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OSHUA COX AND BRONWYN BAILEY use a new approach to answer the question of whether private equity investment increases employment.

"*State and municipal pension funds embarked on a grand experiment by boosting their commitments to alternative assets during the last decade. From the point of view of the beneficiaries, and of taxpayers, the direct cost of these third-party managers was … tens of billions of dollars per year..*"
—Jeff Hooke, Carol Park, and Ken C. Yook

JASON SCHARFMAN details three ways in which institutional investors have increased the operational due diligence they do on alternative investment fund managers.

PORTFOLIO MANAGEMENT RESEARCH

Practical Applications Report

Practical Applications of Private Equity Investment and Local Employment Growth: *A County-Level Analysis*

The Journal of Alternative Investments
Practical Applications

Overview

In **Private Equity Investment and Local Employment Growth: *A County-Level Analysis***, from the Winter 2020 issue of ***The Journal of Alternative Investments***, **Joshua Cox** (of **Control Risks**) and **Bronwyn Bailey** (of **BB-Advisors**) use a new approach to answer the question of whether private equity investment increases employment. Previous studies have been inconclusive or contradictory. Sometimes past results indicated a loss of employment due to increased efficiencies from private equity investment, while other results indicated an increase in employment, albeit a statistically insignificant one. These studies focused on company-level employment growth, however. In contrast, Cox and Bailey examine countywide data and look for spillover effects: employment growth beyond that in the company receiving the private equity investment. The authors examine a host of control variables that might otherwise explain employment growth. In each statistical test, the association between lagged, countywide employment growth and private equity investment is positive and statistically significant.

Key Takeaways

- **There is a positive association between private equity investment and employment growth.** The results indicate that for each $1 million in additional private equity investment, a little more than 1.3 new jobs are created.
- **The results imply that private equity investment can create positive externalities.** Specifically, statistical tests using county-wide employment data suggest that the job-creation effects of company-specific private equity investment spill over from the company receiving financing to the local economy.
- **The popular notion that a higher minimum wage reduces employment growth is not supported empirically.** The minimum wage variable has a positive sign that is the opposite of that hypothesized.

Authors: Joshua Cox and Bronwyn Bailey
Source: *The Journal of Alternative Investments*, Winter 2020, Vol. 22, No. 3
Report Written By: Kathryn Wilkens
Keywords: private equity, employment, labor, economic impact, financial investment

Key Definitions

Externalities

Externalities are spillover effects, which can be positive or negative. An example of a negative externality is pollution. An example of a positive externality is when the job-creation effects of company-specific private equity investment spill over from the company receiving financing to the local economy through job growth and increased consumer spending.

Right-to-work state

A right-to-work state is a state that has enacted laws permitting individuals to work in unionized workplaces without joining a union or paying union dues, thereby making union membership optional. As of 2019, the right-to-work states comprise Alabama, Arizona, Arkansas, Florida, Georgia, Guam, Idaho, Indiana, Iowa, Kansas, Kentucky, Louisiana, Michigan, Mississippi, Nebraska, Nevada, North Carolina, North Dakota, Oklahoma, South Carolina, South Dakota, Tennessee, Texas, Utah, Virginia, West Virginia, Wisconsin, and Wyoming.

Huber–White sandwich estimator

Huber–White sandwich estimators are a tool for estimating the standard errors of linear regression results when the data display "heteroscedasticity"—that is, when the error terms of the

Discussion

The study examines whether private equity investment tends to create jobs by boosting economic growth, or to reduce jobs by cutting costs and improving efficiencies. Previous studies on the economic impact of private equity investment often have been inconclusive or contradict one another.

> "This study is unusual because it marries a financial investment topic with hypotheses more often found in labor economics and socioeconomic studies."
>
> *—Joshua Cox and Bronwyn Bailey*

APPROACH

The authors' regression approach defines the dependent variable as employment growth from 2011 to 2014. This is the absolute change in employment for 3,141 individual US counties, not the percentage change. This approach contrasts to many previous and often inconclusive studies of employment level changes within companies financed with private equity. Expanding the scope from the company level to the county level allows the authors to test the hypothesis that investment in a company can produce externalities to the local economy.

The independent variable of interest is private equity investment, measured as the sum of private equity investment in each county during 2011 and 2012. The longer span for the employment growth variable accommodates previously documented lags in employment changes after investment. Independent control variables represent labor supply, labor quality, labor cost, unionization (a dummy variable), agglomeration and urbanization, industry concentration, and dummy variables for eight US regions.

Two types of regressions are performed. The first is a set of five level-level regressions, where the set of independent variables is increasingly larger and more encompassing; the second type is a log-log regression that contains all independent variables. The level-level regressions utilize ordinary least squares regression methods, while both the dependent and independent variable measurements are in their original levels, e.g., 115 jobs. The log-log regression

regression have uneven variability. The error terms of the regression represent the portion of the relationship among the regression variables that is *not* explained by the regression model.

transforms the dependent and independent variables into natural logs of the original levels, e.g., *ln*(115). One notable difference between the two types of regressions is that the 3,141 sample size of the level-level regressions is decreased to 329 counties in the log-log model, because more than 2,000 counties did not receive any private equity investment during the sample period. In creating this model, the authors dropped counties that had no private equity investment. A motivation for using the log-log mode is that both key variables (the dependent variable, employment change, and the independent variable of interest, private equity investment) have distributions that are skewed to the right, like the lognormal distribution.

Six regression models are tested, correcting for heteroscedasticity in errors with the Huber–White sandwich estimators. They are 1) a level-level model with a single baseline independent variable (discussed below); 2) a model that adds private equity investment as the independent variable of interest; 3) a model that adds 7 core control variables, for a total of 9 independent variables; 4) a model that adds 3 industry concentration variables, for a total of 12 independent variables; 5) a level-level model that adds 7 geographic control variables, for a total of 19 independent variables; and 6) a single log-log model with all 19 independent variables.

CHANGE SCORING METHOD

The use of an absolute change in the dependent variable (employment) is consistent with many social science studies but less common in financial research, which more often uses percentage changes. This absolute change from the initial period level (T1) to the second period level (T2), referred to as a "change scoring method," is used because the dependent variable is in units (jobs). A percentage change of 10% in employment may require relatively little investment in a sparsely populated county but far more in a county with a very large population. For this reason, Model 1 regresses a change in employment (T2 – T1) against baseline employment (T1). Results show that higher levels of employment in the first period (2011) result in higher changes from 2011 to 2014.

MAJOR FINDINGS

Level-level regression models 2 through 5 yielded statistically significant coefficients and stable estimates for private equity investment, ranging from 1.31 to 1.36. The interpretation is that, all else equal, for each $1 million in additional private equity

investment, a little more than 1.3 new jobs are created. The log-log model yielded a statistically significant coefficient of 0.06. The interpretation is that a one percent change in private equity investment yields a 0.06 percent change in employment. These two results are very similar, given that the mean county-level private equity investment over the 2011 to 2014 period is $114 million, since $e^{0.06*ln(114)} = 1.33$.

> "The log-log model shows that a one percent change in private equity investment yields a 0.06 percent change in employment, holding all other variables in the model equal."
>
> ***—Joshua Cox and Bronwyn Bailey***

CONTROL VARIABLE HYPOTHESES AND FINDINGS

Model 3 includes a group of core variables: labor supply (unemployment), labor quality (education and labor force age), labor cost (average annual pay and minimum wage), effect of unionization (right-to-work state), and agglomeration and urbanization (metro).

Model 4 adds a set of control variables for industry concentration, and model 5 adds a set of regions.

Core Variables. Interestingly, in level-level model 3, the core variable for a unionization effect produces the only statistically significant coefficient of all the core variables. The effect of unionization is represented as a dummy variable. If a county resides in a "right-to-work" state, it is assigned a 1; if not, it is assigned a 0. The results are as hypothesized: positively correlated with net new jobs. In the log-log model, the right-to-work state variable remains positive but becomes statistically insignificant. Yet other core variables become significant in the log-log model: labor force age (with a negative correlation to employment change) and average annual pay and metro, both with positive correlations with employment change. Metro is a dummy variable assigned to 1 if the US Census Bureau indicates that it is a metropolitan area.

Industry Concentration. The presence of certain industries, proxied by a location quotient—manufacturing, services, and financial—are hypothesized to have a positive effect on economic growth based

on past studies. The industry concentration coefficients in model 4 are negative for all three industries in both level-level models and positive in log-log model 6. Only the coefficient for services is significant in model 4, and highly significant in log-log model 6, where manufacturing is also significant. Additionally, in log-log model 6, the core variable labor force age and the industry concentration coefficient for services have significant signs that are opposite of those respective signs in level-level model 4, and thus become consistent with their respective hypotheses. Interestingly, the minimum wage variable becomes significant in model 4, with a positive sign that is the opposite of that hypothesized. (The expectation is that a higher minimum wage will reduce employment growth.) But the coefficient becomes insignificant, albeit still positive, in log-log model 6.

Regions. In level-level model 5, the coefficients for the New England, Mideast, and Great Lakes regions are negative and statistically significant; the Plains, South West, Rocky Mountain, and Far West regions are positive and statistically significant. The labor force age and manufacturing variables becomes significant and positive in this model. These results imply that job loss and growth are concentrated in specific regions. Yet in log-log model 6, only the South West and Far East regions are significant, and still positive.

For all six models, the variable of interest, private equity investment, remains stable, from 1.31 to 1.36, and is always significant.

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Bronwyn Bailey brings almost 20 years of experience directing investment analysis, business strategy, marketing, and communications for venture capital, private equity, asset management, and corporate clients. She recently founded BB-Advisors, a consulting firm servicing the private capital ecosystem.

Ms. Bailey led industry outreach and analytical research at the American Investment Council (AIC), the private equity trade association. She began her private capital career at SVB Financial Group's venture fund division, SVB Capital, where she briefed investors on fund performance, wrote quarterly points-of-view to help clients navigate market shifts, and monitored a $1 billion fund portfolio. She also advised the ILPA on a new performance benchmark and managed an analytics team at BlackRock to optimize marketing and sales efforts for iShares ETFs. She began her career as a management consultant at Gemini Consulting in London and PwC in Los Angeles, advising global telecom, media, and technology clients on strategy and financial services. Ms. Bailey graduated magna cum laude from Cornell University and earned a doctorate from the University of California, Los Angeles. She is a CAIA charterholder.

Practical Applications of

Analysis of Three Emerging Trends in Limited Partner Operational Due Diligence

Author: Jason Scharfman
Source: *The Journal of Alternative Investments*, Winter 2020, Vol. 22, No. 3
Report Written By: Doug McNair
Keywords: limited partner (LP), operational risk, operational due diligence

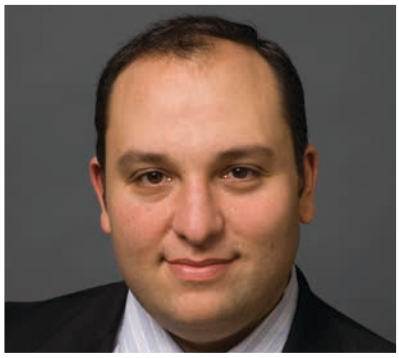
Overview

In **Analysis of Three Emerging Trends in Limited Partnership Operational Due Diligence**, from the Winter 2020 issue of ***The Journal of Alternative Investments***, author **Jason Scharfman** (of **Corgentum Consulting**) details three ways in which institutional investors (known as limited partners, or LPs) have increased the operational due diligence (ODD) they do on alternative investment fund managers (known as general partners, or GPs). ODD is the process by which LPs analyze the potential for investment losses due to inadequate processes, failed systems, or fraudulent behavior among GPs. Prompted by high-profile instances of fraud committed by fund managers (like Bernie Madoff) and increased regulatory requirements, LPs have improved their ODD by expanding its scope (the number of risk factors evaluated), depth (the amount of detail requested), and integration with investigative due diligence (such as criminal background checks on fund managers).

To help coordinate and ensure the quality of this expanded ODD, some LPs have stopped outsourcing investigative due diligence to third parties and brought it in-house to help integrate it with ODD. Eliminating the middleman in this way helps focus the investigation on what is most relevant to the LP while containing costs as well.

Practical Applications

- **LPs should be aware of the importance of doing expanded ODD on GPs.** This is due to increased government regulation, high-profile incidents of fraud by GPs, and heightened public awareness of the need for due diligence.
- **LPs should ensure their ODD is broad in scope, deep, and integrated with investigative due diligence.** It should cover as



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Jason Scharfman is the managing partner of Corgentum Consulting, a specialist consulting firm that performs operational due diligence reviews and background investigations of fund managers of all types. Corgentum works on behalf of institutional investors and high-net-worth individuals.

Before founding Corgentum, Mr. Scharfman oversaw the operational due diligence function for a $6 billion alternative investment allocation group at Morgan Stanley. He was also a member of a team that oversaw all of Morgan Stanley's hedge fund operational due diligence efforts. Prior to joining Morgan Stanley, he held positions at Lazard Asset Management, SPARX Investments and Research, and Thomson Financial—mainly focusing on due diligence and risk

(*Continued on next page*)

management within the alternative investment sector.

Mr. Scharfman received a JD from St. John's University School of Law, an MBA in finance from Baruch College's Zicklin School of Business, and a BS in finance with an additional major in Japanese from Carnegie Mellon University. He also holds the Certified Fraud Examiner (CFE) and Certified in Risk and Information Systems Control (CRISC) credentials.

Key Definitions

Limited partner (LP)

A limited partner is a part owner of a business (a limited partnership) whose liability for the company's debts is limited to the amount of the limited partner's investment in the company. A limited partner is not allowed to participate in the control of the business. By contrast, a general partner (GP) has a role in controlling the business and has unlimited liability for its debt. Limited partnership agreements often select Delaware law as their governing code. The key provisions are in Del. Code Ann. tit. 6, chap. 17 (https://delcode.delaware.gov/title6/c017/index.shtml).

Operational risk

Operational risk refers to the risk of loss or other adverse outcomes resulting from (1) inadequate or failed internal processes or many operational risk categories as possible, obtain extensive detail on each category, and be done in tandem with background investigation of GPs.

- **LPs should consider bringing their investigative due diligence in-house to better coordinate it with ODD.** This is because in-house personnel (perhaps assisted by an ODD consultant) are better able to gauge the severity of operational risks revealed by investigative due diligence.

Discussion

The author lists and provides detail on the ways in which LPs have recently expanded their ODD on GPs who manage hedge funds, private equity, and other alternative investments.

BACKGROUND

Operational due diligence (ODD) is a separate process from investment due diligence, which focuses on the investments chosen by GPs and the potential gains or losses caused by those choices. ODD focuses on whether the people, processes, and systems employed by GPs may put the LP at risk of losses.

The impetus for LPs to improve their ODD has come from multiple sources. High-profile cases of investment managers defrauding their clients have raised public awareness of the need for investors to do due diligence on the people entrusted with their money. Also, government agencies have increased the technical rules and requirements that investment managers and custodians

> "[One] motivator for the increase in operational due diligence has been a series of high-profile operational failures and frauds, many of which have been in the hedge fund industry—with notable examples including the Madoff fraud, the Bayou Hedge Fund Group fraud, and the Galleon insider trading case. These unfortunate cases … have continued to remind investors to focus on operational due diligences."
>
> *—Analysis of Three Emerging Trends in Operational Due Diligence*

systems, (2) incompetence or malfeasance on the part of an organization's employees or other individual, or (3) external causes. Identifying, assessing, and managing operational risk are critical functions of any organization. Their importance is amplified when the organization engages in activities that can produce severe or extreme negative results.

Operational due diligence (ODD)

ODD is the process by which stakeholders in an organization assess its effectiveness in identifying, assessing, and managing operational risk. In the context of an investment fund managed by a GP, ODD is the process by which LPs gather and analyze data on the GP to determine the operational risk associated with managing the fund.

must follow. This has caused LPs and GPs to substantially increase the resources they spend on ensuring compliance with regulations. As a result, LPs have improved their ODD to satisfy regulators and the investing public that they are acting responsibly on behalf of their shareholders.

In the past, LPs have used several different staffing models to perform ODD:

- Dedicated: One or more full-time employees are entirely devoted to ODD.
- Shared: The ODD function is covered by the same people who perform investment due diligence.
- Modular: The various ODD functions are divided among several people with different areas of expertise, possibly managed by an operational generalist who coordinates their efforts.
- Hybrid: The LP combines the above approaches in some way and may also outsource some of the process to a third-party ODD consultant.

The author is in favor of an approach that integrates investigative due diligence (for example, criminal background checks on GPs) with one of the approaches above.

FINDINGS

The author explains that LPs have recently improved their ODD in three main ways:

1. Widening its scope (expanding the number of operational risk factors they review)
2. Increasing its depth (probing for more detail on each operational risk factor)
3. Integrating ODD with investigative due diligence (investigating operational risks in tandem with criminal and other background checks on GPs)

In the area of scope, LPs have become aware that in the past, they investigated only a limited number of broad areas of operational risk—thus exposing themselves to losses from operational risks not considered. As a result, they have tried to detect and investigate areas of operational risk they previously might have missed. Exhibit 1 illustrates one way in which the scope of ODD has expanded over time:

Exhibit 1: Operational Due Diligence Scope Expansion		
1st Generation	2nd Generation	3rd Generation
• Fund accounting/ Trade operations	• Fund accounting/ Trade operations • Regulatory • Cash management and controls	• Fund accounting/ Trade operations • Regulatory • Cash management and controls • Valuation techniques and pricing resources • Legal/Compliance • Service provider reviews

In the area of depth, LPs have expanded their ODD by probing for more detail in each area of operational risk. Exhibit 2 provides an example of this:

Exhibit 2: Example of Increasing Depth in ODD Review with Core Factor Depth Expansion		
	Shallow ODD Review	Deeper ODD Review
Operational risk factor	Regulatory	Regulatory
Initial sub-category	List of regulatory registrations	List of regulatory registrations
Further sub-categories (with increasing depth)		• Review of previous regulatory audits • Analysis of mock audit program

In the area of integrating ODD with investigative due diligence, LPs have brought more of the investigative function in-house and

Exhibit 3: Representative LP Investigative Due Diligence Review Scope				
Criminal	Litigation	Regulatory	Factual Information	Media
• Arrest records • Parole and probation records • Driving records	• Court dockets • Judgment and lien searches	• Regulatory records • OFAC and global sanctions • Federal agency decisions	• Employment and education verification • Social security verification • Fictious names	• Web content • Broad media • Industry-specific periodicals

also have widened the scope of background investigations on GPs. Previously, LPs might have outsourced the investigative function to third parties, who would simply check on a GP's educational background and employment without considering the specific needs of the LP. But now, particularly in the wake of Bernie Madoff and other high-profile instances of fraud, investigative due diligence may cover the material listed in Exhibit 3.

Dedicated in-house personnel, possibly working with an ODD consultant, may better understand whether red flags uncovered by investigative due diligence create operational risks as well. They also may be better able to gauge the severity of such operational risks as they relate to the LP's specific circumstances. Bringing more of the investigative function in-house may result in cost savings as well, thus improving the entire ODD process while helping the company's bottom line.

> "LPs have increasingly found that the real value of investigative due diligence is less in the list of results found and more in an assessment of the risk severity of those results. By integrating the ODD and investigative due diligence processes, LPs are effectively eliminating the middleman and find they are better equipped to perform these assessments themselves, armed with knowledge of an operational backdrop of a fund manager."
>
> ***—Analysis of Three Emerging Trends in Operational Due Diligence***

Overall, then, LPs should be aware of the importance of doing expanded ODD; should ensure that their ODD is wide in scope, deep, and integrated with investigative due diligence; and should consider bringing more of the investigative function in-house to ensure a better understanding of all risks uncovered by all investigative processes.

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Practical Applications of

Alternative Asset Fees, Returns, and Volatility of State Pension Funds: *A Case Study of the New Jersey Pension Fund*

The Journal of Alternative Investments
Practical Applications

Authors: Jeff Hooke, Carol Park, and Ken C. Yook
Source: *The Journal of Alternative Investments*, Winter 2020, Vol. 22, No. 3
Report Written By: Doug McNair
Keywords: state pension fund, general partner (GP), alternative asset fees

Overview

In **Alternative Asset Fees, Returns, and Volatility of State Pension Funds*: A Case Study of the New Jersey Pension Fund*** from the Winter 2020 issue of ***The Journal of Alternative Investments***, authors **Jeff Hooke (Johns Hopkins Carey Business School)**, **Carol Park (Maryland Public Policy Institute)**, and **Ken C. Yook (Carey Business School)** investigate whether state and municipal pension funds are benefiting from their increased investments in alternative assets. The authors focus on whether the performance of alternative asset funds is good enough to justify their relatively high fees.

Examining the New Jersey state pension fund—whose annual reports provide the most detailed data—they find that its private equity (PE) and hedge fund (HF) holdings both underperform commonly used benchmarks, and its HFs' performance is substantially correlated with that of publicly traded assets while also being more volatile. Therefore, the PE and HF performance and diversification qualities are not good enough to justify their higher fees. Also, those fees are inadequately reported due to a questionable "honor system" of fee reporting and a lack of auditing. For all these reasons, the authors recommend that pension funds substantially reduce their alternative-asset holdings.

Practical Applications

- **State pension funds should substantially reduce their holdings of alternative assets.** PE and HFs do not perform as advertised and therefore do not justify their higher fees.
- **State pension funds can get better performance at lower cost by reallocating monies from alternative assets to a mix of low-cost stock and bond index funds.** Such indexes consistently outperform PE and HFs without the added volatility.
- **State pension funds that keep some money in alternative assets should consider ending the "honor system" of carried-interest**

Key Definitions

State pension fund

A state pension fund provides guaranteed retirement income for state employees. The state and its employees pay into the fund, and then a manager invests those contributions with the goal of financing all pension payments.

General partner (GP)

A general partner is a part owner of a business (a limited partnership) and has a role in controlling the business and unlimited liability for its debt. By contrast, a limited partner (LP) is not allowed to participate in the control of the business and is liable for the company's debts only to the extent of its investment in the company. Limited partnership agreements often select Delaware law as their governing code. The key provisions are in Del. Code Ann. tit. 6, chap. 17 (https://delcode.delaware.gov/title6/c017/index.shtml).

Alternative asset fees

Alternative-asset fees are what GPs charge LPs. They include fixed fees based on the size of the LP's investment, plus performance fees that award the GP a portion of the managed fund's annual earnings.

fee reporting. The authors found fee-reporting irregularities that should prompt pension fund managers to directly invoice GPs for these fees and audit GPs' fee-reporting practices as well.

Discussion

The authors set out to determine whether state pension funds have benefitted from allocating more of their assets to alternative investments like PE and HFs. The authors use state pension fund annual reports to track the fees, performance, and volatility of such alternative assets. The authors find that the pension funds' PE and HF holdings underperform traditional, publicly traded assets like stocks and bonds, while charging higher fees that are also inadequately reported and audited.

BACKGROUND

Over the last decade, pension funds have substantially increased their investment in alternative assets. As of 2017, at least 32 states had an active alternative asset investment program, with an average of 25% of assets allocated to PE, HFs, and similar alternative assets. State pension fund managers have done this because PE is advertised as being less volatile than traditional equities while providing higher returns, whereas HFs are marketed as offering diversification because they do not rise or fall in value in tandem with stock and bond indexes.

These purported benefits come at the cost of higher fees that the public would not have to pay if state pension funds invested only in traditional, low-cost investments like index funds. The authors therefore decided it would be in the public interest to investigate whether the public is really getting its money's worth from these alternative pension fund holdings.

> "State and municipal pension funds embarked on a grand experiment by boosting their commitments to alternative assets during the last decade. From the point of view of the beneficiaries, and of taxpayers, the direct cost of these third-party managers was … tens of billions of dollars per year."
>
> **—Alternative Asset Fees, Returns, and Volatility of State Pension Funds: *A Case Study of the New Jersey Pension Fund***

METHODOLOGY

Other researchers have studied alternative asset fees in pension funds, but most have estimated such fees using complex financial models. For this study, the authors used a hitherto overlooked data source, state pension fund annual reports. They examined the Comprehensive Annual Financial Reports (CAFRs) of 33 state pension funds, found that five states provided disclosure of their alternative asset fees, and determined that New Jersey's CAFR provided the most detailed information of all. They therefore decided to use New Jersey's pension fund as a case study, focusing on the state's PE and HF holdings during the five-year period ending June 30, 2017.

RESULTS

For the period from 2013 to 2017, the authors tracked the New Jersey pension fund's total annual PE and HF fees and returns. They used the S&P 500 as a benchmark to measure the PE holdings' performance against that of lower-cost publicly traded stocks. They also used an alternative benchmark of three percentage points above the S&P 500 returns because the institutional investment industry often uses it to take into account PE's lack of liquidity and higher leverage (which translates to higher expenses due to interest payments). The results are shown in Exhibit 1.

Exhibit 1: State of New Jersey Pension Fund: Private-Equity Fund Fees, Returns, and Comparison Benchmarks

	Total Fees as % of PE Assets	Net PE Return	S&P 500 Return	S&P 500 Return + 300 bps
Year				
2013	3.20%	14.74%	25.00%	28.00%
2014	3.46%	24.01%	16.94%	19.94%
2015	3.50%	17.41%	11.20%	14.20%
2016	3.33%	6.27%	5.61%	8.61%
2017	2.98%	12.66%	16.04%	19.04%
Mean	3.29%	15.02%	14.96%	17.96%
Standard Deviation (SD)		6.50	7.20	
Sharpe Ratio (Mean/SD)		2.31	2.08	

Note: Fiscal year ends June 30.
Source: New Jersey State Investment Council Annual Reports.

As shown in Exhibit 1, PE's mean performance over the five-year period was almost exactly the same as that of the S&P 500 and substantially below that of the industry benchmark of S&P 500 plus 300 bps. However, PE showed slightly less volatility than the S&P 500 (as measured by standard deviation) and therefore had a better risk-adjusted return (as measured by the Sharpe ratio). It is also important to note that since over half of PE fund investments remained unsold over the five-year period, PE's reported year-to-year returns were highly dependent on the GP's own estimates of year-end fund asset valuations.

The authors then did the same analysis for the New Jersey pension fund's HF holdings. Since a diversified HF is a mix of equities and fixed-income investments, the authors used two benchmarks: (1) a 60%/40% portfolio of US equities and bonds and (2) 500 bps over LIBOR (a commonly used HF benchmark among institutional investors) (see Exhibit 2).

Exhibit 2: State of New Jersey Pension Fund: Hedge Fund Fees, Returns, and Comparison Benchmarks

	Total Fees as % of HF Assets	Net HF Return	60% Stock + 40% Bond Return	LIBOR + 500 bps
Year				
2013	4.51%	12.57%	15.01%	6.07%
2014	3.82%	10.53%	11.04%	5.68%
2015	2.83%	4.21%	7.65%	5.56%
2016	1.99%	(5.13)%	0.50%	5.79%
2017	2.23%	7.99%	9.30%	6.32%
Mean	3.08%	6.03%	8.70%	5.88%
Standard Deviation (SD)		6.98	5.34	0.31
Sharpe Ratio (Mean/SD)		0.86	1.63	19.09

Note: Fiscal year ends June 30.
Source: New Jersey State Investment Council Annual Reports.

The HF holdings significantly underperformed the 60/40 stock/bond benchmark—and although they slightly outperformed LIBOR plus 500 bps benchmark, they were significantly more volatile than both and had a lower risk-adjusted return (especially compared to LIBOR + 500 bps). Also, the authors found that the HFs' performance was almost perfectly correlated with that of the 60/40 stock/bond portfolio—a finding that undercuts the HF industry's claim that HFs provide diversification because their performance has a low correlation with traditional asset classes.

Overall, then, the pension fund's PE and HF holdings did not perform as advertised: They posted the same or lower returns than traditional investments and did not provide significant diversification. This directly calls into question whether investing in such alternative assets is worth the higher fees.

Investigating the issue further, the authors found cause for concern when examining the fee-reporting practices of GPs. State pension funds pay GPs fixed fees based on the size of their capital investment, plus performance fees (called "carried-interest fees") that give GPs a percentage of PE and HFs' profits (if any). The authors' prior research found that many state pension funds aren't aware of these performance fees because 1) GPs deduct them before reporting their funds' performance, 2) pension fund documents don't require GPs to report them, and 3) pension fund managers don't ask about them. Even New Jersey, the state with the most detailed reporting of the 33 funds examined, doesn't invoice GPs directly for these performance fees or audit such fees. The resulting "don't ask, don't tell" policy creates an "honor system" of fund fee reporting that neither state nor federal agencies pay much attention to. The authors found this surprising, given the trillions of public dollars under management by state pension funds.

The authors then investigated whether the performance fees that GPs reported to the New Jersey state pension fund correlated with the actual performance of the PE and HFs they manage. In theory, the current year's performance fees should be based on the current year's fund performance. The authors found that the HFs' performance fees had an 80% correlation with the current year's performance, but the PE's performance had no correlation with the current year's performance. Instead, it had a 100% correlation with the previous year's performance—meaning, for example, 2015 PE performance fees were based on 2014 returns. These reporting irregularities,

> "It appeared that New Jersey carry fees for 2015 … were based off 2014 returns, when such carry fees should have been based off 2015 returns. This result brought into question … whether institutional investors know what they are paying for."
>
> **—Alternative Asset Fees, Returns, and Volatility of State Pension Funds: *A Case Study of the New Jersey Pension Fund***

combined with the subpar performance of PE and HFs, seriously call into question whether New Jersey pensioners and taxpayers are getting their money's worth from these alternative assets.

The authors conclude that pension fund managers can get better returns at a lower cost—with far better fee reporting and no loss of diversification—by reallocating monies out of PE and HFs into a blend of low-cost publicly traded stock and bond index funds. They recommend that pension fund managers substantially reduce their holdings of alternative assets and also consider putting an end to the "honor system" of carried-interest fee reporting.

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Practical Applications of

Demystifying Illiquid Assets: *Expected Returns for Private Equity*

The Journal of Alternative Investments
Practical Applications

Overview

In **Demystifying Illiquid Assets: *Expected Returns for Private Equity*** from the Winter 2020 issue of ***The Journal of Alternative Investments***, authors **Antti Ilmanen**, **Swati Chandra**, and **Nicholas McQuinn** (all of **AQR Capital Management**) analyze the risks, past performance, and expected future returns of the private equity (PE) industry. The increasing popularity of PE may come from the perception that PE outperforms publicly traded stocks while being less volatile. The authors assert that this view is flawed. Most investors gauge PE's performance against the large-cap S&P 500 Index, but buyout funds (which make up the largest PE sector) invest in smaller, undervalued companies and use a great deal of leverage. Significantly, PE does not appear to have outperformed leveraged or value-oriented small-cap stock benchmarks, especially more recently. Also, PE's lower volatility is an illusion, because PE does not use mark-to-market accounting to report daily fluctuations in value, while public equity does.

Nevertheless, many investors believe PE will outperform public equity in the future. The authors are less optimistic, however, given the relative richening of PE versus public equity. Using a yield-based expected-return framework, they estimate that PE may outperform public equity by only about 1% per year, after fees.

Practical Applications

- **Financial advisors should inform clients that representative samples of small-company stocks (like a leveraged Russell 2000 Index or a basket of small-cap value stocks) may be the most appropriate benchmarks for PE.** Advisors also should inform clients that PE may not outperform such benchmarks, after fees.
- **Financial advisors should educate clients about how PE's reportedly smoother returns are illusory.** This is because, unlike public equity, PE does not have daily reported prices.
- **Financial advisors should inform clients that PE's performance edge over public equity has been shrinking and may not**

Authors: Antti Ilmanen, Swati Chandra, and Nicholas McQuinn
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Report Written By: Doug McNair
Keywords: benchmark, buyout fund, mark-to-market (MTM) accounting

rebound to the high levels observed historically. This is primarily due to PE's richening valuations versus public equity.

Key Definitions

Benchmark

A benchmark is a standard against which investors measure the performance of similar investments. Popular benchmarks include the S&P 500 Index (which tracks the average performance of 500 large-company stocks) and the Russell 2000 Index (which tracks the average performance of 2000 small-company stocks).

Buyout fund

A buyout fund is a private equity (PE) fund that buys a controlling interest in companies believed to be underperforming or undervalued. Buyout funds take over management of such companies, work to improve the companies' performance or cut their operating costs, and then resell the companies at a higher price. Buyout funds comprise the largest segment of the US PE market.

Mark-to-market (MTM) accounting

MTM accounting is the practice of tracking and reporting the fluctuations of the share prices of investments as they rise and fall on the markets every day. MTM accounting is standard industry practice in public equity markets but is generally not used in PE.

Discussion

PE is increasingly popular with investors seeking to diversify their portfolios. Given PE's key differences from publicly traded stocks—such as the fact that PE is illiquid, meaning investors cannot pull their money out at any time, but must lock it in for months or even years—investors need to ask themselves several questions: How much should I allocate to PE? What are good benchmarks for PE's performance? And, perhaps most importantly, does PE's reportedly higher performance persist after paying PE's higher fees? To help investors answer these questions, the authors analyze the PE industry's historical and expected performance.

BACKGROUND

At first glance, the reasons for PE's growing popularity are obvious: For many years, PE has reported higher returns and lower volatility than publicly traded stocks. However, the authors note that PE's performance edge over public equity (meaning the amount by which it reportedly outperforms publicly traded stocks) has been shrinking in recent years. Despite this, demand for PE has continued to grow—and investors have become increasingly willing to pay PE's higher fees. The authors surmise that investors are willing to pay a premium for PE because the lower volatility of its reported returns makes it appear less risky than public equity.

However, the authors say this is an illusion. PE's reported lower volatility is because PE managers do not use mark-to-market (MTM)

> "Why then is PE vaunted for its diversification benefits? The answer lies in the lack of regular, mark-to-market pricing for illiquid assets in general. This induces the common practice of appraisal-based or self-reported NAVs that do not reflect the daily fluctuations in public markets, making for artificially smoothed returns that understate risk and correlation to public markets."
>
> —**Demystifying Illiquid Assets: *Expected Returns for Private Equity***

accounting, while public-equity managers do. So, public equity's reported value fluctuates every day, while PE's does not; this makes PE's reported returns artificially smooth.

In fact, PE may be riskier than publicly traded companies, as PE managers take on two to four times as much debt as public-equity managers. This higher debt-to-equity (D/E) ratio means higher equity risk, which, in theory, should require higher returns.

HISTORICAL ANALYSIS

The authors evaluate PE's historical performance edge over public equity. Most analysts have used the S&P 500 Index as a benchmark against which to measure PE's performance. Exhibit 1 shows that from 1986 to 2017, PE outperformed the S&P 500 by an average of 2.3% per year—a substantial long-term performance edge that would seem to justify PE's higher fees.

However, the authors note that the S&P 500 is not the right yardstick as

- the largest sector of the PE market is US buyout funds, which buy a controlling interest in underperforming or undervalued US companies; and
- most targets of buyout funds are smaller companies, not the large companies tracked by the S&P 500 Index.

Hence, the most appropriate benchmarks for the performance of small-company stock funds may be the Russell 2000 Index or representative baskets of small-company value stocks—not the S&P 500 Index.

So, investors who favor PE because it outperforms the S&P 500 are using the wrong benchmark. Rated against small-company stock benchmarks that account for PE's higher use of leverage and focus on undervalued companies, PE's historical performance edge vanishes. It outperforms a leveraged version of the Russell 2000 Index by only 0.7%, and it underperforms a basket of small-cap value stocks by 1.6%:

Exhibit 1: Historical Performance of Private Equity (July 1, 1986 – December 31, 2017)

	Cambridge PE (US Buyout Funds)	S&P 500	Russell 2000 (Leveraged)	Basket of Small Value Stocks
Average Return	9.9%	7.5%	9.1%	11.4%
PE's Excess Return over Public Equity		2.3%	0.7%	(1.6%)

Note: We use a leveraged version of the Russell 2000 Index because it is a better benchmark for PE, due to PE's higher use of debt financing for investments.

These comparisons suggest that PE investors have gotten little or no additional return over public equities after accounting for the higher fees they have paid.

Another measure of PE performance is public market equivalents (PMEs). These too indicated that PE's performance edge has been shrinking in recent years. Based on PMEs, PE seems to have stopped consistently outperforming the S&P 500 Index around 2006. Moreover, PE has underperformed a leveraged, adjusted version of the S&P 600 Index, which more closely aligns with PE's characteristics.

This shift toward negligible outperformance occurred around the time when demand for PE began to increase. So, the authors surmise that PE's growing popularity has driven up PE's valuations relative to public equity—thereby making it harder for investors to "buy low, sell high" and realize gains. Also, since the financial crisis of 2008, stricter regulations and other factors have made it harder for PE managers to take on large amounts of debt to buy assets, thus limiting the riskier investment practices that can lead to higher returns. Nevertheless, it is possible that if these regulations are loosened, PE's performance edge over the S&P 500 could widen again as PE managers return to higher levels of leverage. Moreover, a recent study by Brown and Kaplan (2019) suggests somewhat better PE performance in the past decade, though the overall picture of a declining edge is still evident.

PROJECTED FUTURE PERFORMANCE

Institutional investors widely expect PE to outperform public equity in the future by 2%–3%. PE's shrinking performance edge hasn't dampened this optimism—and the authors speculate that even if investors fully realize that the S&P 500 is not an accurate benchmark and that PE hasn't outperformed cheap, small-cap stocks, they still might be willing to pay PE's higher fees to obtain PE's artificially smooth returns.

The authors' expectations for PE are more conservative. They introduce a yield-based framework as a way to estimate PE's expected returns over the next 5 to 10 years. Using industry data on PE's valuations and leverage—plus assumptions on growth rate, cost of debt (meaning the interest rates PE funds pay to take on debt for the purpose of buying companies), and ability to "buy low, sell high"—the authors estimate that PE may achieve gross average annual returns of around 9.6%. However, after paying PE's high fees, investors may only realize average annual returns of 3.9%.

On the other hand, the authors estimate that public equity will post net average annual returns of 3.1%—meaning that PE investors may realize an outperformance over public equity of only around 0.8%. The authors concede that the lack of good quality data on PE makes many of these assumptions debatable, and believe that investors may find the broad framework more useful than any point estimates. They further remind that their analysis focuses on industry performance; top-quartile funds will undoubtedly perform better—but these are not as easy to identify ex ante as is commonly thought.

The authors conclude by noting that PE posted its highest performance during the 1990s and 2000s, when PE relative valuations were low and PE leverage was higher. Current market conditions are quite different and make such gains highly unlikely in the future. Investors making asset allocation decisions should therefore take a closer look at the true relative performance and risks of PE versus public equity before deciding whether and how much to allocate to PE.

> "The early 1990s and 2002–2005 were halcyon years, when both PE valuations and the cost of debt were low; it is no wonder, then, that those vintages delivered high subsequent returns. Our current outlook is far more modest, reflecting PE's rich valuations and low leverage."
>
> **—Demystifying Illiquid Assets: *Expected Returns for Private Equity***

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Practical Applications of

Skew and Trend Aversion: *The Impact of Positive Skew and Behavioral Biases on Allocation Decisions*

The Journal of Alternative Investments
Practical Applications

Authors: Zachary Dugan and Alexander Greyserman
Source: *The Journal of Alternative Investments*, Winter 2020, Vol. 22, No. 3
Report Written By: Kathryn Wilkens
Keywords: behavioral biases, loss aversion, recency bias, skew, trend following, portfolio optimization

Overview

In **Skew and Trend Aversions: *The Impact of Positive Skew and Behavioral Biases on Allocation Decisions***, from the Winter 2020 issue of ***The Journal of Alternative Investments,*** **Zachary Dugan (International Standard Asset Management, Johns Hopkins University)** and **Alexander Greyserman (International Standard Asset Management)** investigate potential reasons for small portfolio allocations to trend-following strategies that are observed in most portfolios. Trend-following strategies can deliver "crisis alpha," which is a positive return when markets are down. Their returns are positively skewed with a low correlation with the S&P 500, but their average returns are close to the S&P 500. These characteristics indicate that most portfolios could benefit from a healthy allocation to this strategy. The authors explain that investors are particularly prone to behavioral biases when evaluating strategies that have positively skewed returns. By quantifying biases implied by suboptimal portfolio allocations to trend-following strategies, they expose commonly chosen poor allocation decisions so that the reader can avoid making suboptimal choices.

Practical Applications

- **Question low allocations to trend-following strategies.** Typical allocations to trend-following strategies of 5% are shown to be suboptimal. They likely are due to trend aversion, which is the combination of three behavioral biases: loss aversion, recency bias, and the ambiguity effect.
- **Beware of loss aversion.** Loss aversion to trend-following effects can be reduced by finding optimal portfolio allocations, for example, by maximizing the Sharpe ratio or minimizing the variance.
- **Recency bias can be reduced by analyzing longer return histories for trend-following strategies.** Trend-following strategies produce many small and negative returns that are outweighed by few very large returns, so short histories may underestimate the mean return by not including the less frequent large positive returns.

Key Definitions

Loss aversion

Loss aversion is the theory that people hate losing more than they enjoy winning. If a loss aversion factor is two, as found in numerous psychology studies, the disappointment of losing is twice as strong as the joy of winning.

Recency bias

Recency bias is the financial version of the availability heuristic in which recent information is overemphasized.

Ambiguity effect

The ambiguity effect is the aversion to a trading strategy due to the unknown proprietary nature of its trading system.

Discussion

Trend aversion, a combination of three behavioral responses to trend following strategies, can explain why actual allocations to trend-following strategies are much lower than the allocations implied by optimization techniques. The authors show that to maximize the Sharpe ratio of a portfolio invested in the S&P 500 and a trend-following strategy, investors should allocate 57% to the trend-following strategy in the absence of behavioral effects. However, most actual portfolios have an allocation of less than 5%, reflecting trend aversion.

Trend-following strategies, like most quantitative trading strategies, will trigger some degree of the ambiguity effect because of the inherently technical and complicated nature of various "black box" algorithms upon which they rely. Investors also tend to suffer from recency bias and loss aversion to trend-following strategies. The authors demonstrate that these three behavioral biases induce investors to shun allocations to trend-following strategies that are advantageous.

> "Despite evidence of the portfolio benefits, actual investor allocations to trend-following strategies are typically 5% or less."
>
> *—Dugan and Greyserman*

APPROACH

The authors use two return streams representing the trend-following strategy to infer the reduction in allocation due to loss aversion. One trend-following return stream is not altered. The second is identical to the first, but all negative returns are magnified by a multiplier. For example, given a loss-aversion multiplier of 1.5, a loss of 2% would be treated as a loss of 3% in the second return stream. Two optimizations produce two sets of allocations split between the S&P 500 and each of the trend-following return streams. The optimal allocation to the unadjusted trend-following return stream is logically higher than the optimal allocation to the trend-following return stream with magnified losses. The difference in the size of the allocations to the trend-following strategy is the allocation reduction due to loss aversion. Thus, a direct link is made between allocation

reductions and loss-aversion multipliers that runs in both directions. By reversing the process, beginning with observed portfolio allocations, a loss-aversion multiple can be inferred.

Multiple simulations then make it possible to observe relationships among allocations, loss aversion, and Sharpe ratios. It is important to keep in mind that Sharpe ratios calculated with artificially adjusted returns would not actually be realized, but would capture the impact of loss aversion. In contrast, "realized Sharpe ratios" represent realistic results that recreate portfolios based on unadjusted returns after determining what allocations the adjusted returns would imply.

The first set of results is based on two-asset portfolios with return streams, as described previously. One asset is a representative trend-following strategy created by using three moving-average crossover methods with risk equally weighted and a targeted volatility of 18%. The correlation between the simulated trend-following strategy and the SG Trend Index is 0.76. The other asset is the S&P 500, with the same average return and volatility as the representative trend-following strategy.

The authors extend the analysis to a different two-part portfolio consisting of 1) a passive portfolio of traditional and alternative assets and 2) the representative trend-following strategy. Next they examine the same assets within the context of a tactical asset allocation framework instead of a passive portfolio. They examine recency bias by varying the lookback period used to created allocations, and finally examine the interactions between recency bias and loss aversion.

FINDINGS

Dugan and Greyserman show that in a simple two-asset portfolio of S&P 500 and trend-following strategies, the optimal allocation to trend following is on the order of 50%. Two-asset portfolio results show that once the loss-aversion multiplier reaches 1.75 and 2.0, investors will see a 25% and 40% loss in the realized portfolio Sharpe ratio. These results quantify the substantial reduction in performance when allocation decisions are clouded by loss aversion. The authors quantify a connection between the standard loss multiplier from psychological research of 2.0 and the typically observed 5% allocation to trend-following strategies.

The results for the other two-asset portfolios produce similar results and confirm that higher loss aversion leads to lower allocations to the trend-following strategy.

To illustrate the impact of recency bias, the authors employ portfolio variance minimizations with a rolling 18-month lookback window, and subsequently utilize lookback windows ranging from 2 to 106 months. Results show that the longer the lookback period, the higher the allocation to the trend-following strategies. This indicates that higher recency biases (i.e., shorter lookback windows) lead to lower and suboptimal allocations to trend-following strategies.

The authors acknowledge that there are many other valid non-biased reasons for not allocating to trend-following strategies. However, their results provide compelling evidence that behavioral biases may be faulty reasons for underallocation.

> “Behavioral biases in allocation decisions are a reality that must be addressed to maximize portfolio potential…”
>
> ***—Dugan and Greyserman***

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Practical Applications of

Cryptocurrency Survival Analysis

The Journal of Alternative Investments
Practical Applications

Author: Jan Lansky
Source: *The Journal of Alternative Investments*, Winter 2020, Vol. 22, No. 3
Report Written By: Kathryn Wilkens
Keywords: cryptocurrency, survival analysis, Bitcoin, exchange, token, trading

Overview

In **Cryptocurrency Survival Analysis,** from the Winter 2020 issue of ***The Journal of Alternative Investments***, **Jan Lansky (University of Finance and Administration)** investigates the probabilities of individual cryptocurrencies being delisted. Although exchanges list more than 2,500 cryptocurrencies, a very high percentage of them ultimately will be delisted. Lansky provides background on cryptocurrencies, describes the data collection procedure, tallies live and dead cryptocurrencies, and shows how to calculate conditional probabilities of their demise.

Most cryptocurrencies fail within five years of being listed on an exchange, yet the conditional probability of survival increases with the life of the cryptocurrency. For example, the probability of being delisted within one year is 35% for a new cryptocurrency, 27% after trading for one year, 19% after trading for two years, and 12% after three years.

Practical Applications

- **Cryptocurrencies constitute an expanding area for potential participation and investment.** Since the first cryptocurrency, Bitcoin, was created in 2009, more than 2,500 cryptocurrencies have been listed on exchanges.
- **Consider waiting at least a year before buying a new cryptocurrency.** More than 70% of delistings occur during the first year of a cryptocurrency listing.
- **Consider waiting five years before buying a new cryptocurrency.** Cryptocurrencies that have been trading for five years have only a 9% chance of being delisted within one year.

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Key Definitions

Coin, Altcoin

A cryptocurrency coin operates independently on its own blockchain. Examples are Bitcoin, Litecoin, and Ethereum. Most, but not all, coins are created by miners that are rewarded for verifying transactions. Coins other than Bitcoin are known as *altcoins*.

Token

A token is a cryptocurrency that depends on a third-party blockchain platform. Although tokens can serve as digital cash, most have other primary purposes and are generally created through initial coin offerings.

Fork

A fork is when the code of a cryptocurrency changes, resulting in a new version. A *hard fork* occurs when new and old versions are incompatible, whereas a *soft fork* designates compatibility between old and new versions.

Discussion

The number and types of cryptocurrencies have exploded since the first cryptocurrency, Bitcoin, was introduced in 2009. While Bitcoin is still very much alive, many other cryptocurrencies are now dead. A significant portion of both existing altcoins and tokens, as well as those yet to be created, will become obsolete and delisted within a year. Why do some cryptocurrencies thrive while others die? The article offers insights by estimating conditional probabilities that a cryptocurrency of a certain age will be delisted within one to five years.

BACKGROUND AND METHODOLOGY

As a form of digital cash, Bitcoin is a novel innovation in several ways. Importantly, no central authority or middleman is required to prevent double spending, as in traditional payment systems. This is accomplished by a decentralized network of users who verify transactions using a consensus system based on proof of work—the result of finding the solution to a difficult math problem. Achieving a sufficient consensus permits new transactions to enter the blockchain. These peer-to-peer transactions are anonymous and tamper-proof.

The proliferation of altcoins as peer-to-peer payment systems was primarily the result of tweaking the Bitcoin protocol. The development of Ethereum, representing an entirely new system, followed. Ethereum provided a platform for the creation of a different type of cryptocurrencies, called tokens, through initial coin offerings (ICOs) similar to IPOs. Forking is also a method of creating a new cryptocurrency, and the first altcoin created by forking was Bitcoin Cash in 2017.

> “Proof of work precedes cryptocurrencies and was originally used to fight spam.”
>
> ***—Cryptocurrency Survival Analysis***

Survival analysis, often used to determine the likelihood of the economic success or failure of a company’s stock, is applied to the universe of cryptocurrencies in a novel way. Lansky creates a database of daily price data on 2,599 live and delisted cryptocurrencies from CoinMarketCap.com. The database covers the period from April 28, 2013, to April 6, 2018. Lansky tabulates

the number of live cryptocurrencies and the number subsequently delisted for each three-month interval in the sample period. He then derives a formula that provides the conditional probability that a cryptocurrency will be delisted in a period of *m* to *n* days of its existence, provided that the cryptocurrency was previously traded for *m – 1* days.

FINDINGS

The tabulated results indicate that more than 70% of the extinct cryptocurrencies were delisted during their first year of existence. Of the live cryptocurrencies, 15% were traded for three or four years, whereas only 2% of the dead cryptocurrencies were traded for the same length of time.

> "If a cryptocurrency loses its users, it becomes worthless."
>
> *—Cryptocurrency Survival Analysis*

Exhibit 1 shows Lansky's estimates of the probability of a cryptocurrency being delisted, dependent on the length of its existence.

Exhibit 1: Probability of Delisting

Trading Period	Probability that a Cryptocurrency will be Delisted Within				
	1 year	2 years	3 years	4 years	5 years
0 years	35.1%	52.7%	61.6%	66.4%	70.9%
1 year	27.1%	40.9%	48.2%	55.2%	
2 years	18.9%	28.9%	38.6%		
3 years	12.4%	24.3%			
4 years	13.6%				

Notice that the delisting probabilities decrease as the number of years the cryptocurrency has been traded increases, except for the cryptocurrencies that have traded for four years (with a 13.6% probability of delisting within a year, up from 12.4% for cryptocurrencies trading for three years.) The author attributes this exception to an error resulting from a low sample size; the corrected probability for being delisted within one year using a formula based on the other results is 9%. Using the same formulaic approach, some

delisting within one-year estimates are made for cryptocurrencies that have been trading for more than four years. They are 6%, 4%, 3%, 2%, 1.5%, and 1% for those already traded for 5, 6, 7, 8, 9, and 10 years, respectively. The probability of any currency being delisted within 10 years is 76%.

Lansky notes that the mortality rates presented may be understated because currencies from some ICOs die before they are ever listed on an exchange and are therefore not included in the study. On the other hand, he also points out that some cryptocurrencies that are delisted are not actually dead because they "miraculously" regain value after being delisted.

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Practical Applications of

Cryptocurrency Value and 51% Attacks: *Evidence from Event Studies*

The Journal of Alternative Investments
Practical Applications

Authors: Savva Shanaev, Arina Shuraeva, Mikhail Vasenin, and Maksim Kuznetsov
Source: *The Journal of Alternative Investments*, Winter 2020, Vol. 22, No. 3
Report Written By: Kathryn Wilkens
Keywords: cryptocurrency, alternative investment, 51% attack, event studies

Overview

In **Cryptocurrency Value and 51% Attacks: *Evidence from Event Studies***, from the Winter 2020 issue of ***The Journal of Alternative Investments***, authors **Savva Shanaev, Arina Shuraeva**, **Mikhail Vasenin**, and **Maksim Kuznetsov** analyze cryptocurrency altcoins. Their findings suggest that altcoins with certain characteristics tend to be vulnerable to 51% attacks that result in a significant drop in their value on the day of the attack. The characteristic vulnerable altcoin has a low market capitalization and resides on a proof-of-work blockchain with a low hash rate. Furthermore, when the prices of these coins suddenly increase without a clear explanation, it can signal an impending attack. It is notable that the percentage drop in value due to a 51% attack is much larger than the decrease in stock prices that typically occurs when companies experience a data breach or other cybersecurity attack.

Key Takeaways

- **Altcoins on proof-of-work blockchains with low hash rates are vulnerable to 51% attacks.** Results show that the majority of the altcoins that have experienced 51% attacks share these characteristics and also generally have low market capitalizations.
- **Sudden, unexplained increases in a coin's price can signal a 51% attack.** There were significantly positive abnormal returns prior to 9 of the 14 attacks, suggesting market manipulation is a preparatory move by attackers.
- **It is not profitable to buy "undervalued" securities after an attack because the market is efficient.** Empirically, there are no abnormal returns after 51% attacks.

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Key Definitions

Proof of work (PoW)

PoW is a specific type of consensus algorithm that enables blocks to be added to a blockchain without a trusted central authority. The PoW requires ***miners*** to solve complex, computationally and energy intensive calculations (hashes) and rewards miners with the newly created coins and/or transaction fees.

51% attack

A 51% attack is a short-term hostile takeover of a blockchain that occurs when miners or validators act together to gain control of the network's computational power.

Hash rate

The hash rate or hash power of a network describes how many hashes are computed per second. Higher hash rates make a 51% attack more difficult.

Discussion

The popularity of cryptocurrencies as new forms of digital payments and sometimes potential investment vehicles stems from their many perceived benefits. Widely recognized benefits include the immutability of transaction records on a blockchain network, and by using decentralized consensus systems, the prevention of "double spending" without the need for a central authority. These attributes are the result of algorithms intentionally designed to enable safe, valid transactions within a decentralized network that is not vulnerable to malicious actors. Nevertheless, despite the inherent safeguards put in place, so-called "51% attacks" do occur. Although rare, these attacks are a real risk that cryptocurrency users and investors need to understand. The authors show how the value of cryptocurrencies is directly impacted by 51% attack events.

BACKGROUND AND SCOPE

Cryptocurrencies are divided into two large groups: altcoins and tokens. The authors focus on the vulnerabilities of a specific type of altcoin that is based on the proof-of-work (PoW) consensus system. Altcoins are usually created by miners and are native to their own blockchains. Tokens, in contrast, are not native coins in the sense that although some may serve as a type of coin, they rely on another blockchain. Tokens often are used for purposes other than as digital payments and often are classified as such (for example, as utility tokens). Importantly, the supply of tokens is often created all at once rather than mined over time. Very few tokens are mineable; the majority are not, and they are not the focus of the article. Altcoins, such as Bitcoin Gold, are vulnerable to 51% attacks due to the nature of their PoW consensus algorithms, which require miners to confirm transactions and often generate (mine) new coins. While the authors focus on coins with PoW consensus systems, tokens, and any cryptocurrency on a decentralized network, as well as cryptocurrency exchanges and wallets, also are subject to various kinds of cyberattacks.

One reason that 51% attacks are unlikely is that even though the attackers gain control over the network and can create coins for themselves, they do not have control over the value of the coins. Since the value of the coins drops after an attack, it's hard to make a profit by "double spending," that is, by creating extra low value coins. Yet there are other, nonfinancial motives for coordinating an

attack, and so the risk is not entirely mitigated by the lack of a profit motive. Indeed, while 51% attacks for financial gain had been very rare, their numbers increased dramatically in 2018. Reasons cited for this change include the introduction of several new proof-of-work altcoins with low hash rates.

APPROACH

The sample size of 14 cryptocurrencies experiencing a 51% attack was obtained by using qualitative data from various sources, and was exhaustive at the time of the writing. When there were any conflicting news reports regarding the date of the attack, the authors recorded the earliest date reported. Additionally, the authors collected the price series of each of the 14 altcoins for 30 days prior to the event and 10 days following the attack. Summary statistics illustrate that the decrease in the value of each altcoin in the sample ranged from 4.5% to 62.0%. The largest amount stolen was $35 million, in the second attack on the altcoin Verge.

The results of the simple summary statistics reveal the main conclusion: altcoins may lose significant value due to a 51% attack. However, given the small sample size and other statistical concerns, the authors also perform several regressions for robustness checks. These detailed tests reveal certain nuances that are masked in the summary statistics.

The first set of regressions is modeled after the event studies that are prominent in the stock market literature on abnormal returns due to corporate events. They use an equally weighted pseudo-portfolio of altcoins, both testing a constant returns model and using Bitcoin as the market proxy. In the latter approach, they then define abnormal returns as those that differ from Bitcoin. For both approaches, the authors test cumulative abnormal returns (arithmetic averaging) and buy-and-hold abnormal returns (geometric averaging) for 12 event windows including and surrounding the 51% attack event. The event windows are described with the notation $[x;y]$, where x is the start of the time window indicated as a number of days relative to the 51% attack, and y is the end of the time window, indicated in the same way. This approach allows for the testing of possible pump-and-dump behaviors by attackers. Yet this approach is also subject to statistical problems, such as potential volatility clustering, so that an additional series of panel regressions with dummy variables is employed. Further tests account for possible heterogeneity biases.

> “The market model and constant return model present consistent results showing significant pseudo-portfolio value drop on the event date (–15.21% and –12.60% in constant return and market model, respectively, both significant at 1%.)”
>
> **—Currency Value and 51% Attacks: *Evidence from Event Studies***

> “A sudden and unexplainable increase in coin value can therefore signal that the price is being manipulated as a preparatory move before the attack.”
>
> **—Currency Value and 51% Attacks: *Evidence from Event Studies***

RESULTS

For all six tested event windows that include the event date—[0;0], [–3;0], [–1;0], [0;1], [0;3], and [0;6] —abnormal returns are negative and statistically significant for all four methods of calculations (constant returns and market model with cumulative and abnormal returns), except for the [–3;0] window of the constant return model. These are very consistent results where most of the negative returns happen on the event day itself.

The authors next present the results for six events surrounding but not including the event date: [–3;–1], [–2;–1], [–1;–1], [1;1], [1;3], and [1;6]. Two important conclusions can be drawn. First, there are significantly positive abnormal returns prior to the attack, suggesting market manipulation as a preparatory move by attackers. This is not universal, however, as it occurs in 9 of the 14 attacks. Second, there are no abnormal returns after the attack. This suggests that it is not profitable to buy “undervalued” securities after an attack because the market is efficient.

The robustness tests do not change the results. However, the authors provide one additional insight emphasizing the importance of 51% attack risk. The size of the abnormal returns of coins surrounding 51% attacks is substantially higher than those of stock returns around security breaches and cyberattacks. The authors note that the methodologies used in the article can be applied to several other events of interest in the cybersecurity space, such as forks in blockchains. Additionally, the results suggest that a 51% attack might represent a diversifiable fundamental risk factor that is unique to PoW altcoins with low hash rates.

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