beginning of the quarter. Total return is the sum of income and capital returns. Income return refers to cash distributions such as dividends,

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[8] Generally, switches between fund providers are free. The first switch in a year between funds of the same provider is also free, and thereafter is less than $10 per switch regardless of the size of the account.

[9] Prudential Standard SPS 310 Audit and Related Matters; Prudential Practice Guide SPG 310 Audit and Related Matters

[10] The database is dynamic and updated upon additional or revised data, so the database at any point in time may not exactly match the database at another point in time.

[11] Section 254 of the Superannuation Industry (Supervision) Act 1993; Crimes Act 1914 Part IA

[12] Section 11C(2) of the Superannuation Industry (Supervision) Act 1993

[13] Sections 35A, 105, 303, and 306 of the Superannuation Industry (Supervision) Act 1993

interest, and rent. Capital return is the sum of realized and unrealized capital gain/loss. Realized capital gain/loss reflects the change in the market value of assets disposed. Unrealized capital gain/loss reflects the change in the market value of assets that continue to be held. Funds can invest in assets worldwide and returns are net of foreign exchange gain/loss on translation to Australian dollars.

I also use data on all US listed equities and US equity mutual funds from CRSP over 1994 through 2005, the same database and sample period used in BP. To ensure my findings are robust and generalizable, I repeat my tests using an extended period of 1926 through 2018 for US listed equities and 1961 through 2018 for US equity mutual funds. Tests that involve mutual fund holdings use data from 2002.

II. What creates the discontinuity?

A. Total return

I test for a discontinuity in the total return of Australian pension funds. Throughout the paper, I use two approaches from literature to test for a discontinuity in distributions to ensure robustness. The approaches differ in how they perceive a discontinuity. The first approach, such as the BP test, views discontinuity as a bin on the return distribution being significantly higher or lower than under a theoretical smooth distribution.[14] The second approach, such as the McCrary test, views discontinuity as a bin on the return distribution being significantly higher or lower than the surrounding bins.[15] The BP test can identify the point of discontinuity *ex post* but is sensitive to the density of the two immediate bins bracketing the point. The McCrary test uses a range of bins to estimate the density but can only test for a discontinuity at one point at a time, which must be set *ex ante* based on theory.

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[14] This is the approach used in Bollen (2011), Bollen and Pool (2009), Cassar and Gerakos (2011), Jorion and Schwarz (2014), and Shi (2017)

[15] This is the approach in Almond and Xia (2017), Aragon and Nanda (2017), Ben-David, Franzoni, Landier, and Moussawi (2013), Bollen and Pool (2012), Carhart, Kaniel, Musto, and Reed (2002), Cici, Kempf, and Puetz (2016), Cumming and Dai (2010), and Dimmock and Gerken (2016).

1. BP test

The BP test consists of two steps. In the first step, I plot the distribution of fund returns pooled across funds and periods. To be comparable with BP, I exclude zero returns and consecutive returns of 0.0001, and then follow Silverman (1986) to determine the theoretical bin width of the distribution as

$$\alpha \; 1.364 \min(\sigma, Q/1.340) \; N^{-1/5}, \tag{1}$$

where σ is the standard deviation of returns, Q is the interquartile range of returns, N is the number of returns, and α is a scalar set to 0.776 to correspond to an underlying normal distribution. I obtain a theoretical bin width of 49 bps. To assist exposition and for comparability with later distributions, I use a bin width of 50 bps.

Figure 1 Panel A shows the distribution of total returns for the -10% to 10% region. This region captures 92% of the sample. There are 40 bins in total. Bin -1 covers -0.5% ≥ return > 0%, bin 0 covers 0% ≥ return > 0.5%, and so on. The tick marks denote the starting return of each bin interval. The two solid bars indicate bins -1 and 0, the first bins below and above zero. Similarly to Figure 1 of BP, the distribution has a bell shape except for an economically significant discontinuity at zero – there are far more slightly positive returns than slightly negative returns. Whereas the distribution of monthly returns in BP appears centered at zero, the distribution of quarterly returns here is centered to the right of zero, with the peak in the 1.5% to 2% region. Later tests show the distribution mechanically shifts to the right with longer return horizons.

In the second step, I test whether the density of each bin in the return distribution is significantly different from what is expected under a smooth distribution. To obtain the smooth distribution, I fit a Gaussian kernel density function to the return distribution. The density estimate at point t is

$$\hat{f}(t; h) = \frac{1}{Nh} \sum_{i=1}^{N} \phi\left(\frac{x_i - t}{h}\right), \tag{2}$$

where h is the bandwidth of the kernel, N is the number of returns, x_i is an observation of return, and ϕ is the standard normal density. The bandwidth is equal to the bin width. For any bin, the expected density under the density function is the total number of observations, N, times the probability, p, that an observation is in the bin as obtained by integrating $\hat{f}$ over the bin interval. The test statistic, Z, to evaluate the significance of the difference between the observed density, X, and expected density, Np, is

$$Z = (X - Np)/\sqrt{Np(1-p)}, \tag{3}$$

which is asymptotically normally distributed with mean Np and standard deviation $\sqrt{Np(1-p)}$ per the DeMoivre-Laplace theorem.

Figure 1 Panel A shows the test statistic for each bin under the distribution. The two box markers indicate bins -1 and 0 and correspond to the two solid vertical bars in the distribution. The two dashed horizontal lines indicate the 95% critical values in a two-tailed test. The test statistic is most extreme and statistically significant only for the two bins around zero that create the discontinuity. The frequency of returns in the bin above zero is significantly higher, and the frequency of returns in the bin below zero is significantly lower, than what is expected under a smooth distribution. Satisfying the falsification test, the test statistic is substantially smaller and not statistically significant for any of the other bins in the distribution.

As robustness, I do not exclude zero returns and consecutive returns of 0.0001, use the theoretical bin width, or trim 1% of each tail. Results are stronger on not excluding any returns because these increase the density of the first bin above zero that create the discontinuity. Trimming the tails mitigates the effect of any outliers on the measures of mean and standard deviation used to determine the theoretical bin width. Trimming gives a theoretical bin width of 48 bps, so is essentially unchanged

2. McCrary test

The McCrary test likewise consists of two steps. In the first step, I plot the distribution of fund returns pooled across funds and periods. To be consistent with the BP test, I exclude zero returns and consecutive returns of 0.0001, and then determine the bin width of the distribution as

$$2\sigma N^{-1/2}, \tag{4}$$

where the variables are as previously defined. Results are robust to not excluding any returns.

In the second step, I smooth the distribution using the local linear density estimator described in McCrary (2008), separately for returns above and below zero. I use a bandwidth of 3% points around zero. The discontinuity, $\hat{\theta}$, is the log difference of the value of the estimated density functions at zero:

$$\hat{\theta} = \ln \lim_{x \uparrow 0} \hat{f}(x) - \ln \lim_{x \downarrow 0} \hat{f}(x), \tag{5}$$

where the variables are as previously defined.

Table 1 Panel A reports the estimate of the discontinuity, robust standard error in parentheses, and exponential of the estimate. There is a log difference in densities of 0.383 around zero in the total return distribution and this is statistically significant at 1%. Since the log difference in densities is equivalent to the log of the proportional densities, this indicates the density above zero is an economically significant $e^{0.383}$ = 1.466 times higher than the density below zero. This estimate is more conservative than under the BP test, where the density of the bin above zero is 1.960 times higher than the density of the bin below zero, because the McCrary test extrapolates the trend in density farther from zero to estimate the density at zero. Results are robust to, and stronger, using the bias-corrected local polynomial density estimator described in Cattaneo, Jansson, and Ma (2019) or using a bandwidth of 5% or 10% points.

Other studies use a similar approach to the McCrary test but measure the discontinuity differently. Cumming and Dai (2010) measure the frequency of positive returns as a proportion of all returns in the two bins around zero. In similar vein, Cici, Kempf, and Puetz (2016) measure the frequency of positive return minus the frequency of negative returns within various bandwidths around zero. However, these implicitly assume the distribution in the absence of manipulation is unimodal, symmetric, and centered at zero, which may be reasonable for shorter term horizons such as monthly returns. For longer term horizons such as the quarterly returns used here, the distribution is centered to the right of zero so there is mechanically more positive than negative returns.

Bollen and Pool (2012) and Dimmock and Gerken (2016) use the Burgstahler and Dichev (1997) test from accounting literature and test whether the number of returns in the bin below zero is statistically significantly lower than the average of the two bins that surround it. However, this assumes that the distribution in the absence of manipulation is linear, whereas it could have substantial curvature, and is sensitive to noise that leads to a very high or very low number of returns in any of the relevant bins (Bollen and Pool (2009)).

B. Income vs. capital return

BP do not have the data to identify what creates the discontinuity and conjecture it is the result of managers overstating returns to avoid reporting losses, such as via opportunistic revaluation of assets. Nonetheless, their conjecture has since been widely embraced. Total return is comprised of income and capital return. Income returns reflect cash receipts earned by the fund on its assets, such as dividends, interest, and rent. If the discontinuity is due to managers overstating returns, then the discontinuity should be in the capital return distribution. Thus, I separate each pension fund's total return into its income and capital components and then repeat the test for a discontinuity on each component.

First, I use the BP test. I obtain a theoretical bin width of 12 and 54 bps respectively for the income and capital return distributions. To assist exposition and enable comparability across the distributions, I use a bin width of 50 bps. Results are robust to using the theoretical bin width. Figure 1 Panels B and C show respectively the income and capital return distributions, along the same horizontal axis as Figure 1 Panel A. The income return distribution has high kurtosis, in line with income returns being low and consistent, across funds and over time at any fund, relative to capital returns. The income return is less than 2.6% for 90% of the observations. Like the hedge funds examined in discontinuity literature, the Australian pension funds can invest internationally so the instances of negative income return include the effect of foreign currency translation to Australian dollars. The capital return distribution has a smooth bell shape with no discontinuity. The distribution is centered to the right of zero, though not as far right as the total return distribution, with a peak in the 0.5% to 1% region. The distribution shifts to the left mechanically on the removal of income return from total return.

Under each distribution is the BP test statistic for each bin. The income return distribution exhibits extreme discontinuity, as expected since it is effectively truncated at zero. In contrast, the test statistics are of similar magnitude across all bins and not statistically significant for any bin in the capital return distribution. Removal of income return from total return removes the discontinuity entirely. The discontinuity is created by income return.

Second, I use the McCrary test. Table 1 Panel A reports the results for the capital return distribution. There is no discontinuity around zero. The log difference in densities around zero is 0.126 and this is not statistically significant at any conventional level. This log difference is equivalent to the density above zero being merely $e^{0.126} = 1.134$ times higher than the density below zero, compared to 1.466 times higher under the total return distribution. Some small difference in the density remains due to the natural curvature of the distribution.

C. Effect of manager valuations

What is the effect, then, of manager valuation of assets? Funds worldwide are required to report assets at fair value, the price that would be received to sell the asset in an orderly transaction at the measurement date.[16,17,18] For the most part, this is the market closing price on the exchange. However, where the asset is unlisted, managers have the discretion to set the price that they deem is appropriate, such as on the basis of internal valuation models.

[16] For Australia, see AASB 13 Fair Value Measurement and AASB 1056 Superannuation Entities.

[17] For the US, see Section 2(a)(41) of The Investment Company Act of 1940, ASC 820 Fair Value Measurements and Disclosures, ASC 946 Financial Services – Investment Companies, ASC 960 Plan Accounting – Defined Benefit Pension Plans, and ASC 962 Plan Accounting – Defined Contribution Pension Plans.

[18] For countries worldwide, see IFRS 13 Fair Value Measurement, IAS 26 Accounting and Reporting by Retirement Benefit Plans, and CFA Institute Global Investment Performance Standards.

For this subsection, I focus on the subsample of funds that comprise 41% of all observations. Since 2010, to encourage market competition, legislation mandates all pension fund providers to offer at least one diversified balanced fund with standard features so for there to be a comparable product across all providers ("MySuper fund").[19] These funds are subject to additional reporting, including income and capital returns by asset allocation. Asset allocations are defined by, *inter alia*, each combination of listing status and asset class. The asset classes are cash, fixed income, equity, property, infrastructure, commodities, and other.[20]

Unrealized capital returns on listed assets arise on changes in the market price of exchange-traded securities, while unrealized capital returns on unlisted assets arise on changes in the valuation by the manager. Valuation of unlisted equities, such as private businesses, has been expected to provide substantial opportunity for manipulation. Thus, I test for a discontinuity in the capital return distribution after excluding the portion relating to unrealized capital return on unlisted equities. This conservatively attributes the entire unrealized capital return as opportunistic, whereas only a part or none of it may be. Results are robust to also excluding the unrealized capital return on other unlisted asset classes.

Figure A1 Panel A of the Internet Appendix shows the equivalent capital return distribution under the BP test for this subsample of funds and Panel B shows the distribution after excluding the portion of capital returns created by revaluation. For comparability with other distributions, I use a bin width of 50 bps. The theoretical bin width is 53 bps for Panel A and 50 bps for Panel B. Results are robust to using the theoretical bin width. Below each distribution is the test statistic for each bin. Despite slightly more noise from the smaller sample, both distributions have a similar smooth bell shape with no discontinuity. Actually, the distribution is smoother after revaluation. Untabulated results show neither distribution has a discontinuity under the McCrary test either. Overall, regardless of whether managers manipulate returns to avoid reporting losses, the capital return distribution does not provide evidence of it.

[19] See Part 2C of the Superannuation Industry (Supervision) Act 1993. Some providers merely repackaged a pre-existing balanced fund to comply with the requirements.
[20] 'Other' refers to assets not elsewhere classified, and can include hedge funds, mezzanine debt, and convertible debt.

III. How does income return create the discontinuity?

A. Convex income-capital return relation

I track how income return creates the discontinuity, or how the addition of income return transforms the smooth capital return distribution into a discontinuous total return distribution. If an equal amount of income return is added to the capital return of all funds, then that would merely shift the capital return distribution to the right while preserving its smooth bell shape. For the capital return distribution to change shape, funds with capital loss should have higher income return than funds with capital gain. This would push more funds with capital loss to the right compared to funds with capital gain, leading funds to gather above zero return.

To test this, I examine how income return changes with capital return. First, I plot the mean income return of funds in each bin of the capital return distribution. Results are robust to using the median return. Figure 2 shows the mean income return in each bin as dots overlaid with a quadratic trend separately for above and below zero, along the same horizontal axis as Figure 1. The relation is flat in the positive region. Funds with capital gain have income return that is consistent and low on average. The relation is downward sloping in the negative region. Funds with capital loss have greater income return than funds with capital gain and this increases the greater the capital loss. Together, the income-capital return relation is convex.

Second, I estimate the relation between income and capital return using

$$IR_i = \alpha + \sum_{p=1}^{P} \gamma_p CR_i^p + Positive_i\left(\beta + \sum_{p=1}^{P} \delta_p CR_i^p\right) + \varepsilon_i, \qquad (6)$$

where for each observation i, IR is the income return, CR is the capital return, $Positive$ is an indicator variable that equals 1 where $CR \geq 0$ and 0 otherwise, and p is the polynomial order. I alternatively estimate a linear function, $P = 1$, and quadratic function, $P = 2$. The model allows for different functions below and above zero capital return. The set of γ terms captures the relation below zero. The set of δ terms gives the adjustment to the equivalent γ terms to obtain the relation above zero. β allows for a discontinuous gap between the functions at zero, for there is no *a priori* basis to restrict β to zero to force join the functions.

Table 2 Panel A reports the estimate of the income-capital return relation under linear and quadratic functions with robust standard errors in parentheses. The number of observations is slightly smaller than the full sample because it corresponds to the -10% to 10% plot range of Figure 2. To assist interpretation, I discuss results in terms of the linear function, which sufficiently captures the trend. The difference is nominal under the quadratic function. For funds with capital gain, the slope is economically insignificant and effectively flat at $\hat{\gamma}_1 + \hat{\delta}_1$ = -0.375 + 0.391 = 0.016, indicating an increase in capital return from 0% to 10% is associated with an increase in income return on average from 0.60% to merely 0.76%. The addition of income return to these funds would shift the positive region of the distribution to the right by generally 0.60% to 0.76% points, or 1.2 to 1.5 bins, without changing the shape. The coefficient $\hat{\delta}_1$ is statistically significant at the 1% level, indicating the slope of the relation changes at zero.

For funds with capital loss, the slope is statistically and economically significant at $\hat{\gamma}_1$ = -0.375, indicating a decrease in capital return from 0% to -10% is associated with an increase in income return on average from 0.8% to 4.6%. For income return to offset negative capital return and move the fund to the positive region, income return must increase by at least as much as capital return decreases. This is sufficient for funds in the -2% to 0% return region, where income return increases on average from 0.8% for funds with 0% capital return to 1.2% for funds with -1% capital return to 1.6% for funds with -2% capital return. For funds with capital return below -2%, inclusion of income return is largely insufficient to push funds into the positive region.

As robustness, I repeat the tests for a discontinuity and convex relation before and after 2016, which approximately splits the sample in half. I similarly find a discontinuity and convex relation within each subperiod, indicating results are not idiosyncratic to a period.

B. Bin migration

Figure 2 indicate the discontinuity is created by funds from bins slightly below zero moving to bins slightly above zero on the addition of income return. To ensure the movement of funds from this narrow region is sufficient to create the discontinuity and identify the funds that moved, I track the migration of each fund along the same horizontal scale as the capital return distribution in Figure 1 Panel C transforms into the total return distribution in Figure 1 Panel A. I refer to the capital return bin as the "old bin" and, after inclusion of income return for each fund, the total return bin as the "new bin".

Table 3 summarizes the migration of funds from their old bin to new bin within the -10% to 10% return range. To assist exposition, I aggregate the bins into 10 regions each covering a 2% interval. For example, the first region from the left of the distribution covers -10% ≥ return > -8% or equivalently -20 ≥ bin number > -16, the next covers -8% ≥ return > -6% or equivalently -16 ≥ bin number > -12, and so on. The columns set out the old bin regions. The rows set out the new bin regions. The cells show the percentage of observations that moved from an old bin region to a new bin region. The sum of cells on the downward diagonal shows 63.3% of funds have not moved between regions. The sum of cells below the downward diagonal shows 36.1% of funds moved rightward to a higher region on the inclusion of income return.

In line with Figure 2, Table 3 confirms the discontinuity is driven by the migration of funds from the -2% to 0% region to the 0% to 2% region. Within the -2% to 0% region, 8.7% of funds flowed out while only 4.0% of funds flowed in, leading to a net decrease of 4.8%. An insufficient number of funds flowed in from the -10% to -2% region since there are fewer funds in the tail of the distribution and these have insufficient income return to offset the negative capital return. Of the 8.7% of funds that flowed out, 6.7% flowed into the 0% to 2% region and 1.6% into the 2% to 4% region. Within the 0% to 2% region, the flows in and out are more balanced so the density is effectively maintained.

IV. Can managers manipulate the income return?

A. Real activities manipulation

Since the discontinuity in total returns is created by income not capital return, I evaluate whether managers could instead manipulate total returns through the income return component.

Income return reflects cash receipts, so this would entail real activities rather than book manipulation. Setting aside outright systematic fraud, this is not possible.

First, managers cannot manipulate the magnitude of percentage income return. The dollar income return (numerator) reflects cash distributions set by security issuers, including after the fund has purchased the security, and held by independent custodians. The portfolio value (denominator) is as of the beginning of the period. Even if portfolio values are revised retrospectively, the bulk of portfolios are determined by market closing prices rather than manager valuation. To increase the percentage income return would also require revising portfolio values down.

Second, managers are not able to manipulate the timing of income return. Under accounting standards worldwide, while funds can recognize income on an accrual basis – that is, in advance of cash receipts – recognition is allowed only upon declaration of distributions by security issuers. Further, the lengthy quarterly return horizon is often sufficient to close the accrual process and for the recognition to be supported by cash receipts. The median investment income receivable – that is, return yet to be supported by cash receipts – across all fund providers is just 0.07% of assets.

Third, managers are not able to jointly manipulate income and capital return so to sort themselves into the convex relation that creates the discontinuity. Managers are not able to observe a capital loss and then switch into assets that would provide the higher income return to offset it. Capital return is observable only at the end of the period after income return has been recognized during the period, not vice versa. Nor can managers control the capital return. Even if a manager attempt to manipulate market prices, such as through portfolio pumping,[21] the funds are highly diversified with a small weight in any security so it is not feasible or cost-effective to simultaneously influence the market price of the numerous holdings. Even if managers revalue some assets, the bulk of portfolios are set by market prices that are subject to change continuously until the period end.

[21] For example, see Agarwal, Daniel, and Naik (2011), Ben-David, Franzoni, Landier, and Moussawi (2013), Bernhardt and Davies (2005), Carhart, Kaniel, Musto, and Reed (2002), Duong and Meschke (2020), and Hu, McLean, Pontiff, and Wang (2014).

To examine the relative scope for market prices and manager valuations to affect capital returns, I plot the mean asset allocation of the funds in each bin in the capital return distribution. Funds report the portfolio value in terms of seven asset classes: cash, fixed income, equities, property, infrastructure, commodities and other. I aggregate these into cash and fixed income, equities, and all other. Results are robust to using the median asset allocation or not aggregating the asset classes.

Figure 3 shows the mean asset allocations for each bin, along the same horizontal axis as Figure 1 and Figure 2. All funds are largely invested in fixed income or equities. Funds with capital return closer to zero hold more cash and fixed income while funds with capital return further from zero hold more equities, in line with equities having a wider range of expected return. The mean allocation in cash and fixed income increases from a minimum of 21.5% at the tails to a maximum of 62.8% at zero. The mean allocation in equities has the opposite pattern and decreases from a maximum of 64.2% at the tails to a minimum of 25.3% at zero. All funds are largely invested in fixed income or equities. The exposure to all other asset classes is much smaller, with a range of 10.5% to 19.9%. Capital returns are predominately driven by market prices.

Fourth, managers who seek to increase returns would be more likely to increase risk, not decrease it by switching into lower risk assets such as fixed income for higher income return (Brown, Harlow, and Starks (1996)). In line with this, Figure 3 shows that the asset allocation for funds along the capital return distribution is symmetrical around zero. Funds with capital loss do not hold more fixed income than funds with capital gain. The convex relation and bin migration also do not affect only funds slightly below zero, but is part of a systematic trend throughout the distribution. Overall, it is not possible for the convex relation to reflect investment actions by the fund manager.

B. Sources of returns

I investigate whether there is support instead for the alternative explanation that the effect of income return and the associated convex relation is a facet of the underlying assets. Funds would then passively benefit from holding assets that yield higher income return when the market price falls. Thus, I identify whether a particular asset class drives the convex relation. I use the subsample of balanced funds described in Section II.C that additionally report returns by asset class and plot the income return by asset class for each bin of the capital return distribution. In light of the reduced sample leading to fewer observations per bin, especially at the tails, I use the median return to mitigate the effect of any outliers. Results are effectively unchanged if the mean return is used.

Figure 4 shows the median income return from cash and fixed income, equities, and all other asset classes within each bin of the capital return distribution, along the same horizontal axis as Figures 1 to 3. The shape of the overall trend sufficiently captures the convex relation in Figure 2, showing prior results are replicable within a subsample and that an effect in the subsample can reflect an effect in the population. The break down shows the convex relation is driven by dividends from equities. While income return from cash and fixed income also increases as capital return decreases, these contribute a much smaller extent.

I also plot the median capital return by asset class within each bin of the capital return distribution. Results are effectively unchanged if the mean return is used. Figure A2 of the Internet Appendix shows the capital return from cash and fixed income, equities, and all other asset classes for each bin, along the same horizontal axis as Figures 1 to 4. While returns from all asset classes increase in absolute value as funds move further from zero, equities are by far the largest contributor to capital return and the key determinant of the fund's position on the capital return distribution. The variation in capital return on average ranges from -6.8% to 7.3% with a standard deviation of 2.3% for equities, compared to a range of -2.4% to 1.4% (-1.7% to 2.0%) and standard deviation of 0.5% (0.5%) for cash and fixed income (all other asset classes). Thus, funds incur capital losses predominately because of capital losses on equities and equities with capital losses have higher income return on average.

As a falsification test, I test for a discontinuity and convex relation using only the portion of pension fund returns from listed equities, where there is little scope for manipulation. I find a significant discontinuity similar to Figure 1 and a convex relation similar to Figure 2.

C. Equity returns

If the discontinuity and convex relation is a facet of the underlying assets rather than the result of manager actions, then it should be present in assets generally rather than just the assets held by the pension funds. Like the hedge funds examined in discontinuity literature, the pension funds invest in assets worldwide, listed and unlisted, so data is not available for all underlying asset markets. I test whether the discontinuity and convex relation are present in US listed equity returns, where data coverage is comprehensive, regulatory oversight is established, and the market is deep. This also provides a falsification test in testing for a discontinuity where misreporting is not possible, since equity returns are based on market closing prices and collated by independent data vendors.

First, I tests for a discontinuity in US listed equity returns. Monthly total and capital returns are reported in CRSP. Income return is the difference between total and capital return. Since the associated convexity plot later examines the relation between income and capital return, there must be income return to examine. However, equities do not pay dividends monthly so the sample mixes months where the income return is and is not applicable. Thus, I exclude observations with no income return.

In relation to the BP test, Figure 5 shows the distribution of US listed equity returns for 1994 through 2005 with a bin width of 70 bps and the associated test statistics below it. There is an economically significant discontinuity at zero. This differs from BP. The distribution is centered at zero, reflecting the shorter return horizon used. By the nature of the vehicle, pension funds have a greater preference for yield. Australian pension funds, in particular, are a key investor of Australian equities, which are distinguished by high dividend yields. US firms have preferred to reinvest earnings rather than distribute them as dividends. This makes using US market a difficult setting to find an effect. Nonetheless, there is still a statistically significant discontinuity. Results are robust to, and stronger, using an extended period of 1926 through 2018, as shown in Figure A3 of the Internet Appendix, or the first and second half of the extended period. Thus, it is not idiosyncratic to a period but has been a consistent feature of returns.

In relation to the McCrary test, Table 1 Panel B reports estimates of the discontinuity using a bandwidth of 5% points around zero. The bandwidth is slightly wider than for pension funds to correspond to the wider bin width. Although the McCrary test is more conservative, it nonetheless confirms there is a significant discontinuity in the total return but not capital return distribution. The log difference in densities around zero in the total return distribution is 0.073, indicating the density above zero is 1.075 times higher than the density below zero, whereas the difference is not statistically different from zero in the capital return distribution. Results are robust to, and stronger, using the bias-corrected local polynomial density estimator described in Cattaneo, Jansson, and Ma (2019) or other bandwidths.

Second, I repeat the plot and estimate of the convex relation for US listed equity returns. Figure 6 shows the mean income return for each bin as dots overlaid with a quadratic trend separately for above and below zero. Similarly to Figure 2 for pension funds, there is a convex relation for US listed equities. Results are robust to, and stronger, using an extended period of 1926 through 2018, as shown in Figure A4 of the Internet Appendix, or the first and second half of the extended period. Thus, it is not idiosyncratic to a period but has been a consistent feature of returns.

Table 2 Panel B reports the estimate of the convex relation under linear and quadratic functions with robust standard errors in parentheses. Since the quadratic trend reflects the relation well, I discuss results in terms of the quadratic function. For equities with capital gain, the relation is flat. A change in capital return from 0% to 30% is associated with a change in income return on average from 0.90% to 0.93%. The slope of the relation changes at zero. For equities with capital losses, a change in capital return from 0% to -30% is associated with an increase in income return from 0.90% to 2.43%. The less negative slope corresponds to a less extreme discontinuity compared to pension funds.

D. Mutual fund returns

If the discontinuity is a facet of the underlying assets and present in US listed equity returns, then it should be evident in other funds. Thus, I repeat the tests for a discontinuity on US equity mutual fund returns. This also provides another falsification test in testing for a discontinuity where misreporting is not possible, since the funds predominately invest in US listed equities and net asset values are based on market closing prices as confirmed by independent custodians.

First, I test for a discontinuity in total returns. I use monthly returns reported in CRSP for 1994 through 2005, the same return horizon, return type, database, and sample period as BP. As is conventional in literature, I use returns at the fund not share class level to avoid double counting. I identify US equity mutual funds using the CRSP objective code "EQ". BP identify the funds using a combination of ICDI and Standard & Poor's objective codes, which are not available. To ensure my sample is effectively the same as BP, I replicate the 12 yearly distributions reported in Figure IA.1 of BP. Figure A5 of the Internet Appendix shows the shape of the distribution, horizontal axis, and vertical axis for every year are effectively the same as BP, so the pooled sample across all years should be effectively the same. It also shows a discontinuity visually is not obvious statistically if the discontinuity is not created solely by the two bins that bracket zero.

Figure 7 shows the distribution of total returns pooled across all years from 1994 through 2005 with a bin width of 30 bps and the associated test statistics under the BP test. There is an economically significant discontinuity at zero. This differs from BP. The discontinuity is larger than for US listed equities but smaller than for pension funds, reflecting the greater focus on yield by pensions funds compared to mutual funds. Some bins further from zero are also significant, but not to the same extreme, due to the distinctive bimodal shape of the distribution and the substantially larger sample size which makes significance tests sensitive to small differences. Results are robust to, and stronger, using an extended sample period of 1961 through 2018, as shown in Figure A6 of the Internet Appendix, or the first and second half of the extended period. Thus, it is not idiosyncratic to a period but has been a consistent feature of returns. The larger sample size on extending the sample period reduces the noise and the distribution reverts to an underlying unimodal bell shape centred at zero, save for an economically significant discontinuity at zero.

Table 1 Panel C reports the results of the McCrary test. There is a statistically and economically significant discontinuity in the total return distribution. The log difference in densities around zero is 0.236, indicating the density above zero is 1.266 times higher than the density below zero.

Second, I test for a discontinuity in capital returns. Since CRSP does not separate fund returns into income and capital components, I use the price return on the on the mutual funds' holdings, weighted by actual portfolio weights, to proxy for the capital return. To ensure the holdings return can be a close proxy, I require market data to be available for at least 90% of the portfolio value. The sample is limited to US equity funds so would not be substantially affected by non-equity assets. Following literature that use holdings return to proxy for gross return, I assume holdings disclosed at the beginning of the quarter are held over the subsequent quarter and calculate their buy-and-hold returns.[22] Using beginning rather than end of quarter holdings would also give holdings returns that are more highly correlated with reported returns (Kacperczyk, Sialm, and Zheng (2008)). Results are robust to requiring data to be available for at least 50% of the portfolio value or using holdings disclosed at the end of the quarter.

Figure A7 of the Internet Appendix shows the capital return distribution and the associated test statistics under the BP test. The capital return distribution has the same distinctive bimodal shape as the total return distribution in

[22] For example, see Agarwal, Fos, and Jiang (2013), Chen, Jegadeesh, and Wermers (2000), Daniel, Grinblatt, Titman, and Wermers (1997), Grinblatt and Titman (1989), and Wermers (2000).

Figure 7, indicating that holdings returns can sufficiently reflect the key features of fund return, except there is no discontinuity around zero. The test statistics are not statistically significant at any conventional level.

Table 1 Panel C reports the results under the McCrary test. There is no discontinuity in the capital return distribution. The difference in densities around zero is not statistically significant at any conventional level.

V. Heterogeneous effects

A. Effect by income return

I investigate whether the applicability of income return can be an omitted variable that explains the presence or absence of a discontinuity in return distributions. Figure 1 shows the removal of income return removes the discontinuity entirely from the total return distribution. This represents a discrete test, in that it examines the distribution either with or without income return. I now turn to a continuous test, and examine how the total return distribution varies with the level of income return. Compared to funds, there is a long time-series of total and income return reported for US listed equities. Thus, I test how the magnitude of the discontinuity in US listed equity returns changes with the dividend yield over time.

This test involves two steps. In the first step, I repeat the tests for a discontinuity in US listed equities returns by each year from 1926 through 2018. For the BP test, to ensure differences in the magnitude of the discontinuity is not mechanically due to a wider (narrower) bin width leading to more (fewer) observations in a bin, I plot the distribution for each year using a common bin width of 100 bps. The theoretical bin width is within 0 to 200 bps for 94% of the years. The magnitude of the discontinuity is the difference in density between the upper and lower bins. The density of the bin is positively correlated with its t-statistic, with a highly significant Pearson (Spearman) correlation of 0.301 (0.302) for the lower bin and 0.630 (0.605) for the upper bin. Meanwhile, the McCrary test estimates the magnitude of the discontinuity directly.

In the second step, I relate the magnitude of the discontinuity each year to the mean income return in that year and a time trend. As univariate analysis,

Table A1 of the Internet Appendix reports the Pearson (Spearman) pairwise correlation between the variables below (above) the downward diagonal. I discuss results in terms of the BP test and Pearson correlation; results are similar in terms of the McCrary test and Spearman correlation. The discontinuity has narrowed over time, with a significantly negative correlation of -0.401. Dividend yields on average have also decreased over time, with a significantly negative correlation of -0.717. This suggests the narrowing of the discontinuity is related to the fall in dividend yields of US listed equities. Indeed, the discontinuity is significantly positively correlated with dividend yields at 0.516.

As multivariate analysis, I estimate the following model using OLS:

$$Discontinuity_t = \theta_0 + \theta_1 t + \theta_2 \overline{IR}_t + u_t, \tag{7}$$

where for each calendar year t, $Discontinuity$ is the magnitude of the discontinuity and $\overline{IR}$ is the mean income return (dividend yield) of the observations in the distribution. The time trend controls for changes in the tick size regime from 1/8 to 1/16 to 1/100 that may create microstructure effects on the return. Results are robust to also controlling for total return.

Table 4 reports the estimates of the coefficients with robust standard errors in parentheses. Under Panel A, which uses the BP test to estimate the discontinuity, Column (1) shows that the discontinuity has narrowed over time, from 2.7% to 1.3% over 1926 to 2018 using model estimates, and this change is statistically significant. However, Column (2) shows that once dividend yield is controlled for, the time trend is no longer statistically significant. The narrowing of the discontinuity is driven by the fall in dividend yields. Panel B, which uses the McCrary test to estimate the discontinuity, provides consistent results.[23] The discontinuity has narrowed over time from a log difference of 0.667 down to 0.483 over 1926 to 2018 using model estimates, which is equivalent to the density above zero decreasing from 1.948 times higher to 1.621 times higher than the density below zero. Although the McCrary test is more

[23] The sample size reduces by one because there are insufficient observations for 1935.

conservative, which reduces the significance of its estimates, the effect of income return on the discontinuity remains statistically significant.

B. Effect by return horizon

Another test of the applicability of income return is to examine how the discontinuity varies with the return horizon. Whereas market prices can change daily, income returns are more sporadic, occurring quarterly, if at all. Further, where income returns do occur, Figure 1 shows that income returns are low and consistent compared to capital returns. Thus, income return would be a smaller determinant of total return than capital return as the return horizon increases. If the discontinuity is due to income return, then the discontinuity should also weaken as the return horizon increases.

Figure 1 Panel A shows the total return distribution and test statistics under the BP test based on 3-month returns for pension funds, and Figure A8 of the Internet Appendix shows the equivalent distribution and test statistics based on 6-month, 9-month and 12-month returns. The distribution mechanically shifts to the right the longer the return horizon, as expected since longer term returns would be greater than shorter term returns. There are fewer opportunities for funds in the lower tail to cross zero and create a discontinuity. The discontinuity also dissipates the longer the return horizon. While the size and significance of the discontinuity is stark for 3-month returns, it is weaker for 6-month returns, and absent for 9- and 12-month returns. At longer return horizons, for the fewer funds that do cross zero, there is less ability for income return to affect total return and create a discontinuity.[24]

C. Influence of monitoring

If a discontinuity reflects misreporting, then it should be absent or weaker where there is stronger monitoring, such as by auditors. While it may not be feasible to examine the effect of audits using self-reported commercial databases since they do not require funds to submit

[24] Another way to test the effect by income return may be to examine the discontinuity by fund style. However, the test is data intensive and infeasible for small samples (Bollen and Pool (2012) p. 2267).

audited data (e.g. CISDM (2013)) or update values on revisions after audits (Schneeweis, Kazemi, and Szado (2011)), systems, procedures, and internal controls must be in place to produce reliable reports about the pension funds and these must be audited annually.[25] US mutual funds are also audited. Nonetheless, a discontinuity persists for Australian pension funds and US equity mutual funds, showing it is independent of monitoring by auditors. Over 90% of the pension funds are audited by a Big 4 auditor, so it is not feasible to compare the discontinuity by audit quality. Audit standards worldwide require audits to review the entirety of the period since the last audit and actions after the period end until the auditor sign-off date,[26,27] so it is not feasible to compare between audited and unaudited months.

D. Earnings distributions

The discontinuity in the return distribution mirrors the discontinuity in the earnings distribution from accounting literature.[28] However, the distributions are not entirely equivalent. The earnings distribution comprises of a dip down before zero and a rise up after zero in addition to a large discontinuity at zero.[29] This provides the basis for the hypothesis that firms manipulate earnings to migrate from bins slightly below zero to the bins slightly above zero. In contrast, the return distributions do not dip down or rise up around zero but consists of a clean discontinuity at zero. Thus, it is not evident where funds migrate *from* or migrate *to*. If funds manipulate to avoid reporting losses, then it is dubious that the prevalence of manipulation is of the exact extent across the varied contexts to lower the height of bin -1 to exactly match bin -2, or raise the height of bin 0 to exactly match bin 1, but not more.

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[25] APRA Prudential Standard SPS 310 Audit and Related Matters
[26] For the US, see AS 2110: Identifying and Assessing Risks of Material Misstatement, AS 2401: Consideration of Fraud in a Financial Statement Audit, and AS 2801: Subsequent Events.
[27] For countries worldwide, see ISA 240: The Auditor's Responsibilities Relating to Fraud in an Audit of Financial Statements, ISA 315 (Revised): Identifying and Assessing Risks of Material Misstatement through Understanding the Entity and its Environment, and ISA 560: Subsequent Events.
[28] The cause of the discontinuity remains unresolved. Some claim it reflects manipulation e.g. Burgstahler and Dichev (1997) and Hayn (1995). Others claim it does not e.g. Beaver, McNicholas, and Nelson (2007), Dechow, Richardson, and Tuna (2003), and Durtschi and Easton (2005).
[29] For example, Figures 1 to 4 of Figures 2, 3, 4 and 6 of Beaver, McNicholas, and Nelson (2007); Burgstahler and Dichev (1997); Figures 2, 5 and 9 of Dechow, Richardson, and Tuna (2003); and Figures 1, 3, 4, 7 and 9 of Durtschi and Easton (2005).

VI. Conclusion

A discontinuity at zero in the pooled distribution of total returns has been attributed to manipulation by managers to avoid reporting losses. Using unique regulatory data that can separate total returns into income and capital components, I find there is no discontinuity in the capital return distribution. The discontinuity is created by income returns, for which misreporting is not possible. Income return has an asymmetric contribution: income return does not change with capital gain but increases the greater the capital loss, leading funds to gather above zero. The discontinuity a facet of the underlying assets, outside the control of managers, and also present in the distributions of US listed equities and US equity mutual fund returns. The applicability of income return is an omitted variable that explains the absence or presence of a discontinuity in return distributions. To adjust for the asymmetric effect of income return, tests for a discontinuity to infer manipulation should, at the very least, be in the capital not total return distribution.

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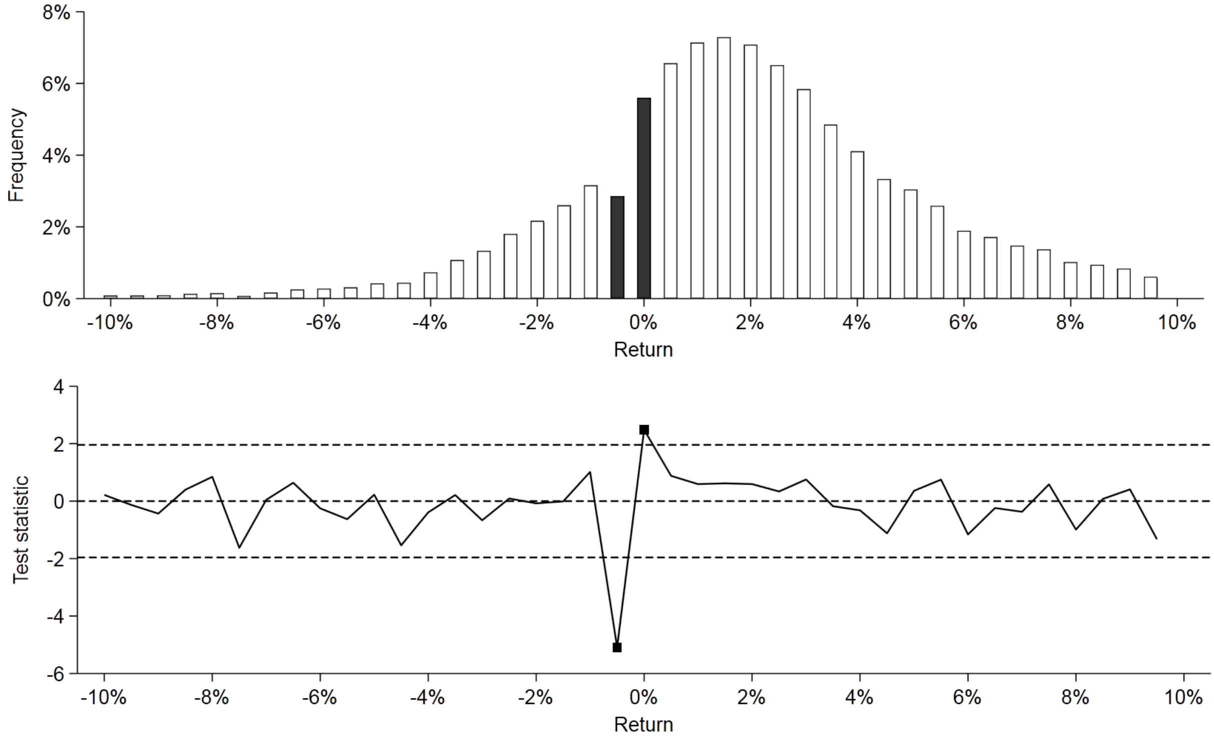
Figure 1: Bollen and Pool (2009) test for the discontinuity.

The figures examine quarterly returns of all institutional pension funds in Australia as provided by the Australian Prudential Regulation Authority for fiscal 2013 to 2018, n = 12,412. Panel A examines total returns. Panel B examines income returns. Panel C examines capital returns. Within each panel, the top graph shows the distribution of returns for the -10% to 10% region, n = 11,434. The bin width is 50 bps and there are 40 bins. The tick marks on the horizontal axis denote the starting return of each bin interval. The two solid bars indicate the two bins that bracket zero. The bottom graph reports the following standard normal test statistic to assess whether the density of each bin is significantly different from what is expected under a smooth distribution

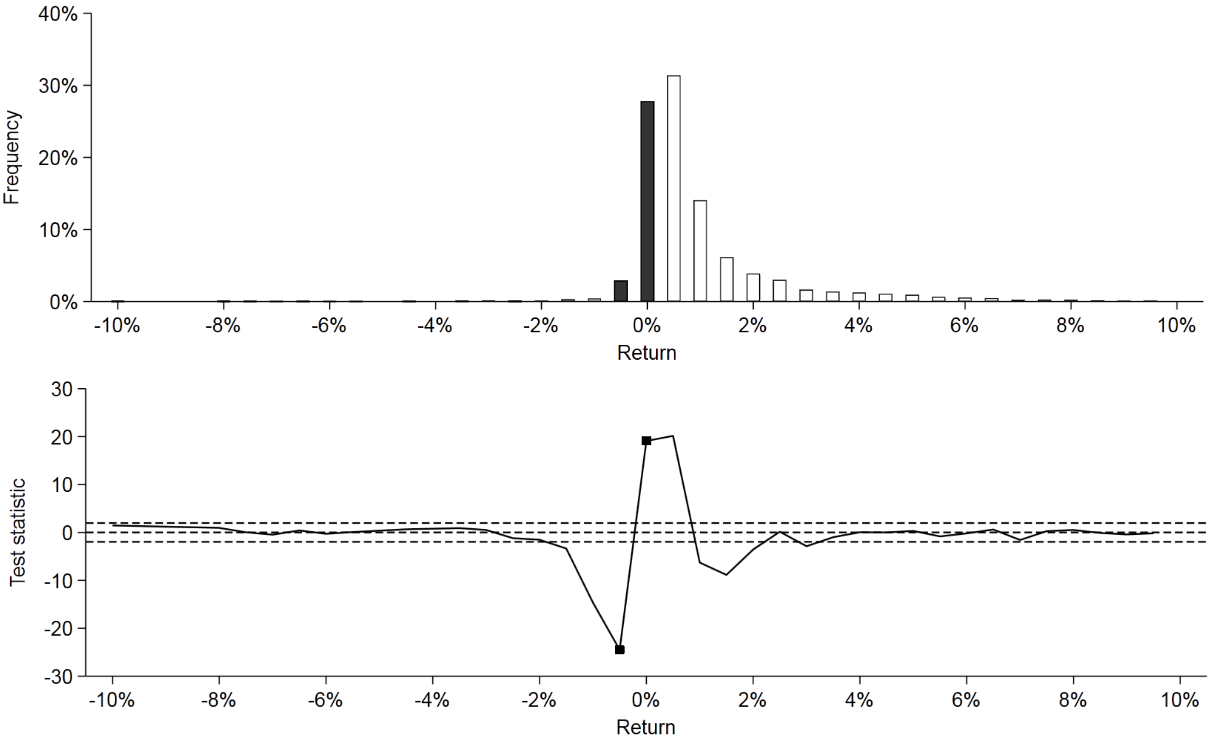
$$(X - Np)/\sqrt{Np(1-p)}$$

where X is the observed density, N is the number of observations, and p is the probability that an observation is in a given bin under the smooth distribution. The smooth distribution is estimated by fitting a Gaussian kernel density function to the observed distribution. The two box markers indicate the two bins that bracket zero. The dashed horizontal lines indicate the 95% critical values in a two-tailed test.

Panel A: Total return



Panel B: Income return



Panel C: Capital return

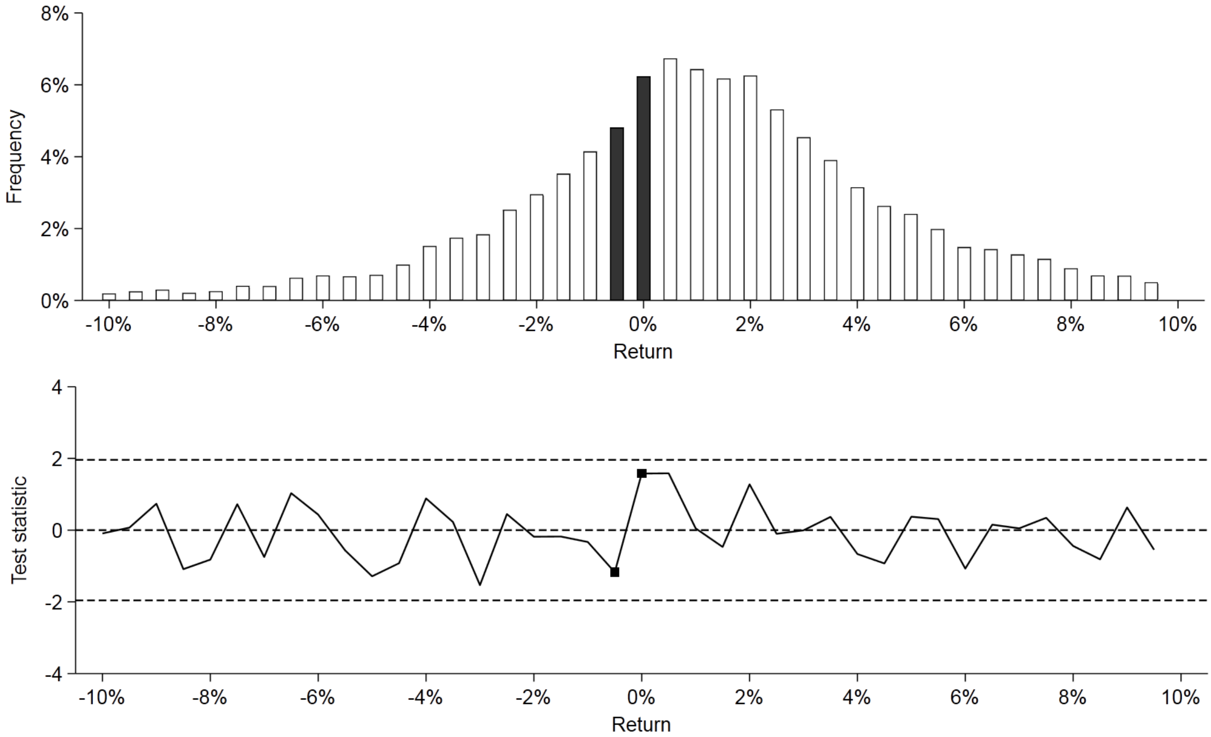


Figure 2: Convex relation in pension fund returns.

This figure plots the mean income return of pension funds in each bin of the capital return distribution in Figure 1. It is overlaid with a fitted quadratic trend separately for above and below zero.

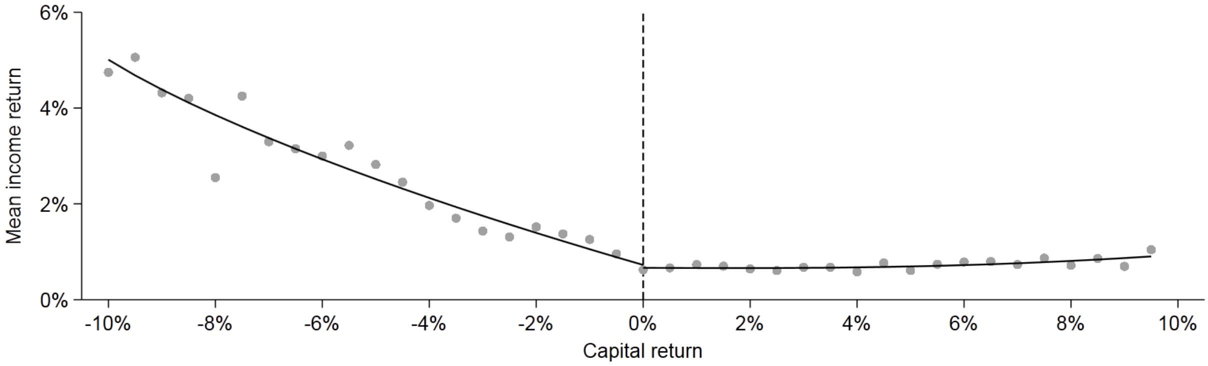


Figure 3: Asset allocation of pension funds.

This figure shows the mean asset allocation of pension funds in each bin of the capital return distribution in Figure 1. Reported asset allocations are aggregated into cash and fixed income, equities, and all other. The dashed (thick solid) [thin solid] line denotes cash and fixed income (equities) [all other].

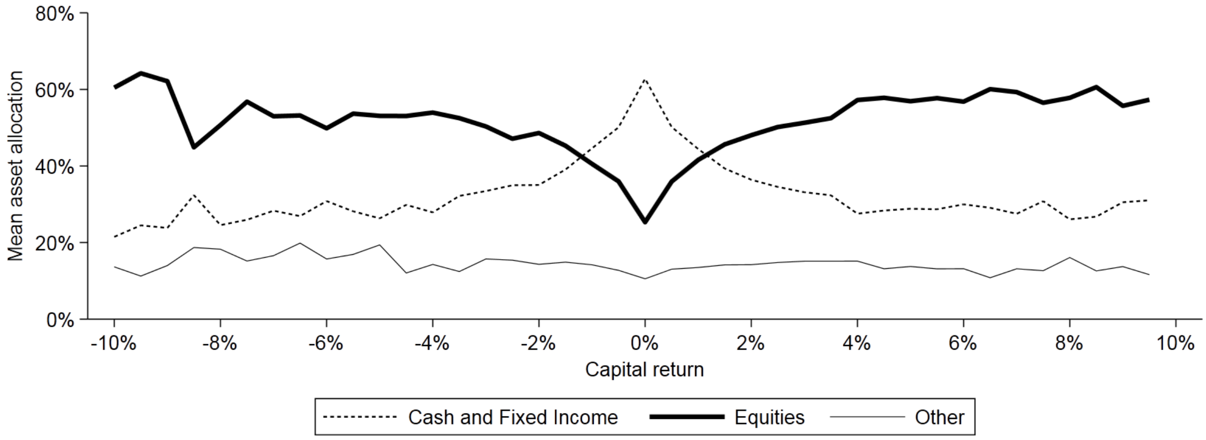


Figure 4: Sources of income return in pension funds.

This figure examines the subsample of funds that additionally report returns by asset allocation. It reports the breakdown of income return by asset allocation for each bin of the capital return distribution, along the same horizontal scale as Figures 1 to 3. The white (black) [gray] area denotes cash and fixed income (equities) [all other].

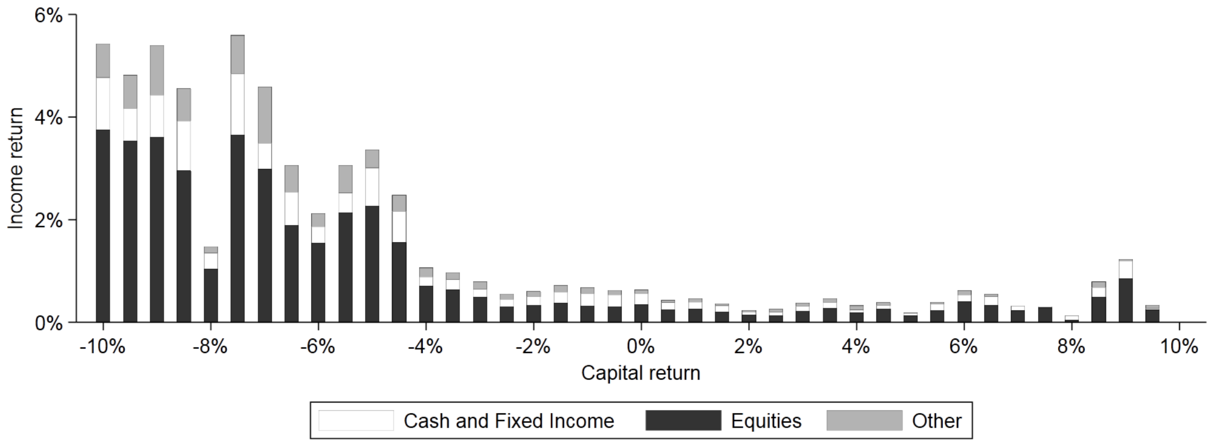


Figure 5: Discontinuity in US listed equity returns.

This figure examines monthly total returns of all US listed equities reported in CRSP for 1994 through 2005. The top graph shows the distribution of total returns for approximately the -20% to 20% region. The bin width is 70 bps and there are 58 bins. The bottom graph reports the standard normal test statistics as per the method described in Figure 1.

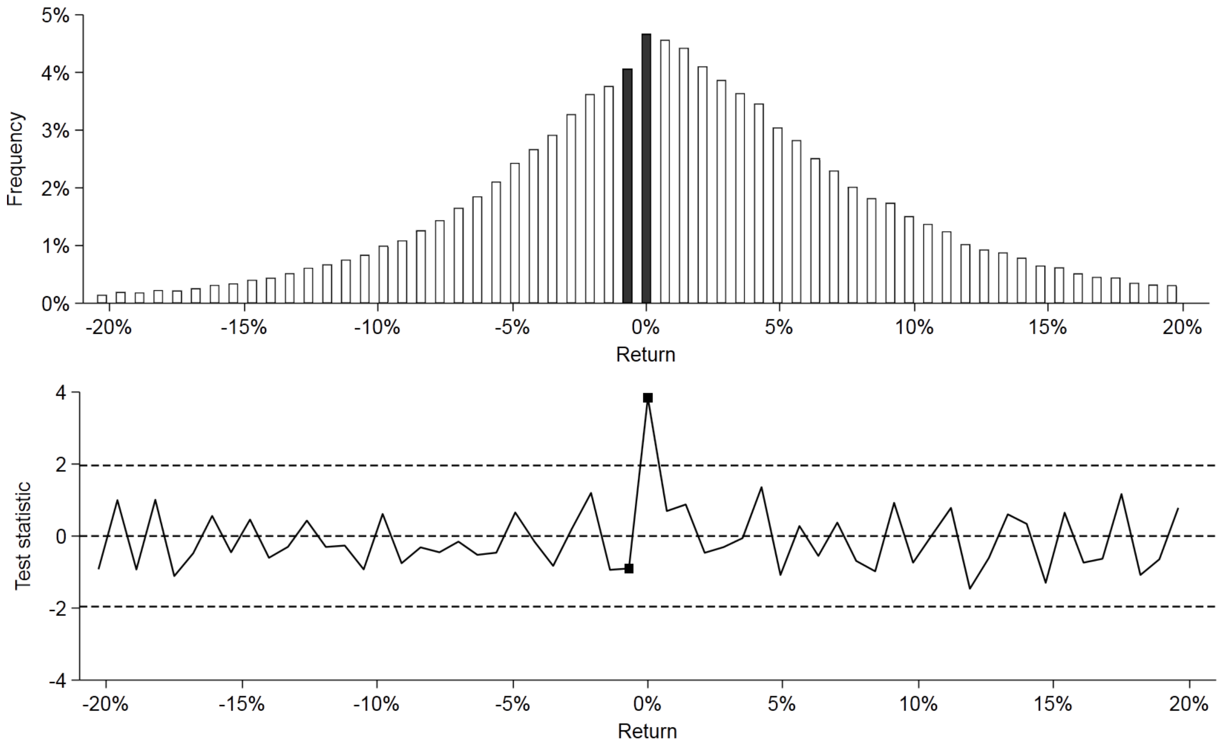


Figure 6: Convex relation in US listed equity returns.

This figure examines monthly total returns of all US listed equities reported in CRSP over 1994 through 2005. It plots the mean income return of the equities in each bin of the capital return distribution for approximately the -30% to 30% region. It is overlaid with a fitted quadratic trend separately for above and below zero.

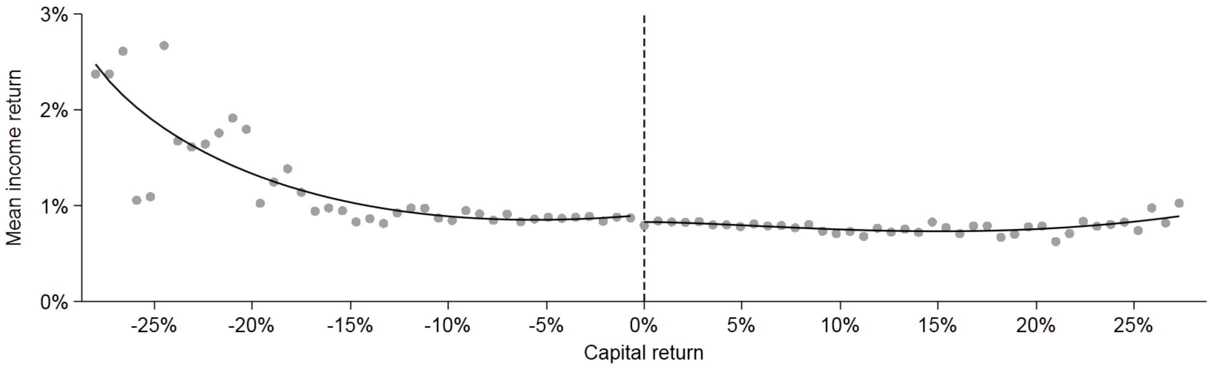


Figure 7: Discontinuity in US equity mutual fund returns.

This figure examines monthly total returns of all US equity mutual funds in CRSP over 1994 through 2005. The top graph shows the distribution of total returns for the -15% to 15% region. The bin width is 30 bps and there are 100 bins. The bottom graph reports the standard normal test statistics as per the method described in Figure 1.

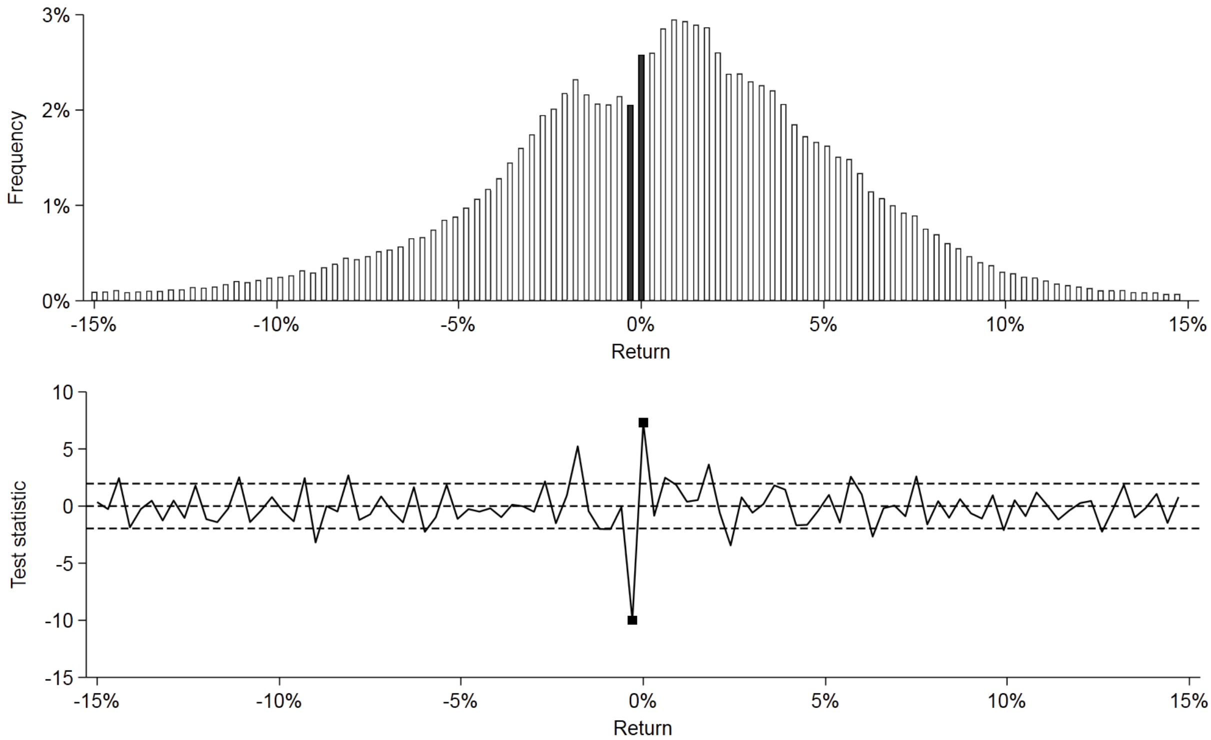


Table 1: McCrary (2008) test for the discontinuity

This table reports the estimated magnitude of the discontinuity, robust standard error in parentheses, and exponential of the estimate under the McCrary (2008) test in various distributions of returns. Panel A examines Australian pension fund returns. Panel B examines US listed equity returns. Panel C examines US equity mutual fund returns. Within each panel, total and capital returns are examined. *, **, and *** respectively denote statistical significance at the 10%, 5%, and 1% levels.

	Discontinuity $\widehat{\boldsymbol{\theta}}$	**Exp($\widehat{\boldsymbol{\theta}}$)**
Panel A: Pension funds		
Total return	0.383***	1.466
	(0.093)	
Capital return	0.126	1.134
	(0.084)	
Panel B: US listed equities		
Total return	0.073***	1.075
	(0.034)	
Capital return	-0.044	0.957
	(0.073)	
Panel C: US equity mutual funds		
Total return	0.236***	1.266
	(0.015)	
Capital return	-0.087	0.917
	(0.073)	

Table 2: Estimate of the convex relation

This table reports OLS estimates of the model

$$IR_i = \alpha + \sum_{p=1}^{P} \gamma_p CR_i^p + Positive_i \left(\beta + \sum_{p=1}^{P} \delta_p CR_i^p \right) + \varepsilon_i$$

where for each observation i, IR is the income return, CR is the capital return, $Positive$ is an indicator variable that equals 1 where $CR \geq 0$ and 0 otherwise, and p is the polynomial order. Panel A estimates the model using Australian pension funds returns in the -10% to 10% range and correspond to the trend in Figure 2. Panel B estimates the model using US listed equities in the -30% to 30% range and correspond to the trend in Figure 6. Within each panel, linear ($P = 1$) and quadratic models ($P = 2$) are estimated. Robust standard errors are in parentheses. *, **, and *** respectively denote statistical significance at the 10%, 5%, and 1% levels.

		Panel A: Pension funds		Panel B: US listed equities	
Dependent variable: Income return		**Linear**	**Quadratic**	**Linear**	**Quadratic**
$\hat{\alpha}$	**Constant**	0.008***	0.010***	0.008***	0.009***
		(0.001)	(0.001)	(0.0001)	(0.0002)
$\hat{\gamma}_1$	**Capital return**	-0.375***	-0.207***	-0.024***	0.027***
		(0.023)	(0.060)	(0.003)	(0.007)
$\hat{\gamma}_2$	**Capital return squared**		2.170**		0.260***
			(0.891)		(0.047)
$\hat{\beta}$	**Positive indicator**	-0.002***	-0.003***	0.001***	-0.0004**
		(0.001)	(0.001)	(0.0001)	(0.0001)
$\hat{\delta}_1$	**Capital return x Positive indicator**	0.391***	0.198***	0.018***	-0.045***
		(0.025)	(0.069)	(0.003)	(0.007)
$\hat{\delta}_2$	**Capital return squared x Positive indicator**		-1.862*		-0.197***
			(0.973)		(0.049)
N		11,434	11,434	109,212	109,212
Adjusted R-squared		0.131	0.132	0.006	0.009

Table 3: Bin migration

This table tracks the migration of funds along the same horizontal scale as the capital return distribution in Figure 1 Panel C transforms into the total return distribution in Figure 1 Panel A on the addition of income return. "Old bin" refers to the capital return bin and "new bin" refers to the total return bin. The bins are aggregated into 10 regions each covering a 2% interval. For example, the first region from the left of the distribution covers -10% ≥ return > -8%, the next covers -8% ≥ return > -6%, and so on. The columns set out the old bin regions. The rows set out the new bin regions. The cells show the percentage of funds that moved from a given old bin region to a given new bin region. The cells on the downward diagonal reflect funds that have not moved between regions. The cells below the downward diagonal reflect funds that moved rightward to a higher region on the inclusion of income return.

		Old bin region (starting return)									
		-10%	-8%	-6%	-4%	-2%	0%	2%	4%	6%	8%	**Total under new bins**
New bin region	-10% ≥ r > -8%	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	**0.4**
	-8% ≥ r > -6%	0.1	0.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	**0.6**
	-6% ≥ r > -4%	0.1	0.3	1.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	**1.5**
	-4% ≥ r > -2%	0.2	0.4	0.9	3.6	0.0	0.0	0.0	0.0	0.0	0.0	**5.3**
	-2% ≥ r > 0%	0.1	0.4	0.6	2.8	7.8	0.1	0.0	0.0	0.0	0.0	**11.7**
	0% ≥ r > 2%	0.1	0.1	0.4	1.4	6.7	20.3	0.1	0.0	0.0	0.0	**29.0**
	2% ≥ r > 4%	0.1	0.0	0.3	0.3	1.6	8.3	15.8	0.1	0.0	0.0	**26.5**
	4% ≥ r > 6%	0.0	0.0	0.1	0.1	0.3	0.5	5.2	8.1	0.0	0.0	**14.3**
	6% ≥ r > 8%	0.0	0.0	0.0	0.0	0.0	0.2	0.3	2.5	4.0	0.0	**7.1**
	8% ≥ r > 10%	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.1	1.5	2.0	**3.7**
	Total under old bins	**1.0**	**1.8**	**3.3**	**8.2**	**16.5**	**29.5**	**21.4**	**10.8**	**5.5**	**2.1**	**100%**
	In	0.0	0.2	0.5	1.7	4.0	8.7	10.8	6.1	3.1	1.7	**36.7**
	Out	-0.7	-1.3	-2.3	-4.6	-8.7	-9.2	-5.7	-2.6	-1.5	0.0	**-36.7**
	Net change	**-0.7**	**-1.2**	**-1.8**	**-2.9**	**-4.8**	**-0.5**	**5.1**	**3.5**	**1.5**	**1.7**	**0.0**
	Total under new bins	**0.4**	**0.6**	**1.5**	**5.3**	**11.7**	**29.0**	**26.5**	**14.3**	**7.1**	**3.7**	**100%**

Table 4: Discontinuity by income return

This table relates the magnitude of the discontinuity in yearly distributions of US listed equity returns over 1926 through 2018 to the mean dividend yield in that year and a time trend. It reports OLS estimates of the model

$$Discontinuity_t = \theta_0 + \theta_1 t + \theta_2 \overline{IR}_t + u_t$$

where for each calendar year t, $Discontinuity$ is the magnitude of the discontinuity in the total return distribution, and $\overline{IR}$ is the mean dividend yield of the observations in the distribution. Panel A estimates $Discontinuity$ using the Bollen and Pool (2009) test for a discontinuity. Panel B estimates $Discontinuity$ using the McCrary (2008) test for a discontinuity. The sample size reduces by one in Panel B because there are insufficient observations for 1935. Robust standard errors are in parentheses. *, **, and *** respectively denote statistical significance at the 10%, 5%, and 1% levels.

		Panel A: BP test		**Panel B: McCrary test**	
Dependent variable: Discontinuity		**(1)**	**(2)**	**(3)**	**(4)**
$\boldsymbol{\theta_0}$	**Constant**	31.604***	4.753	4.519	-3.621
		(7.111)	(10.631)	(3.763)	(4.879)
$\boldsymbol{\theta_1}$	**Year**	-0.015***	-0.003	-0.002	0.002
		(0.004)	(0.005)	(0.002)	(0.002)
$\boldsymbol{\theta_2}$	**Mean income return**		114.951***		34.385*
			(34.070)		(19.566)
N		93	93	92	92
Adjusted R-squared		0.152	0.252	0.008	0.051

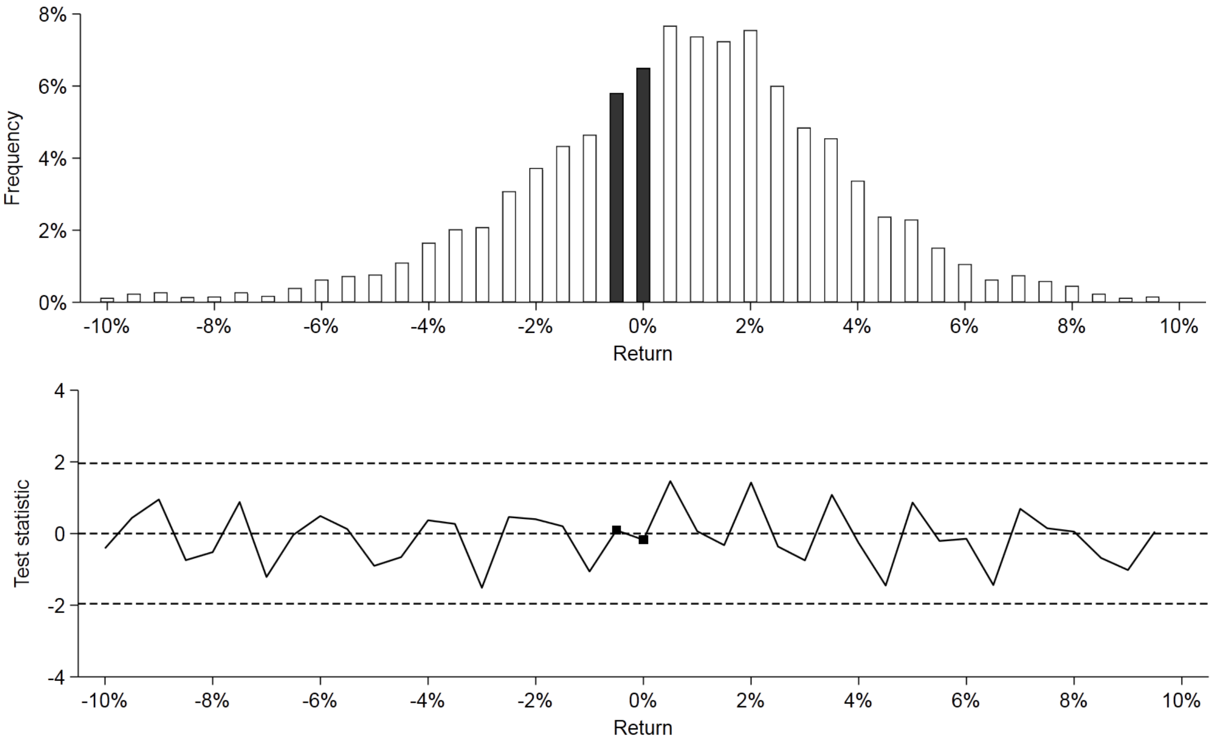
Discontinuities in Returns:
Re-examination of the Misreporting Explanation

Internet Appendix

Contents

Figure A1: Distributions of pension fund capital returns.

Panel A: Capital return including revaluation



Panel B: Capital return excluding revaluation

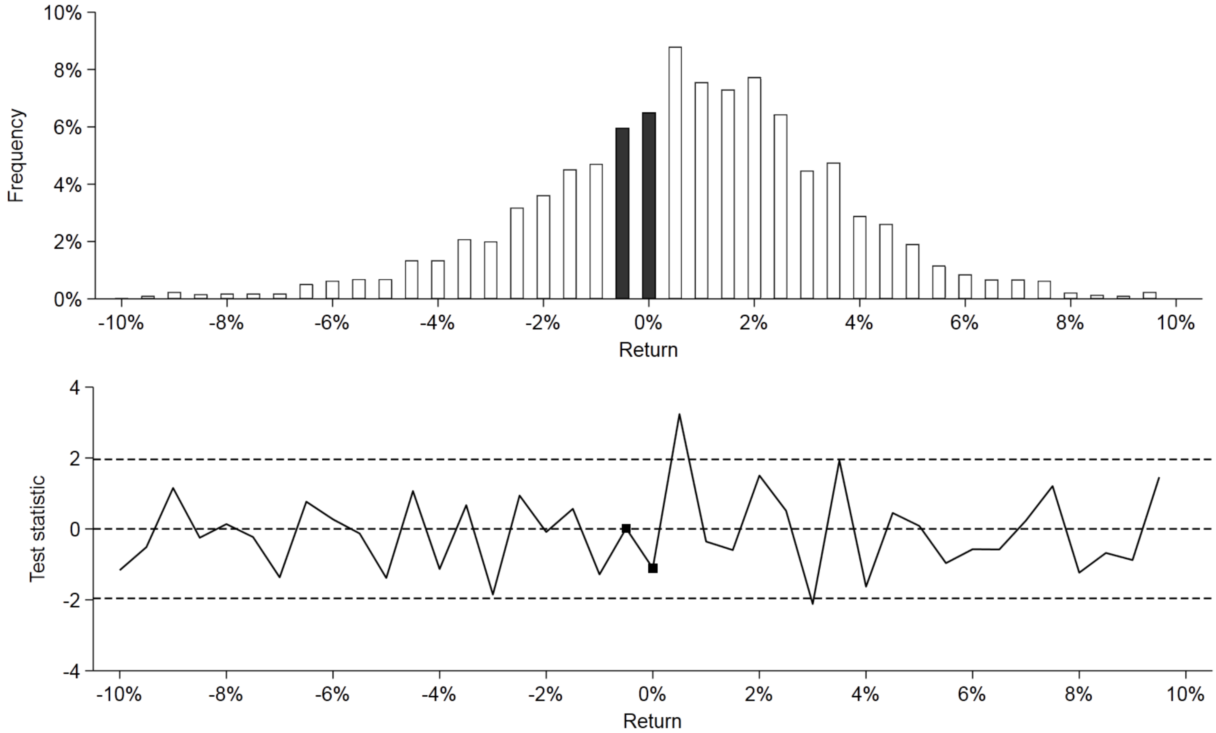


Figure A2: Sources of capital return in pension funds.

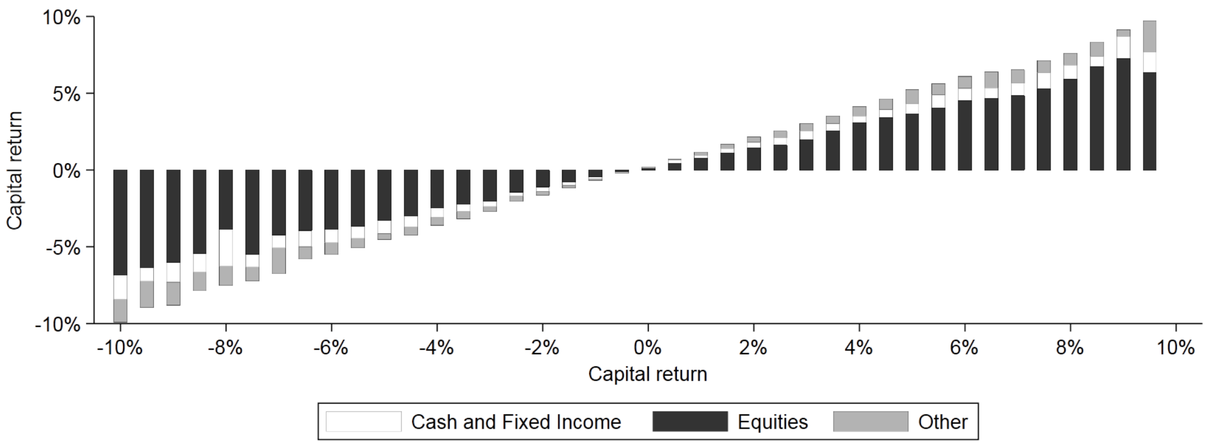


Figure A3: Discontinuity in US listed equity returns, 1926 – 2018.

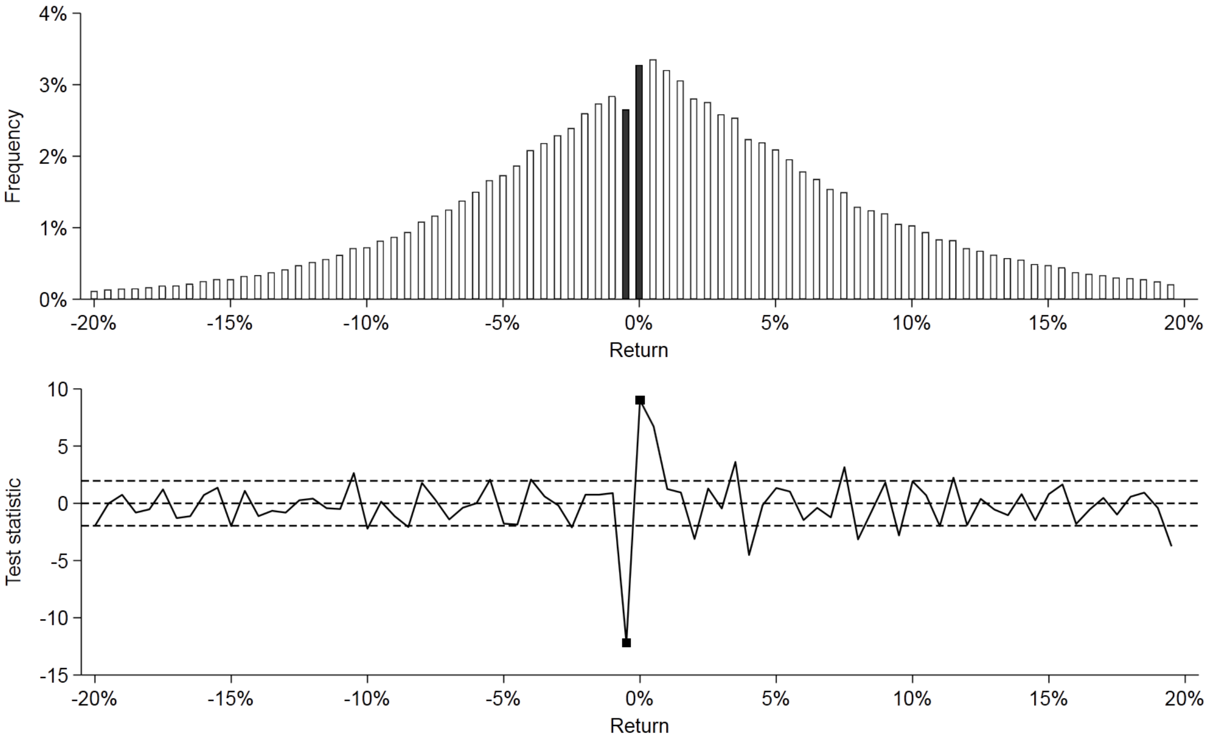


Figure A4: Convexity in US listed equity returns, 1926 – 2018.

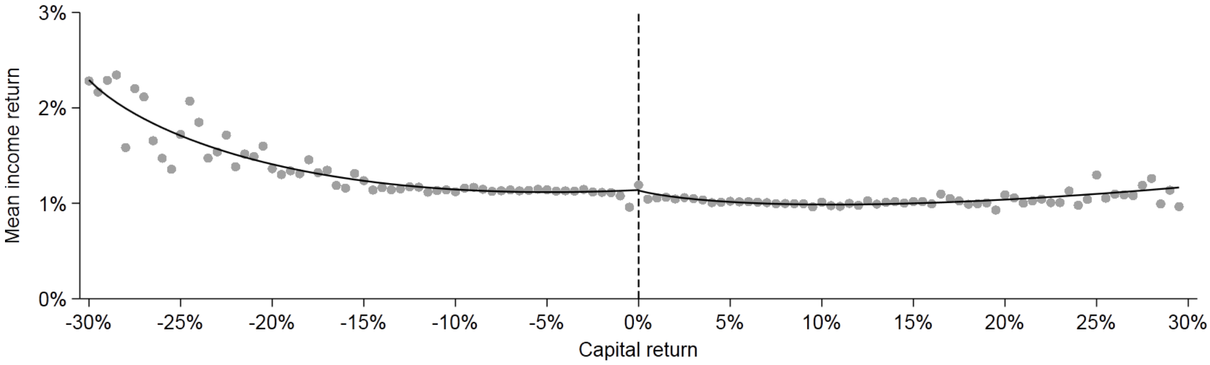


Figure A5: US equity mutual fund returns by year, 1994 – 2005.

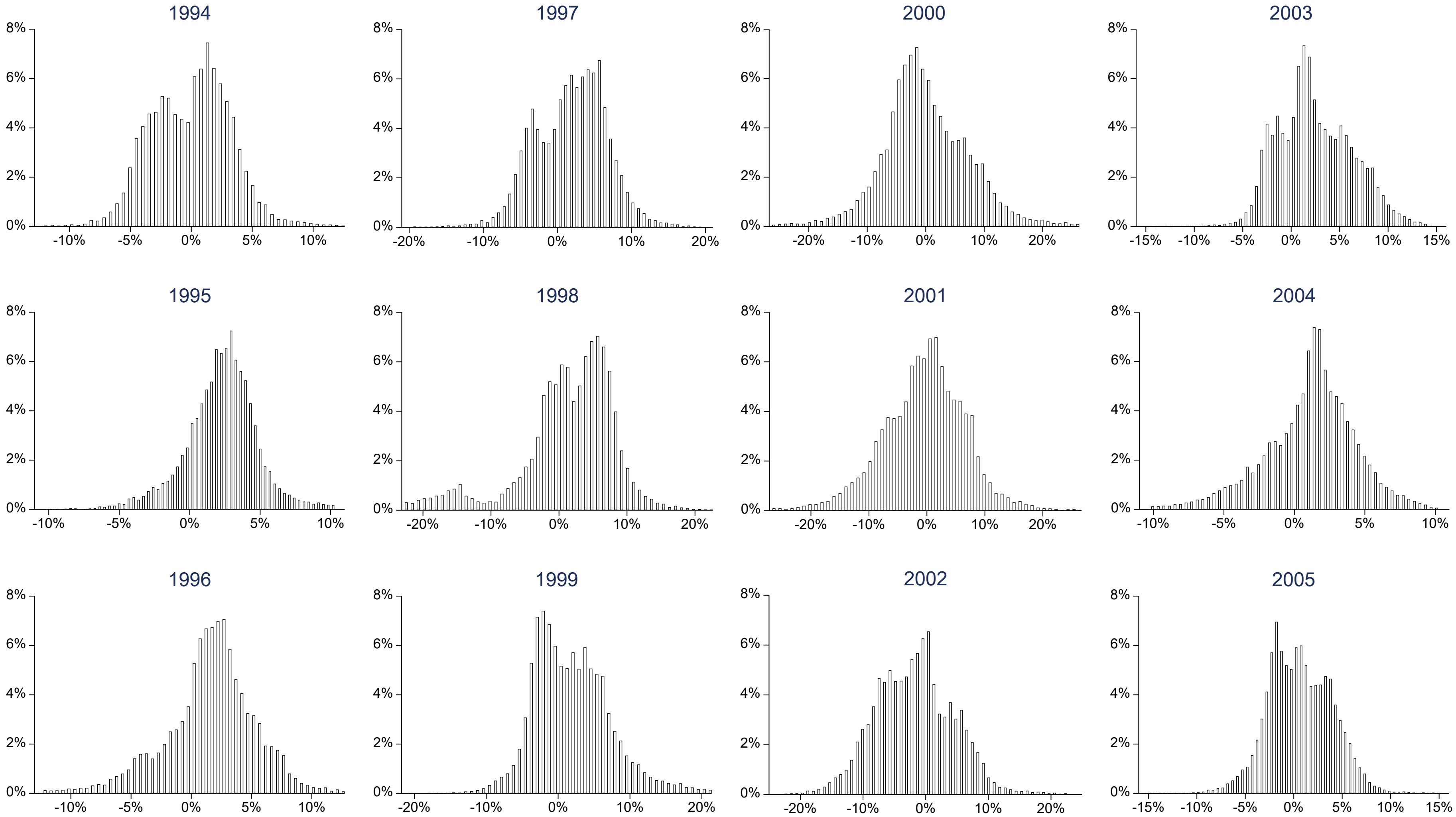


Figure A6: Discontinuity in US equity mutual fund returns, 1961 – 2018.

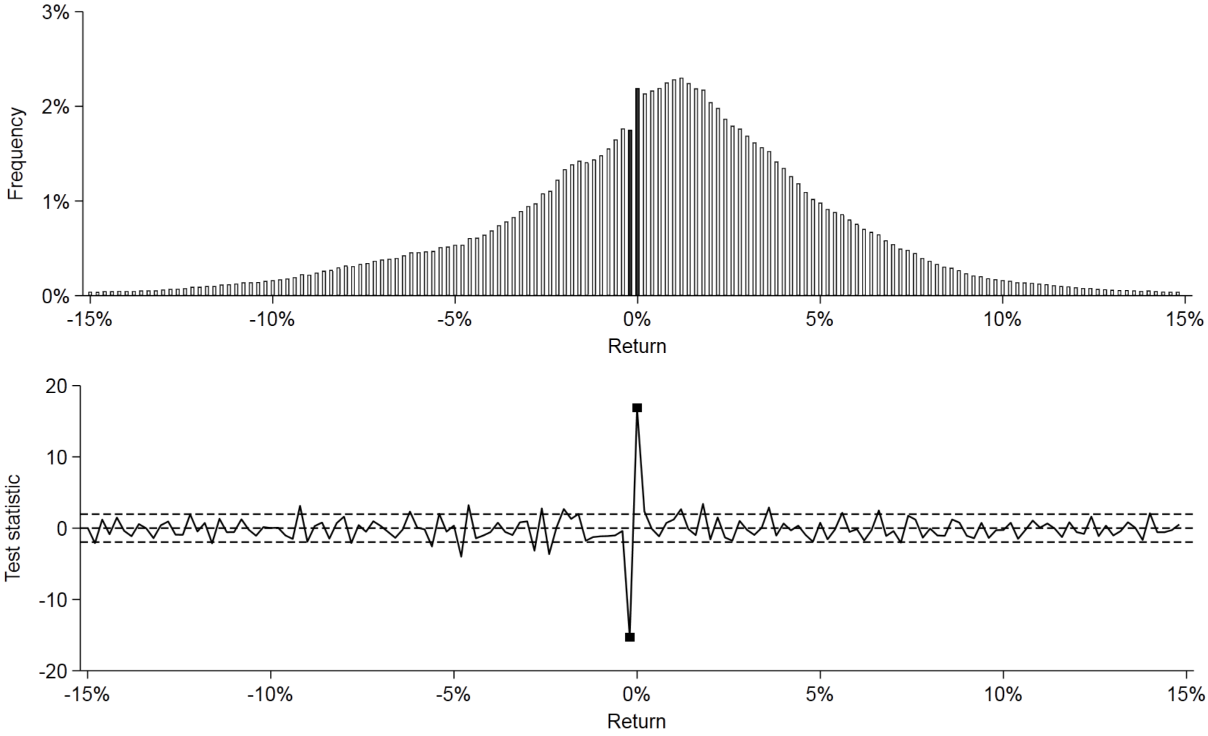


Figure A7: Discontinuity in US equity mutual funds – capital returns.

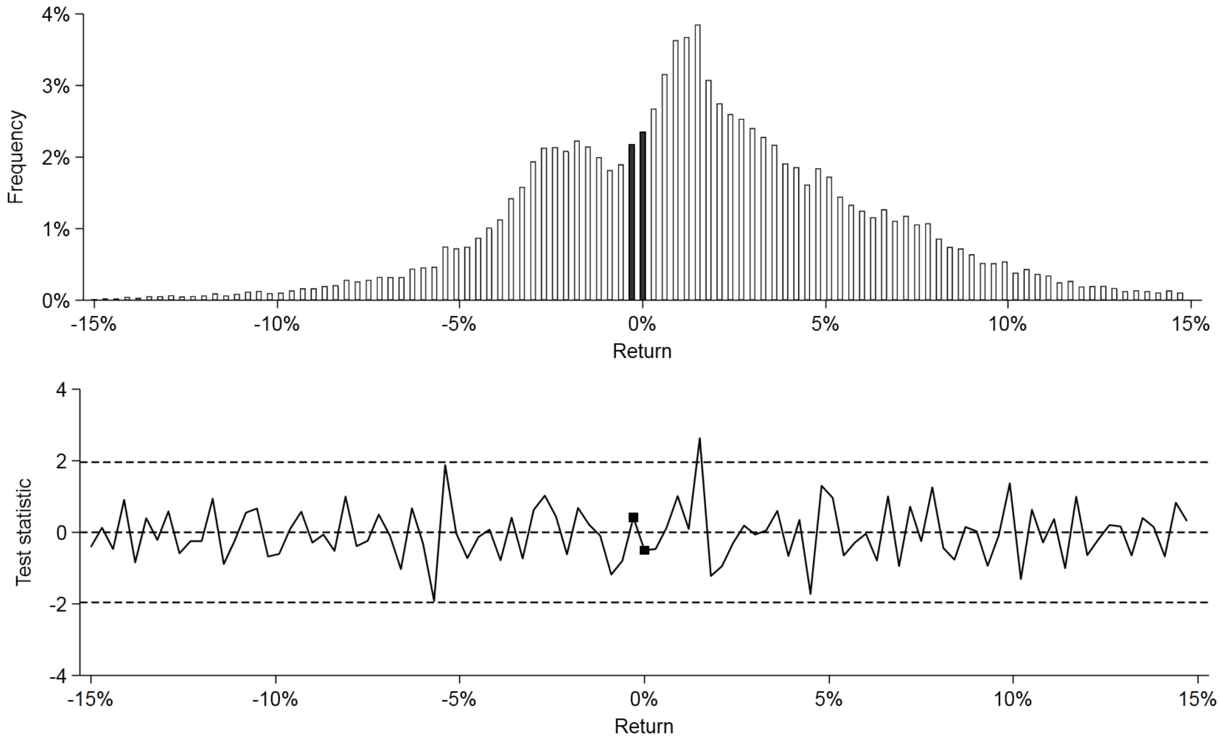
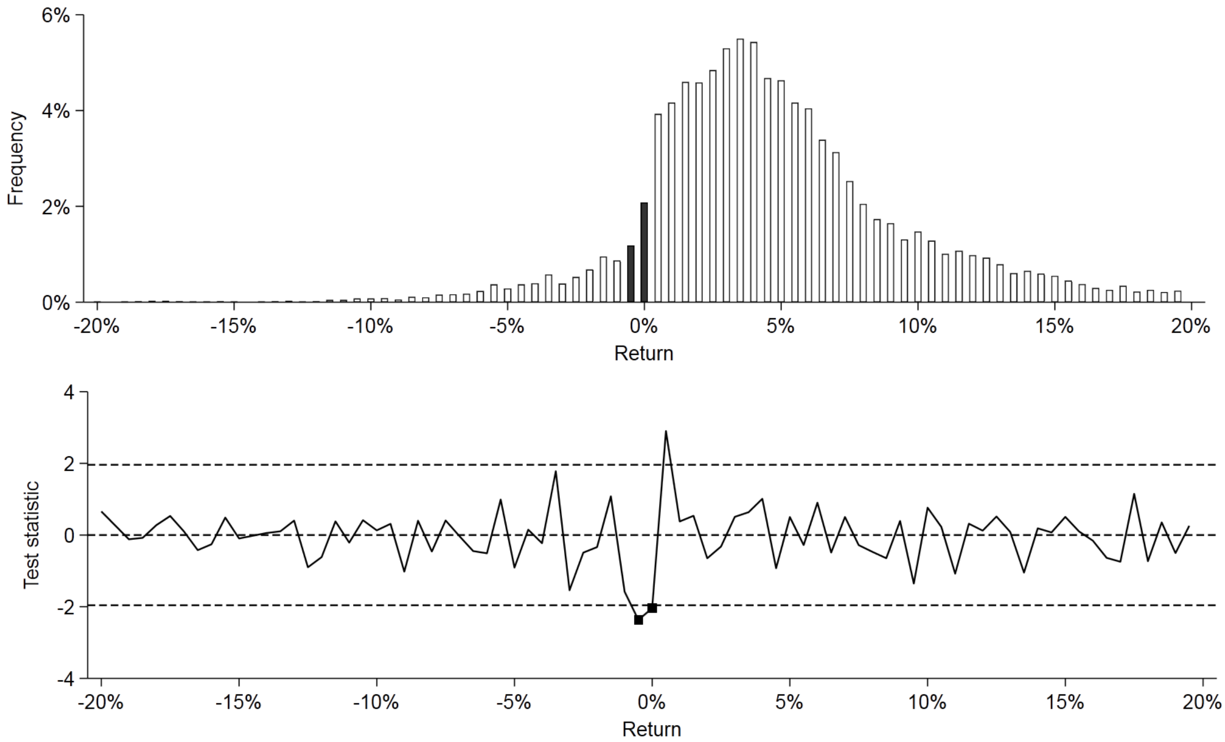
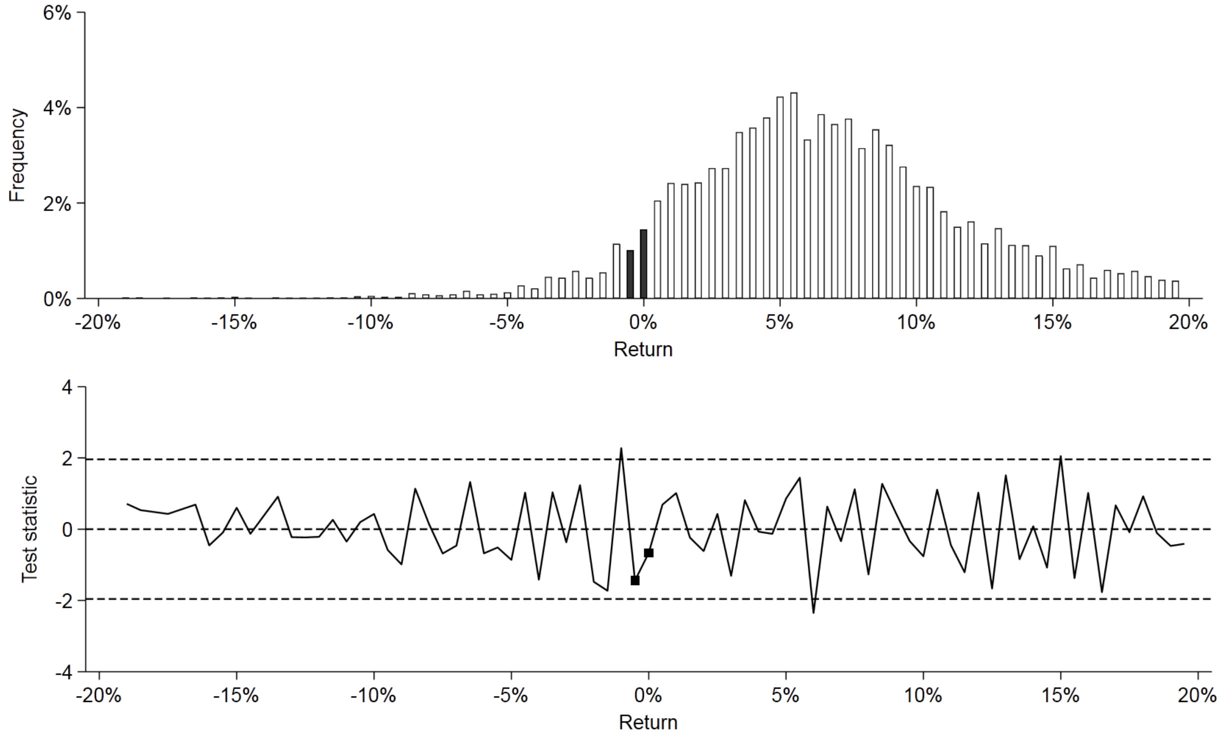


Figure A8: Distribution of pension fund returns by return horizon.

Panel A: 6-month returns



Panel B: 9-month returns



Panel C: 12-month returns

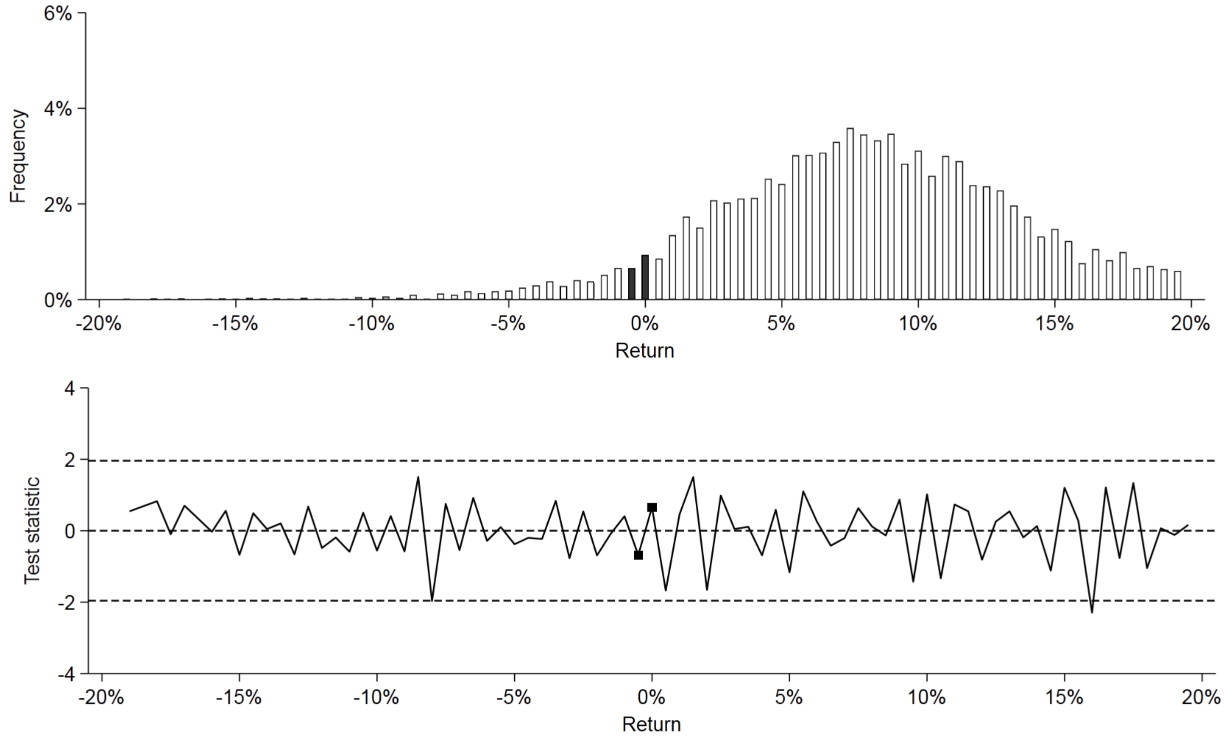


Table A1: Correlation matrix relating to discontinuity by year

The Pearson (Spearman) pairwise correlation is below (above) the diagonal. *, **, and *** respectively denote statistical significance at the 10%, 5%, and 1% levels.

	Discontinuity	Year	Income return
Panel A: BP test			
Discontinuity		-0.424***	0.496***
Year	-0.401***		-0.751***
Income return	0.516***	-0.717***	
Panel B: McCrary test			
Discontinuity		-0.076	0.117
Year	-0.138		-0.749***
Income return	0.259**	-0.717***	