

BACKGROUND RISK AND UNIVERSITY ENDOWMENT FUNDS

Stephen G. Dimmock*

Abstract—This paper tests the effect of background risk on university endowment portfolios, where background risk is defined as the volatility of universities' nonfinancial income. The results show that higher background risk is associated with lower portfolio standard deviations. Universities with higher background risk invest significantly more in fixed income and less in alternative assets. A 1 standard deviation increase in background risk increases the allocation to fixed income by approximately 15% relative to the mean. There is also evidence that wealthier, highly selective universities hold riskier portfolios.

I. Introduction

FOR certain utility functions, economic theory predicts that investors endowed with exogenous nontradable risks, referred to as background risks, should react by reducing their exposure to other sources of risk.¹ For investors, this implies that nonportfolio risk should have a direct effect on portfolio risk and asset allocation. This paper examines how background risk affects the portfolio decisions of one class of sophisticated institutional investors: endowment funds. Specifically, I test how university income risk affects endowment fund portfolio decisions.

The question of whether universities use their endowments to hedge against revenue shocks is of particular interest following the large endowment losses during 2008. For example, in 2009, the *New York Times* (Zezima, 2009), featured a story describing how several universities had frozen construction and laid off staff in response to revenue shocks and how large endowment losses had significantly reduced certain universities' ability to react to revenue shortfalls. If endowments are meant to serve as a cushion against financial distress, as Hansmann (1990) argues, then the risk of financial distress should affect endowment decisions.

Theoretical studies, such as Eeckhoudt, Gollier, and Schlesinger (1996), Gollier and Pratt (1996), Kimball (1993), and Pratt and Zeckhauser (1987), show that background risk will result in reduced portfolio risk for objective functions with decreasing and convex absolute risk aver-

sion. However, Gollier (2001) shows that background risk can have a negligible, or even positive, effect on portfolio risk for objective functions without these characteristics. As Hansmann (1990) and Winston (1999), note, there is not a well-defined and generally accepted theory of university objective functions, so it is unclear if endowment funds will consider background risk.

Even if the functional form of universities' objective functions were known, it is unclear whether endowment funds have objectives distinct from their universities. Black (1976) and Merton (1992) assume that endowment preferences are indistinguishable from university preferences and argue that universities should use endowments to hedge against revenue shocks.² For example, Black (1976, p. 26) states, "It is important to see the endowment fund as just one of the university's sources of income . . . the relevant risk is the risk of all these sources of income taken together, not just the risk of the endowment fund itself." Merton (1992) derives a closed form model of endowment investment and finds that nonfinancial income risk should result in safer endowment portfolios.

By contrast, other authors have argued that endowment funds' objectives are distinct from their affiliated university. Litvack, Malkiel, and Quandt (1974) argue that an endowment's primary goal should be to provide a stable stream of funding. Tobin (1974) acknowledges that endowment trustees might wish to stabilize overall university income, but concludes that the trustees have a duty to ensure intergenerational equity. He argues that this duty requires trustees to ignore universities' other income sources and that the principal goal of an endowment should be to provide smooth, stable payouts. If endowment funds follow the path advocated by Tobin (1974), then background risk should not affect endowment portfolio choice, even if doing so would be optimal from their affiliated universities' perspective.

Although there is little empirical evidence regarding endowments' preferences, several authors discuss the issues in light of actual endowment fund practices. Black (1976) suggests that endowments should maximize some function of the preferences of all individuals associated with the university, both past and present. However, he does not discuss how an endowment might do so. Following a lucid discussion of endowment behavior, Hansmann (1990) concludes that it is difficult to explain standard endowment fund practice in terms of any intelligible objective function.

A final complicating factor is that neither universities nor endowments actually make decisions; their employees make decisions on their behalf. Even if both universities

Received for publication May 25, 2009. Revision accepted for publication November 18, 2010.

* Nanyang Technological University.

I am grateful to Richard Baillie; Keith Brown; Kirt Butler; David Chambers; Long Chen; Elroy Dimson; Louis Eeckhoudt; Will Goetzmann; Joel Harper; Roy Kouwenberg; Zoran Ivkovich; Deborah Lucas; Spencer Martin; Jack Meyer; Luis Viceira; Annette Vissing-Jorensen; Mark Watson; James Wiggins; two anonymous referees; and seminar participants at the 2008 AFA conference; the 2008 EFA conference; the Advances in Portfolio Decision Making conference at the University of Notre Dame; the Bank of Canada–University of Toronto Workshop on Portfolio Management; Michigan State University; and National Taiwan University for helpful comments. I am grateful to John Griswold and Larry Tavares of the Commonfund, Ken Redd and Jessica Shedd of NACUBO, and Cathy Stratham of the NCES for assistance with data. Scott Weisbenner deserves special thanks. I am responsible for all errors.

¹ See Gollier and Pratt (1996), Kimball (1993), and Pratt and Zeckhauser (1987).

² Anecdotal evidence suggests that background risk is an important consideration for university endowment funds. Yale's endowment manager, David Swenson (2000), argues that hedging background risk is one of the central purposes of an endowment.

and endowments have preferences that are sensitive to background risk, hedging against income risk may not be optimal from the perspective of the agents charged with managing the endowment.

In this paper, I do not assume a particular objective function for endowment funds, nor do I take a position on what objective function endowments should maximize. Rather, I test what factors appear to affect endowment funds' portfolio choices. In doing so, I provide some indirect evidence on the nature of universities' objective functions.

I test if background risk, defined as the standard deviation of universities' nonfinancial income, affects endowment fund portfolio risk and asset allocation. The results show that background risk significantly predicts endowment portfolio volatility, even after controlling for many university characteristics. Increasing background risk by 1 standard deviation implies a decrease in portfolio standard deviation of approximately 6.6% relative to the mean. I also find that background risk significantly affects asset allocation. In all specifications, background risk is associated with higher allocations to fixed-income securities and lower allocations to alternative assets.

These results are robust to controlling for a wide variety of university characteristics, and many of the control variable results are also interesting. Endowment size has a significant and positive relation with portfolio standard deviations and allocations to risky assets. Universities with greater endowment payout rates have higher allocations to alternative assets and lower fixed income allocations. Highly selective universities hold significantly more alternative assets and less equity. Heavily indebted universities allocate more of their wealth to fixed income and relatively less to risky assets, resulting in lower portfolio standard deviations.

The results suggest that endowments consider their affiliated universities' idiosyncratic nontradable risks when allocating assets, and this affects realized portfolio standard deviations. My results provide suggestive evidence on the objective functions of university endowments. Endowments manage their portfolios in a manner consistent with decreasing and convex absolute risk aversion.

To the best of my knowledge, this is the first empirical study of background risk and institutional portfolio choice. My results complement prior studies of the effect of background risk from labor income on household portfolio choice such as Guiso, Jappelli, and Terlizzese (1996) and Vissing-Jorgensen (2002), who find a negative relation between labor income risk and equity investment. My results also complement prior academic studies of endowment funds, such as Brown, Garlappi, and Tiu (2010), who find evidence that endowments have positive security selection abilities, and Lerner, Schoar, and Wang (2008), who show that university quality is associated with superior endowment performance.

The remainder of the paper is structured as follows. Section II briefly discusses endowment funds. Section III describes the data. Section IV describes the background risk measures. Section V examines background risk and endow-

ment portfolio volatility. Section VI examines background risk and asset allocation. Section VII concludes.

II. Endowment Funds

Hansmann (1990) addresses the question of why universities hold endowments rather than immediately spend all gifts. He concludes that universities create endowment funds to ensure the survival of universities' reputational capital, protect intellectual freedom, and hedge against financial shocks.³ The goal of protecting against financial shocks dovetails nicely with the focus of this paper: the relation between background risk and endowment investments. Hansmann (1990) further argues that universities are particularly vulnerable to financial shocks for three reasons: their assets are highly organization specific and thus poor collateral, universities cannot issue new equity in a financial crisis, and costs are inflexible because of institutional features such as tenure.

There are two common legal structures for endowment funds: as part of the university itself or as a legally distinct entity such as a foundation. Frequently universities have some endowment assets held directly by the university and other endowment assets held in a separate legal entity. Usually the university administration appoints the endowment board regardless of the endowment's legal structure; thus, legal separation does not imply independence. My data sources do not distinguish these two legal structures, and I treat them as economically equivalent.

Regardless of their legal form, most endowments have similar governance structures. The university administration appoints an endowment board, which is responsible for setting investment policy, asset allocation, and monitoring performance. Beneath the board are employees who are responsible for implementing board decisions and monitoring external portfolio managers. Often the board retains a consultant to advise the board and the investment staff.⁴ In the majority of cases, the endowment staff outsources security selection decisions to external managers, but some endowments manage at least a portion of their endowment internally.⁵

Endowment boards are also responsible for setting the spending rules that determine transfers from the endowments to the universities' operating budgets. By far the most popular rule is to spend a prespecified percentage of a moving average of the endowment's value, typically 5%.⁶

³ In legal jargon, the term *endowment funds* refers only to funds donated with explicit legal restrictions preventing the university from spending any portion of the principal. Frequently university endowments include donations that were given with implicit, rather than explicit, restrictions. In legal terminology, these funds are called quasi-endowments. Endowment and quasi-endowment funds are reported pooled together in the data set, and throughout this paper *endowment funds* refers to both true and quasi-endowments.

⁴ The NACUBO Endowment Survey summary statistics of fund governance show that 74.6% of funds employ an outside consultant.

⁵ The NACUBO Endowment Survey reports that 87% of endowment assets are managed by external asset managers.

⁶ The NACUBO Endowment Survey shows that 82.4% of endowments spend a percentage of a moving average of endowment value.

For true endowment funds, the Uniform Management of Institutional Funds Act (UMIFA) places a high fiduciary burden on trustees to avoid paying out endowment capital.⁷ However, endowments usually follow mechanical payout rules for quasi-endowment funds where UMIFA does not apply. Hansmann (1990) argues that the use of mechanical payout rules for quasi-endowment funds is very difficult to justify from an economic perspective. However, these rules are consistent with Tobin (1974), who argues that mechanical payout rules preserve intergenerational equity.

III. Data

The data set used in this paper combines information on universities and university endowment funds. My source of university data is the Department of Education's National Center for Educational Statistics (NCES). The data source for university endowment funds is the 2003 National Association of University and College Business Officers (NACUBO) National Endowment Survey. NACUBO conducted the 2003 survey in fall 2003, gathering data about the 2002–2003 academic year. Out of 880 institutions invited to participate, 723 responded to the 2003 wave of the survey, for a response rate of 82%. Of the 723 endowments, 20 did not provide portfolio holding information, and another 26 are eliminated for a variety of reasons.⁸ A further 71 observations are lost because of missing explanatory variables in the NCES data, resulting in a final sample of 605 universities.

A. University Data

The National Center for Education Statistics (NCES) gathers data on U.S. postsecondary educational institutions. All U.S. postsecondary educational institutions must file an annual report if they participate in, apply for, or wish their students to be eligible for any form of federal funding.

From the NCES data, I find total 2002–2003 fiscal year nonfinancial income, defined as total current fund revenues from all sources, less transfers from endowment funds.⁹ Total current fund revenue is the sum of tuition and fees; government appropriations and research grants; private gifts, grants, and contracts; transfers from endowment; sales and services from auxiliary enterprises; hospital revenues; and other sources. Table 1 shows that average university

revenues are slightly over \$300 million and \$34,595 per full-time-equivalent (FTE) student.¹⁰ As with most other financial variables in this study, revenues are highly skewed with a mean larger than the 75th percentile.

The research-to-income ratio, defined as the proportion of nonfinancial income spent on research, is based on self-reported information provided to the National Science Foundation and compiled by the Center at the University of Florida. This definition of research spending is very narrow and almost certainly underreports true research spending, but it is consistent across universities.¹¹

Data on donations come from the NCES data set. Because donations are highly variable across years, I take an average from 1983 through 2003.¹² Average annual donations are \$13,341,890.¹³

I use the debt-to-assets ratio as a proxy for university credit constraints, and a high debt load is taken to imply greater financial constraints. Table 1 shows that the debt-to-assets ratio is around 30% for an average university. The payout-to-income ratio is the ratio of the amount the endowment transfers to the university operating budget in 2003, divided by nonfinancial income in that fiscal year. This serves as a measure of the financial importance of the endowment to the university.

As a measure of university quality, I use selectivity, defined as the proportion of applicants admitted.¹⁴ A typical university accepts 68% of applicants, but this varies from open admission policies to acceptance rates below 10%.

Panel B of table 1 shows information on university type. A little under a third of the universities are public. Panel B also shows the proportion of universities falling into the major Carnegie Classifications of Institutions of Higher Education.¹⁵ The Carnegie Institute assigns these classifications based on research intensity and the type of degrees awarded. Doctoral universities have high research spending

¹⁰ This variable and all other highly skewed variables are winsorized at the 99th percentile. Highly skewed variables unbounded at the lower end of the distribution are also winsorized at the 1st percentile.

¹¹ NCES data on research spending use definitions of research that differ depending on if the university follows GASB or FASB accounting standards. As a result, NCES reported research data should not be used for cross-sectional comparison. Despite the accounting differences, the NCES data and the Center research spending figures have a correlation coefficient of 0.83.

¹² Donations for all years are inflation adjusted to June 2003 dollars using all the items in the CPI index for all urban consumers.

¹³ This contains both true and quasi-endowment giving, as well as non-endowment gifts, such as donations to construct buildings. The Voluntary Support of Education (VSE) data set compiled by the Council for Aid to Education contains information on endowment gifts, without any other gifts included. Unfortunately, the VSE data set covers only 70% of the universities with endowment data. However, in the overlapping sample, the NCES measure of donations has a correlation of 0.90.

¹⁴ Only 63% of the universities reporting endowment fund data are ranked by *U.S. News*. The correlation between the proportion of applicants admitted and the *U.S. News* academic rankings is 0.74 for national universities and 0.78 for liberal arts colleges, with *p*-values less than 0.0001.

¹⁵ These do not add up to 100% as a small number of institutions are not categorized. For more information on Carnegie classifications, see <http://www.carnegiefoundation.org/classifications/>.

⁷ After the sample period ended, most states adopted the Uniform Prudent Management of Institutional Funds Act, which places fewer restrictions on payout policy.

⁸ I drop Canadian universities, as they do not report income data to the NCES. Some institutions report their foundation and university information separately. In these cases, I aggregate the foundation and university information to form a single observation. Some universities in the same system report information at the campus level, but portfolio holdings are identical across campuses. In these cases, I aggregate information to the university system level.

⁹ NCES data are submitted separately for each campus, while endowment data are sometimes reported at the university system level. When endowment data are reported at the university system level, I aggregate campus-level data prior to merging. Usually there is only a single campus, and this is not an issue.

TABLE 1.—UNIVERSITY SUMMARY STATISTICS

A: Financial Information				
	Mean	25th%	Median	75th%
Nonfinancial Income	312,630,200	36,586,250	75,547,540	238,149,700
Nonfinancial Income per FTE	34,595	16,902	21,643	31,557
Research-to-Income	6.1%	0.0	0.2	7.9
Average Annual Donation	13,341,890	2,136,834	4,270,327	10,135,600
Debt-to-Assets	31.0%	20.4	29.8	39.8
Payout-to-Income	8.2%	1.3	3.9	10.4
Proportion of Applicants Admitted	68.3%	59.1	72.5	81.3
B: University Type				
	Proportion			
Public	31.7%			
Doctoral	29.9%			
Master's	30.5%			
Bachelor—general	12.3%			
Bachelor—liberal arts	23.1%			
C: Endowment Funds				
	Mean	25th%	Median	75th%
Fund size	286,497,800	28,386,000	67,260,500	185,139,800
Endowment per FTE Student	69,370	7,162	20,439	53,331
Fund size, public	285,545,400	22,182,500	58,511,500	240,544,800
Fund size, private	286,940,900	31,105,250	68,422,000	167,529,800
D: Endowment Fund Returns and Volatility				
	Mean	25th%	Median	75th%
Returns	6.9%	5.6	6.8	8.1
Standard deviation	9.4%	8.3	9.6	10.6

This table contains summary statistics of university finances and characteristics. Panel A shows summary statistics of financial information. Average annual donation is measured over the 1983–1984 fiscal year through 2002–2003. Panel B describes the universities in the sample. Panel C shows summary statistics of endowment fund size as of the end of fiscal 2003. Panel D summarizes the annual returns and standard deviations of the endowment funds from the 2001–2002 academic year through 2007–2008.

and grant at least twenty doctoral degrees per year. Master's universities have graduate programs but award fewer than twenty doctoral degrees per year. Bachelor universities award bachelor's degrees but few, if any, graduate degrees. Relative to Bachelor-General universities, Liberal Arts universities have higher admission standards and focus on liberal arts majors. The indicator variables for public universities and for Carnegie classifications serve as proxies for a large number of university features, and these variables are included primarily to guard against omitted variable bias.

B. Endowment Funds, Portfolio Allocations, and Returns

NACUBO has collected endowment data annually since 1986. However, prior to 1995, it reported all asset allocation data by a confidential numeric code, and it is not possible to link allocations to specific universities. Further, prior to 2002, universities were able to report asset allocations as "balanced," making it difficult to properly classify portfolio holdings for a large portion of the sample. Since there is little variation in the independent variables of interest in this paper, I opt to examine the relation between background risk and portfolio allocations using a cross-section from 2003 rather than a panel.

Panel C of table 1 shows summary statistics of university endowment funds. The average endowment fund size in this study is over a quarter of a billion dollars.¹⁶ However, the

percentiles show that fund size is highly skewed. Average endowment sizes are similar between public and private universities.

Panel D of table 1 shows annualized endowment fund returns and standard deviations for fiscal years 2001 to 2008. The average annual return is 6.9%, and the average standard deviation is 9.4%. Of the 605 universities, only 554 endowments have valid return data due to missing observations in subsequent years.

Virtually all endowment funds own both equity and fixed income, but allocations vary widely, as shown in table 2. Equity allocations range from 1.6% to 100%, while fixed-income allocations vary from 0.3% to 91.5%. Just over 70% of endowment funds hold alternative assets. As the table shows, almost half of endowment funds own hedge funds, and the average allocation is substantial. Private equity and venture capital are both popular, but the allocations are modest. Only a small minority of funds holds oil and gas partnership or commodities, and allocations are small.

IV. Background Risk Measures

The primary source of background risk for endowment funds comes from their affiliated universities' nonfinancial income.¹⁷ Using revenue data from the NCES, I take each

¹⁶ Data are reported as of the fiscal year end. Most of the sample (89.3%) has a June 30 year end. The remaining endowment funds typically have a May 31 year end.

¹⁷ Nonfinancial income equals total university current fund revenues (the sum of tuition and fees; government appropriations and research grants; private gifts, grants, and contracts; transfers from endowment; sales and services from auxiliary enterprises; hospital revenues; and other sources) less transfers from endowment.

TABLE 2.—ENDOWMENT FUND PORTFOLIOS

	Participating	Value Weighted	Equal Weighted
Asset Allocation			
Equities	99.6%	48.7	57.4
Fixed income	98.7	20.7	26.1
Real estate	54.2	5.2	5.0
Alternative assets	70.6	22.9	14.1
Cash	72.4	2.7	5.5
Alternative assets			
Hedge funds	45.8%	16.9	13.2
Venture capital	34.0%	3.2	2.2
Private equity	34.5%	4.8	3.6
Oil and gas	12.6%	2.3	2.2
Commodities	4.3%	4.0	3.4

This table summarizes endowment fund holdings. The first column shows the percentage of endowments participating in an asset class. The second column shows the average value weighted allocation conditional on participation. The third column shows the equal weighted average allocation across institutions, conditional on participation. Panel A shows asset allocation across asset classes. Panel B shows asset allocation across subcategories of alternative assets. All values are measured at the end of the 2002–2003 academic year.

TABLE 3.—BACKGROUND RISK SUMMARY STATISTICS

	Mean	25th%	Median	75th%
Growth rate of nonfinancial income	7.3%	5.6	6.8	8.2
Background risk: Total revenue	10.6%	5.7	8.3	12.0
Growth rate of nonfinancial income per FTE student	6.7%	2.3	5.9	9.6
Background risk per FTE student	11.3%	5.8	8.4	12.5
$\text{Corr}(\text{Income}, R_M)$	-0.01	-0.18	-0.001	0.16

This table shows summary statistics of background risk. All variables are calculated using data from the 1983–1984 through 2002–2003 fiscal years. Background risk: total revenue is the standard deviation of the growth rate of nonfinancial income over the period. Background risk per FTE student is the standard deviation of the growth rate of nonfinancial income per full time equivalent student. $\text{Corr}(\text{Income}, R_M)$: the correlation of the growth rate of nonfinancial income and the CRSP value-weighted stock index returns.

institution's nonfinancial income from the first fiscal year NCES data are available, 1983–1984, through the 2002–2003 fiscal year. It is not clear if universities should be concerned with total income or income per student. For this reason, I measure both total nonfinancial income and nonfinancial income per FTE student. As table 3 shows, the average annual growth rate of total nonfinancial income during this period is 7.3%, and the growth rate per FTE student is 6.7%. I calculate the standard deviation of both the overall and per FTE student growth rates.¹⁸ The average standard deviation of the growth rate of total income is 10.6%, and the average standard deviation of the growth rate per FTE student is 11.3%.

These measures of university background risk almost certainly contain measurement error, which will lead to attenuation bias and understate the true economic importance of background risk. To mitigate this problem, I follow the approach of Carroll and Samwick (1997) and use instrumental variables estimates of the background risk measures. I use the percentage of total revenue from different sources as my instruments. There are five possible revenue sources: tuition, public funding, private gifts (to current revenue not

¹⁸ I have also decomposed the standard deviation of growth rates into permanent and transitory components following the method of Carroll and Samwick (1997). The permanent component of standard deviation significantly predicted portfolio standard deviations and asset allocation, while the transitory component was not significantly related to portfolio choice.

endowments), public gifts (primarily research funding), and other. As required of valid instruments, these variables are highly correlated with the background risk measures. When regressing background risk on the independent variables used in this study, adding these instruments increases the R^2 of the first stage regression by nearly 0.2, and F -tests show the instruments are significant even after adjusting the critical values following Staiger and Stock (1997). Overidentification tests fail to reject the validity of these instruments for the regressions in the subsequent sections.¹⁹

Merton (1992) shows that under specific assumptions regarding university endowments' objective functions, a positive correlation between risky assets and background risk should result in lower allocations to risky assets. To test this idea, I take the correlations between changes in nonfinancial income and the CRSP value-weighted stock index. Table 3 shows that the average correlation between the growth rate of nonfinancial income and the CRSP value-weighted market index, $\text{Corr}(\text{Income}, R_M)$, is low and close to 0, but there is wide variation across universities.

V. Background Risk and Endowment Portfolio Volatility

A. Methodology and Variables

As a direct test of the effect of background risk on endowment risk taking, I run OLS regressions of actual endowment portfolio standard deviations on the background risk measures introduced in the previous section.²⁰

$$\begin{aligned} \sigma_i = & \alpha + \beta_1 \text{BackgroundRisk}_i + \beta_2 \text{Corr}(\text{Inc}, R_M)_i \\ & + \beta_3 \text{Log}(\text{AvgDonations}_i) + \beta_4 \text{Payout-to-Income}_i \\ & + \beta_5 \text{Public}_i + \beta_6 \text{EndowmentperFTEStudent} \\ & + \beta_7 \text{ProportionAdmitted}_i + \beta_8 \text{Debt-to-Assets}_i \\ & + \beta_9 \text{Research-to-Income}_i + \beta_{10} \text{Doctoral}_i \\ & + \beta_{11} \text{BachelorGeneral}_i + \beta_{12} \text{LiberalArts}_i + \varepsilon_i \quad (1) \end{aligned}$$

If universities' objective functions are standard in the sense of Kimball (1993), then background risk will cause investors to reduce their portfolio risk, implying that the coefficient on background risk should be negative.²¹ If endowment funds do not have standard objective functions, the coefficient could be insignificant or even positive.

Merton (1992) shows that for certain objective function assumptions, the correlation between risky asset returns and

¹⁹ In the empirical tests presented later in this paper, if the background risk measures are used directly rather than the instrumental variables estimates of the background risk measures, the results of this paper are qualitatively similar. In all specifications, if the IV estimate is significant, the noninstrumented variable is also significant. However, consistent with attenuation bias, the point estimates are always larger using the instrumental variables estimates.

²⁰ To control for the possibility of common constraints for public universities within the same state university system, I also estimate a specification with state-public fixed effects. The results are qualitatively similar.

²¹ Standard utility functions are defined by Kimball (1993) as those with decreasing absolute risk aversion and decreasing absolute prudence.

background risk will affect portfolio risk. However, there are two caveats for this prediction. First, some endowments have significant allocations to alternative assets with unusual correlation structures, and this may limit the power of these regressions. Second, the correlations are undoubtedly measured with error.

I use the log of average donations as a proxy for portfolio size.²² Portfolio size is an important control as smaller endowments are unable to gain access to many alternative asset funds. Brown et al. (2010) and Lerner et al. (2008) show a strong relation between endowment fund size and portfolio performance, suggesting they have different investment opportunities and greater expertise, which may affect portfolio volatility. However, causality between endowment size and portfolio volatility could run in either direction. If portfolio allocations are stable, then risky portfolios will become relatively large through higher returns. To cleanly measure the effect of size on portfolio choice, I use the log of average donations to the endowment fund as a proxy for size. This has a highly significant correlation of 0.82 with endowment fund size, but it is unrelated to endowment returns.²³

I include the ratio of endowment payout to income and the ratio of endowment per FTE student to control for the financial importance of the endowment to the university. Endowment shocks will have a larger direct effect when endowment payouts are a large portion of total university revenues, which implies greater sensitivity to risk. However, Reed, Tiu, and Yoeli (2008) argue that endowments face an asset-liability problem, and the relevant risk to endowments is the possibility of persistently earning returns below the payout ratio. For example, an endowment invested 100% in T-bills would have few fluctuations in value, but this asset allocation policy would be certain to erode the real value of the endowment over time and is thus extremely risky from the perspective of achieving the endowment's long-term goals. There will be very little cross-sectional variation in the asset-liability problem for endowments as their "liability," the payout policy, is virtually identical across endowments. However, universities' sensitivity to the risk of failing to maintain their payouts should be increasing in endowment dependence. Thus, greater endowment dependence should increase risk sensitivity. But because endowment risk is two-sided, the sign of the effect is unclear.

The proportion of applicants admitted is a measure of excess demand for entrance to the university and is highly correlated with university quality. Higher demand for entrance implies that a university has greater ability to raise tuition while still attracting quality students, which in turn allows these universities to alter their tuition revenues to

recoup financial losses. This is also a measure of university quality and serves as a control for university type.

University debt-to-asset ratios are included as a control variable for two reasons. First, if a university is able to borrow to smooth spending, this reduces the dislocation caused by volatility in endowment payouts and may increase the willingness to bear risk. Second, rather than fund building projects directly, a university can issue tax-exempt bonds and invest an equal amount in taxable bonds as a simple tax arbitrage. However, this strategy can occur only on a limited basis or the university risks losing its tax-exempt status (see Hansmann, 1990, for further discussion).

The research-to-income ratio is included as a control variable for two reasons. First, university cost structure may affect portfolio choice if there are large costs associated with adjusting research spending. But university cost structure is surprisingly difficult to measure, as universities have great discretion in the accounting classification of costs. This variable serves as the one available proxy. Second, the ratio of research to income serves as a control for university type.

Public is an indicator variable equal to 1 for public universities. There are two reasons to think that public universities may behave differently from private universities. First, public universities may anticipate a state-funded bailout in the event of disastrous portfolio performance, which could lead to greater risk taking. Second, the governance structures of universities and endowments differ for public and private universities.²⁴

B. Background Risk and Portfolio Volatility Results

Table 4 shows the results of regressing portfolio standard deviations on background risk. In the first column, background risk is measured using total nonfinancial income. In the second column, background risk is measured using nonfinancial income per FTE student. Both columns are estimated using two-stage least squares, instrumenting background risk to reduce attenuation bias. The *F*-statistics of the instrumental variables in the first stage of the regressions are 19.03 and 9.86, respectively.

The relation between background risk and actual portfolio standard deviations is significantly negative in both specifications. Universities with greater revenue risk hold portfolios with lower standard deviations. These results are consistent with universities that have objective functions that are standard in the sense of Kimball (1993). Even with the dispersion of decision making across agents within a university, endowment managers' actions are consistent with the hypotheses that they consider the entity-wide risk of the university.

²² The estimated coefficients on background risk are qualitatively similar if the log of actual fund size is used in place of the log of average donations.

²³ I test this statement using a panel of endowment returns and gifts. There is no significant relation between giving and endowment returns.

²⁴ The 2003 NACUBO Endowment Survey contains summary statistics of endowment governance. The endowment boards at private universities average more than twice as many members as the boards of public universities. Unfortunately, governance information is not available at the endowment fund level.

TABLE 4.—BACKGROUND RISK AND PORTFOLIO STANDARD DEVIATIONS

Background risk: Total revenue	−8.816** (−2.25)	
Background risk per FTE student		−5.848* (−1.77)
Corr(Inc, R_M)	−0.092 (−0.25)	0.11 (0.28)
Log (Avg. Donations)	0.455*** (4.20)	0.420*** (3.89)
Payout-to-Income	2.623* (1.79)	1.863 (1.35)
Public	−0.194 (−0.78)	−0.223 (−0.84)
Endowment per FTE Student	−0.001 (−0.64)	−0.002 (−1.33)
Proportion Admitted	0.758 (1.29)	0.565 (0.97)
Debt-to-Assets	0.493 (0.67)	0.306 (0.42)
Research-to-Income	−2.212* (−1.83)	−2.109* (−1.72)
Doctoral	0.296 (0.95)	0.435 (1.42)
Bachelor General	−0.113 (−0.38)	−0.108 (−0.36)
Liberal Arts	0.25 (0.95)	0.262 (0.98)
Constant	2.398 (1.37)	2.962* (1.67)
R^2	0.704	0.074
F-test of instrumental variables	19.03***	9.86***

This table shows regression results where the dependent variable is endowment portfolio standard deviations over 2002–2008. In column 1, background risk is the standard deviation of the growth rate of nonfinancial income. In column 2, background risk is the standard deviation of the growth rate of nonfinancial income per FTE student. In both columns, background risk is instrumented using revenue sources. Significant at the *10%, **5%, ***1% level. $N = 554$.

Both columns in table 4 suggest that if background risk increases by 1 standard deviation, the portfolio standard deviation would decrease by approximately 0.6% points, which is 6.6% relative to average endowment portfolio volatility.

The coefficient on the logarithm of average donations, used as a proxy for fund size, is positive and highly significant. This is consistent with endowments having decreasing relative risk aversion, which is a necessary condition for background risk to have a negative effect on portfolio risk. Also, Brown et al. (2010) show that larger endowments earn significantly higher alphas than small funds, suggesting that larger endowments earn greater rewards for their risk taking.

The debt-to-assets ratio is the only other consistently significant variable. Universities with greater debt levels have less volatile portfolios. The results in the next section show this is due to a strong positive relation between the debt-to-assets ratio and allocations to fixed-income securities.

VI. Asset Class Allocations

Given the negative relation between background risk and portfolio standard deviations, it seems reasonable to expect a relation between background risk and asset allocation. By examining allocations across a range of asset classes, it is possible to obtain a deeper understanding of how background risk affects investment decisions.

A. Methodology and Asset Classes

To ensure that predicted asset allocations sum to 100%, I estimate the following system of equations:

$$y_{ij} = \alpha_j + \sum_{k=1}^K \beta_{jk} X_{ik} + \varepsilon_{ij} \quad \text{for } j = 1, \dots, J \quad (2)$$

$$\text{s.t.} \quad \sum_{j=1}^J \alpha_j = 100, \quad \sum_{j=1}^J \beta_{jk} = 0, \quad \sum_j \varepsilon_{ij} = 0$$

$$\text{for } k = 1, \dots, K \text{ and } J = 1, \dots, J$$

$$\begin{aligned} \sum_{k=1}^K \beta_{jk} X_{ik} = & \beta_{j1} \text{BackgroundRisk}_i + \beta_{j2} \text{Corr}(Inc, R_M)_i \\ & + \beta_{j3} \text{Log}(AvgDonations)_i \\ & + \beta_{j4} \text{Payout-to-Income}_i + \beta_{j5} \text{Public}_i \\ & + \beta_{j6} \text{Endow.perFTEStudent}_i \\ & + \beta_{j7} \text{Proportion Admitted}_i \\ & + \beta_{j8} \text{Debt-to-Assets}_i \\ & + \beta_{j9} \text{Research-to-Income}_i + \beta_{j10} \text{Doctoral}_i \\ & + \beta_{j11} \text{Bachelor General}_i \\ & + \beta_{j12} \text{LiberalArts}_i, \end{aligned} \quad (3)$$

where y_{ij} is the percentage of endowment fund i allocated to asset class j . There are J asset classes and K explanatory variables. The constraints force predicted values to equal 100% for each endowment fund.²⁵

The first two asset classes in each of the sum-constrained models are equity and fixed income. Equity is relatively risky. Over the past eighty years, U.S. stocks have returned 12% per year with a standard deviation of 20%. Fixed income is a relatively safe asset class; historically long-term government bonds have earned an average annual return of 5.6% with a standard deviation of 8.1%.

The third category is alternative assets. This is the most challenging asset class to characterize as it includes investment vehicles with a wide range of risk and return characteristics. Hedge funds are the largest component of endowments' alternative asset allocations. Agarwal and Naik (2004) report that hedge funds have returns slightly lower than equity, and many categories of hedge funds have standard deviations approximately half that of equity. However, the authors also show that this attractive mean-variance profile comes at the cost of significant downside risk, as the

²⁵ One drawback to this methodology is that it is possible for predicted values to be negative. However, as a practical matter, this problem is limited. Predicted equity and fixed-income allocations are never negative. In both specifications, around 5% of the predicted values for alternative assets are negative; typically these negative predicted values are close to 0, but in each specification, approximately 2% of the cases are less than −5%. There are a few negative predicted values for real estate (always less than 1% of the observations), but these are never below −1.6%.

TABLE 5.—ASSET ALLOCATION AND BACKGROUND RISK

	Equity	Fixed Income	Alternative Assets	Real Estate	P-Value
Background risk: Total revenue	-9.315 (-0.51)	54.105*** (3.63)	-40.098*** (-2.92)	3.735 (0.65)	0.001
Corr(Inc, R_M)	-1.731 (-0.67)	-0.398 (-0.19)	1.138 (0.58)	0.25 (0.31)	0.965
Log of Avg. Donations	-0.064 (-0.09)	-3.859*** (-6.48)	2.826*** (5.14)	0.724*** (3.16)	0.000
Payout-to-Income	1.317 (0.15)	-9.361 (-1.27)	11.052 (1.62)	-0.737 (-0.26)	0.163
Public	2.382 (1.42)	2.401* (1.75)	-4.544*** (-3.58)	-0.741 (-1.40)	0.005
Endowment per FTE Student	-0.006 (-0.59)	-0.018** (-2.16)	0.013* (1.76)	-0.001 (-0.35)	0.017
Proportion Admitted	16.705*** (4.24)	-7.426** (-2.30)	-12.091*** (-4.05)	-0.374 (-0.30)	0.000
Debt-to-Assets	-5.061 (-1.04)	10.248** (2.56)	-5.183 (-1.41)	-2.193 (-1.42)	0.000
Research-to-Income	-12.898 (-1.48)	11.162 (1.56)	4.787 (0.72)	0.299 (0.11)	0.525
Doctoral	0.773 (0.35)	2.485 (1.39)	0.509 (0.31)	-1.265* (-1.83)	0.053
Bachelor General	-0.37 (-0.18)	2.789* (1.68)	-2.268 (-1.48)	-0.453 (-0.71)	0.459
Liberal Arts	3.488* (1.90)	-1.231 (-0.82)	0.605 (0.44)	-0.875 (-1.51)	0.000
Constant	48.765*** (4.09)	84.530*** (8.64)	-21.429** (-2.37)	-6.907* (-1.83)	
R^2	0.073	0.158	0.297	0.038	

This table shows the results of a sum-constrained model of portfolio allocation. There is one equation per asset class, and the equations are jointly estimated with the constraint that total portfolio allocations must sum to 100%. The final column shows F -tests of each variable's overall significance within the system of equations. Background risk is the instrumental variable's estimate of the standard deviation of the growth rate of nonfinancial income. The F -statistic for the instrumental variables used to estimate background risk is 39.87 (p -value, < 0.0001). Significant at the *10%, **5%, ***1% level. $N = 605$.

distribution of hedge fund returns is similar to a short position in equity put options.

More important than hedge funds' risk profiles is their contribution to the risk of a diversified portfolio. Amin and Kat (2002) show that although hedge funds can improve the mean-variance performance of a portfolio, this comes at the cost of higher kurtosis and lower skewness, and this higher moment risk cannot be eliminated through diversification.

The downside risk of hedge funds is important, as Modica and Scarsini (2005) show that the conditions on objective functions that result in sensitivity to background risk, specifically Gollier and Pratt's (1996) concept of risk vulnerability, also imply sensitivity to downside risk. This implies that if universities' objective functions are sensitive to background risk, they will also be sensitive to downside risk.

Private equity and venture capital are also significant components of endowments' alternative asset allocations. Kaplan and Schoar (2005) find that private equity funds have a median return of 13% with a standard deviation of 27%, implying that private equity is one of the riskiest asset classes. Since private equity funds are composed of leveraged equity it seems unlikely that they could provide significant diversification benefits when combined with publicly traded equity. Kaplan and Schoar (2005) estimate average venture capital fund annual returns of 17% with a standard deviation of 34%. Cochrane (2005) finds that venture capital funds have an average beta of 1.7, suggesting considerable systematic risk. Overall, these studies suggest that pri-

vate equity and venture capital do not provide diversification benefits.

B. Background Risk and Asset Class Allocations

Tables 5 and 6 contain results for the system of equations estimating the relation between background risk and asset allocation. In table 5, background risk is the standard deviation of the growth rate of nonfinancial income. In table 6, it is the standard deviation of the growth rate of nonfinancial income per FTE student. In both tables, the background risk variable is instrumented to reduce attenuation bias. There is one column per asset class, and the fifth column contains p -values from F -tests of the variables' overall significance across all equations. The F -statistics for the instrumental variables in the first stage are 39.87 and 19.03, respectively, and are highly significant.

The coefficients on background risk are significant in both specifications. The t -tests show that higher background risk is associated with higher allocations to fixed income and lower allocations to alternative asset investment. Surprisingly, background risk has little effect on equity. Possibly this is due to the greater standard deviations of venture capital and private equity, or hedge funds' higher moment risk.

In addition to the high standard deviations of private equity and venture capital and the higher moment risk of hedge funds, there are two alternative reasons that back-

TABLE 6.—ASSET ALLOCATION AND BACKGROUND RISK PER FULL-TIME-EQUIVALENT STUDENT

	Equity	Fixed Income	Alternative Assets	Real Estate	P-value
Background risk per FTE Student	0.951 (0.06)	35.577*** (2.79)	-35.201*** (-2.91)	4.075 (0.83)	0.009
Corr(Inc, R_M)	-1.812 (-0.68)	-1.548 (-0.71)	2.339 (1.13)	0.106 (0.13)	0.670
Log of Avg. Donations	-0.076 (-0.11)	-3.738*** (-6.25)	2.726*** (4.81)	0.734*** (3.20)	0.000
Payout-to-Income	-0.794 (-0.09)	-3.317 (-0.47)	7.909 (1.19)	-0.565 (-0.21)	0.760
Public	2.572 (1.49)	2.690* (1.89)	-5.058*** (-3.74)	-0.666 (-1.22)	0.003
Endowment per FTE Student	-0.007 (-0.72)	-0.009 (-1.18)	0.007 (0.90)	0 (-0.15)	0.156
Proportion Admitted	16.292*** (4.20)	-5.686* (-1.78)	-13.239*** (-4.38)	-0.28 (-0.23)	0.000
Debt-to-Assets	-5.153 (-1.06)	10.992*** (2.74)	-5.779 (-1.52)	-2.134 (-1.38)	0.005
Research-to-Income	-12.806 (-1.47)	10.356 (1.44)	5.442 (0.80)	0.232 (0.08)	0.435
Doctoral	0.93 (0.43)	1.78 (1.00)	0.987 (0.58)	-1.305* (-1.90)	0.043
Bachelor General	-0.619 (-0.31)	3.244* (1.96)	-2.393 (-1.53)	-0.461 (-0.72)	0.357
Liberal Arts	3.555* (1.94)	-1.436 (-0.95)	0.717 (0.50)	-0.882 (-1.52)	0.004
Constant	48.326*** (4.01)	82.127*** (8.27)	-18.584** (-1.97)	-7.268* (-1.90)	
R^2	0.072	0.150	0.251	0.033	

This table shows the results of a sum-constrained model of portfolio allocation. There is one equation per asset class, and the equations are jointly estimated with the constraint that total portfolio allocations must sum to 100%. The final column shows F -tests of each variable's overall significance within the system of equations. Background risk is the instrumental variables' estimate of the standard deviation of the growth rate of nonfinancial income per FTE student. The F -statistic for the instrumental variables used to estimate background risk is 19.03 (p -value < 0.0001). Significant at the *10%, **5%, ***1% level. $N = 605$.

ground risk might affect alternative assets rather than equity. First, universities with high background risk may be concerned with maintaining portfolio liquidity in case of a severe negative shock. Private equity and venture capital are highly illiquid due to long lock-up periods (see Lerner & Schoar, 2004). Hedge funds also frequently have lock-up periods (see Brown et al., 2008). If universities use endowment income to smooth revenue shocks, then portfolio illiquidity will be particularly unattractive for the universities most likely to experience revenue shocks.

Second, van Binsbergen, Brandt, and Kojen (2008) argue that endowments' decentralized investment management structure results in a form of background risk. Differences in risk aversion between endowments and delegated asset managers cause asset managers to take actions that are suboptimal from the endowments' perspective. This problem is likely more severe for alternative assets because the portfolio managers have greater scope for their risk aversion to affect behavior, and lock-ups limit endowments' ability to discipline investment managers through withdrawals. If endowments have objective functions that are sensitive to background risk, then higher background risk from nonfinancial income will increase endowments' sensitivity to this problem as, by definition, background risk increases sensitivity to other risks.

The results in table 5 imply that a 1 standard deviation increase in background risk will result in a 4.3% point increase in the allocation to fixed income, which represents a change of 14.8% relative to the average fixed-income

allocation. For alternative assets, the implied change is 3.2% points, which represents a change of a 35.6% relative to the mean. The economic magnitude of the results in table 6 is similar.

The correlation between nonfinancial income and the CRSP value-weighted market index is not statistically significant in any of specifications. Given the measurement error and the absence of valid instrumental variables, it is not possible to draw a clear conclusion from this nonresult.

The most statistically significant variable is the log of average donations, which is included as a proxy for fund size. Large funds have lower allocations to fixed income and invest considerably more in alternative assets and real estate. There are several reasonable explanations of this finding. First, as Kimball (1993) showed, if endowments' objective functions are sensitive to background risk, then the objective functions have decreasing absolute risk aversion. This implies portfolio risk should increase in wealth. Thus, the significance of endowment size is consistent with the results for background risk. Second, there are economies of scale in selecting and monitoring alternative assets, implying lower proportional costs for larger funds. Third, many alternative asset funds have large minimum investments, and so larger endowments have a wider range of potential investments.

The payout-to-income ratio is significant in all specifications. Higher payout-to-income is associated with lower fixed-income allocations and higher alternative asset allocations. This is consistent with Reed et al. (2008), who argue that

TABLE 7.—ALLOCATIONS TO ALTERNATIVE ASSETS AND BACKGROUND RISK

	Equity	Fixed Income	Hedge Funds	Private Equity	Venture Capital	Real Estate	P-value
Specification 1: Background Risk – Total Revenue	–9.315 (–0.51)	54.105*** (3.63)	–23.843** (–2.03)	–8.310*** (–2.58)	–5.205*** (–3.14)	3.735 (0.65)	0.0009
Specification 2: Background Risk – per FTE Student	0.951 (0.06)	35.577*** (2.79)	–22.117** (–2.16)	–6.847** (–2.44)	–4.287*** (–2.95)	4.075 (0.83)	0.009

This table shows results for sum-constrained models of portfolio choice. Alternative assets are broken into three components: hedge funds, venture capital, and private equity. All four models are estimated with the control variables used in the previous specification, but in the interest of brevity, only the background risk coefficients are shown. The *F*-statistics for the instrumental variables used to estimate background risk are 39.9 and 19.1, respectively (*p*-values < 0.0001). Significant at the *10%, **5%, ***1% level. *N* = 605.

persistently earning returns below the payout target is a risk for endowments. Universities with greater endowment dependence are concerned with the possibility that the real value of their endowment will erode due to insufficient returns, and so they diversify their equity holdings through alternative assets rather than fixed income.

The debt-to-assets ratio is significant, and the results show that higher leverage is associated with higher fixed-income allocations. This is consistent with universities' having lower tolerance for revenue fluctuations if they have exhausted their borrowing capacity. At a more general level, this provides supporting evidence that university financial decisions and endowment fund investments are coordinated.

The proportion of applicants admitted is highly significant in all specifications. Selective universities have lower equity allocations and higher alternative asset allocations. This cannot be explained by risk preferences, as there is no relation between the proportion of applicants admitted and portfolio standard deviations. Also, the proportion of applicants admitted affects allocations between equities and alternative assets rather than fixed income. However, there are several reasonable explanations unrelated to risk. First, selective universities may be willing to hold illiquid investments because they have a greater ability to generate additional revenues by increasing enrollments or reducing financial aid. Second, Lerner et al. (2008) suggest that the endowment funds boards of selective universities have greater financial sophistication and access to information. Finally, alumni connections may also be important in obtaining entrance to the highest-quality alternative asset funds, which Kaplan and Schoar (2005) show are often oversubscribed.

Public universities have higher equity allocations and lower alternative asset allocations than private universities. This result does not appear to be related to risk, as the results in table 4 do not show a relation between public universities and portfolio volatility, and this variable is associated with the trade-off between equities and alternative assets rather than fixed income. Rather, this result is consistent with preferences for transparency or liquidity.

The remaining independent variables are included to control for university type. The ratio of research funding-to-income is a measure of a university's research intensity, while the remaining variables are indicator variables for the universities' Carnegie classifications. The results for background risk are similar regardless of whether these variables are included.

C. The Effect of Background Risk on Alternative Assets and Equity

The most surprising result in the previous section is that background risk affects alternative assets rather than equity. To explore this finding in more depth, I examine the relation between background risk and endowment preferences for different types of alternative assets. In the system of equations reported in table 7, alternative assets are broken into three categories: hedge funds, private equity, and venture capital. These regressions include the same control variables as tables 5 and 6, but in the interest of brevity, I display only the coefficients for background risk.

The background risk coefficients for private equity and venture capital are highly significant. The implied effect of background risk is very large given the relatively low average allocations to these two asset classes. When background risk is defined as the standard deviation of the growth rate of nonfinancial income, a 1 standard deviation increase in background risk implies an 87% decrease in allocations to venture capital equity and a 41% decrease in allocations to private equity. When background risk is defined as the standard deviation of the growth rate of income per FTE student, the corresponding implied changes are a 66% decrease in allocations to venture capital and a 58% decrease in allocations to private equity.

These results suggest that the high volatility of venture capital and private equity is an important determinant of the strong negative relation between background risk and alternative assets due to the high volatility of private equity and venture capital. Overall, the results in this section suggest that one reason background risk affects alternative assets rather than equity is that endowment funds with high background risk are especially averse to holding private equity and venture capital, which are the riskiest of all asset classes.

VII. Conclusion

In this paper, I examine the effect of background risk on endowment fund portfolio choice. Theory shows that background risk will result in safer portfolio choices for objective functions with decreasing absolute risk aversion and decreasing absolute prudence. However, for objective functions without these characteristics, the effect of background risk can be negligible or even increase portfolio risk. I find a significant negative relation between background risk and

actual portfolio volatility. Universities with higher income volatility hold portfolios with lower realized standard deviations.

Background risk has a significant effect on endowment fund asset allocation. Universities with higher background risk have higher fixed-income allocations and lower alternative asset allocations. The control variable results show that other nontradable university features significantly affect endowment fund asset allocation. Larger funds, funds that provide a large proportion of their universities' operating budget, and universities with low debt levels hold riskier assets in their endowments. Selective universities and private universities have higher allocations to alternative assets relative to equity.

Overall, the results show that background risk has a significant effect on endowment funds' portfolio choices. Endowment funds manage the overall risk of the entire affiliated university entities, considering both the endowment fund and the universities' nonfinancial operations. The results of this paper provide evidence of the factors affecting the financial decisions of endowment funds and indirect evidence on the nature of universities' objective functions.

REFERENCES

- Agarwal, Vikas, and Narayan Y. Naik, "Risk and Portfolio Decisions Involving Hedge Funds," *Review of Financial Studies* 17:1 (2004), 63–98.
- Amin, Gaurav S., and Harry M. Kat, "Diversification and Yield Enhancement with Hedge Funds," *Journal of Alternative Investments* 5:3 (2002), 50–58.
- van Binsbergen, Jules H., Michael W. Brandt, and Ralph S. J. Koijen, "Optimal Decentralized Investment Management," *Journal of Finance* 63:4 (2008), 1849–1895.
- Black, Fisher, "The Investment Policy Spectrum: Individuals, Endowment Funds and Pension Funds," *Financial Analysts Journal* 32:1 (1976), 23–31.
- Brown, Keith C., Lorenzo Garlappi, and Christian Tiu, "Asset Allocation and Portfolio Performance: Evidence from University Endowment Funds," *Journal of Financial Markets* 13:2 (2010), 268–294.
- Brown, Stephen, William Goetzmann, Bing Liang, and Christopher Schwarz, "Mandatory Disclosure and Operational Risk: Evidence from Hedge Fund Registration," *Journal of Finance* 63:6 (2008), 2785–2815.
- Carroll, Christopher D., and Andrew A. Samwick, "The Nature of Precautionary Wealth," *Journal of Monetary Economics* 40:1 (1997), 41–71.
- Cochrane, John H., "The Risk and Return of Venture Capital," *Journal of Financial Economics* 75:1 (2005), 3–52.
- Eeckhoudt, Louis, Christian Gollier, and Harris Schlesinger, "Changes in Background Risk and Risk Taking Behavior," *Econometrica* 64:3 (1996), 683–689.
- Gollier, Christian, *The Economics of Risk and Time* (Cambridge, MA: MIT Press, 2001).
- Gollier, Christian, and John W. Pratt, "Risk Vulnerability and the Tempering Effect of Background Risk," *Econometrica* 64:5 (1996), 1109–1123.
- Guiso, Luigi, Tullio Jappelli, and Daniele Terlizzese, "Income Risk, Borrowing Constraints, and Portfolio Choice," *American Economic Review* 86:1 (1996), 158–172.
- Hansmann, Henry, "Why Do Universities Have Endowments?" *Journal of Legal Studies* 19:1 (1990), 3–42.
- Kaplan, Steven N., and Antoinette Schoar, "Private Equity Performance: Returns, Persistence, and Capital Flows," *Journal of Finance* 60:4 (2005), 1791–1823.
- Kimball, Miles S., "Standard Risk Aversion," *Econometrica* 61:3 (1993), 589–611.
- Lerner, Josh, and Antoinette Schoar, "The Illiquidity Puzzle: Theory and Evidence from Private Equity," *Journal of Financial Economics* 72:1 (2004), 3–40.
- Lerner, Josh, Antoinette Schoar, and Jialan Wang, "Secrets of the Academy: The Drivers of University Endowment Success," *Journal of Economic Perspectives* 22:3 (2008), 207–222.
- Litvack, James M., Burton G. Malkiel, and Richard E. Quandt, "A Plan for the Definition of Endowment Income," *American Economic Review* 64:2 (1974), 433–442.
- Merton, Robert C., "Optimal Investment Strategies for University Endowment Funds," in Robert C. Merton (Ed.), *Continuous Time Finance*, rev. ed. (Malden, MA: Blackwell, 1992).
- Modica, Salvatore, and Marco Scarsini, "A Note on Comparative Downside Risk-Aversion," *Journal of Economic Theory* 122:2 (2005), 267–271.
- Pratt, John W., and Richard J. Zeckhauser, "Proper Risk Aversion," *Econometrica* 55:1 (1987), 143–154.
- Reed, Andrea, Christian Tiu, and Uri Yoeli, "Risk Management for Decentralized Investors," working paper (2008).
- Staiger, Douglas, and James H. Stock, "Instrumental Variables Regression with Weak Instruments," *Econometrica* 65:3 (1997), 557–586.
- Swenson, David F., *Pioneering Portfolio Management: An Unconventional Approach to Institutional Investment* (New York: Free Press, 2000).
- Tobin, James, "What Is Permanent Endowment Income?" *American Economic Review* 64:2 (1974), 427–432.
- Vissing-Jorgensen, Annette, "Towards an Explanation of Household Portfolio Choice Heterogeneity: Nonfinancial Income and Participation Cost Structures," working paper (2002).
- Winston, Gordon C., "Subsidies, Hierarchy and Peers: The Awkward Economics of Higher Education," *Journal of Economic Perspectives* 13:1 (1999), 13–36.
- Zeizima, Katie, "Data Show College Endowments Lost 23% in 5 months, Worst Drop since '70s," *New York Times*, January 27, 2009, p. 17.