A New Perspective on Endowments

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Background and Motivation.

The last few years have been fiscally brutal to large University and private endowment funds. The 30% to 50% decline in global equity markets together with a noticeable reduction in donation flows and a rigid spending policy based on long-run average returns has forced even the most venerable institutions to rethink all aspects of their asset allocation and spending policies.

Table #1: Asset Allocation of Endowments Funds with at least $1 Billion in Assets

Domestic Equity	30%
Foreign Equity	14%
Private Equity	6%
Fixed Income	15%
Real Estate	5%
Venture Capital	13%
Hedge Funds	6%
Other	11%

Source: NACUBO Survey, 2001.

Table #1 provides a representative picture of the average asset allocation of 41 large University endowment funds with at least $1 billion in assets. Although actual allocations can differ quite substantially between institutions – and even the definitions of these categories are suspect – more than 50% of these funds are invested in some general category of equity. And, as global equity markets have declined, so have the fortunes of these endowments. To complicate matters, the typical endowment spends (i.e. disburses) between 4% and 6% of its asset values in any given year, which creates further downward pressure on these funds. In some cases much too rigid spending rules can actually threaten the long-term survival of the endowment during a prolonged bear market.

Thus, endowment managers, trusties and their dependents are faced with a dilemma. Should they change their spending formula and/or asset allocation as a reaction to recent events, or should they continue business as usual and simply try to weather the storm?

Against the backdrop of these issues, the TIAA-CREF Institute funded a recent project report entitled: “An Actuarial Approach to Endowment Asset Allocation and Spending Policies.” The author of the paper is Moshe Milevsky, Associate Professor at York University in Toronto, and a past visiting scholar to the TIAA-CREF Institute, and Sid Browne, who is a Professor at Columbia University. In the paper they make a strong case for adopting actuarial principles to the management of endowment funds. And, while the paper itself is quite technical and beyond the scope of this overview, the following is a summary of their main results.

The Browne and Milevsky paper argues that endowments funds should set *probabilistic criteria* to guide their asset allocation as well as spending policy. This approach is in contrast to the current *ad hoc* and vague policy of investing for long-term growth or spending a weighted average fraction of assets.

What is a probabilistic criteria?

The general idea has been part of the investment literature for many years and can be traced back to a paper by A.D. Roy in the early 1950’s which applied the concept to portfolio theory, even prior to the noted work of Harry Markowitz. More recently, TIAA-CREF’s Marti Leibowitz applied this idea to the field of pension funding and asset allocation in a series of academic papers and a 1996 book with Larry Bader and Stan Kogelman. The Milevsky and Browne (2003) paper uses technology originally developed by Browne (1997, 1999) to shed light and provide normative guidance to the management of endowment funds.

Normative models of asset allocation and consumption are usually specified in terms of utility functions, risk aversion, time horizons and preferences for a dollar today versus a dollar tomorrow. Naturally, these economic parameters are difficult to estimate or extract from individual investors, and are arguably of little value to a large endowment fund that should not have any pre-specified time preferences or economic risk aversion *per se*. In the words of the late James Tobin (AER, 1974) “The trustees of an endowed institution are the guardians of the future against the claims of the present. Their task is to preserve equity among generations. In formal terms, the trustees are supposed to have a zero subjective rate of time preference.”

In this spirit, a *probabilistic* framework for asset allocation and spending fixes an exogenous tolerance or probability level on various financial constraints and then sets policy so that these constrains are satisfied a given percentage of the time. Thus, for example, instead of picking between stocks and bonds to maximize end-of-period utility -- or selecting a portfolio of stocks to minimize the variance – the portfolio is constructed so that 95% of the time a certain goal is achieved. The benefit of this approach is two-fold. First, the economic risk of the portfolio can be explained in a more intuitive manner to a wide range of trusties who have little formal training in mathematics of portfolio theory, without resorting too much in the way of micro-economic parameters. Second, and more importantly, the concept can be applied to a wide variety of financial decisions.

Quite amusingly, the inspiration for the formal mathematics used by Browne and Milevsky were actually developed back in the 1960's by two very well-known statisticians Larry Dubins and John Savage in a classic book entitled: "How to Gamble If You Must?" Their book was based on the following premise. Imagine a gambler goes to a Casino with $5,000 in his pocket, and all he wants to do is maximize the probability of doubling his money by the end of the evening. In other words, the gambler has a financial goal that must reached within a certain time horizon. What is the optimal gambling strategy? Dubins and Savage humorously motivated their problem in terms of a habitual gambler whose bookie will kill him, unless he comes up with $10,000 by the end of the night. The gambler's objective, quite simply is to maximize the odds of doubling his money. To this gambler, anything less than double is equally insufficient, and anything more than double is equally unnecessary. Of course, the endowment business is very different and this kind of analogy can only be taken so far (managers are only fired, not killed, if they under-perform), but the mathematics in the problems are quite similar.

How is this concept applied to endowment fund management?

The Browne and Milevsky (2003) paper provides two case studies in which their probabilistic criteria can be applied to endowments. The first case revolves around locating a prudent spending strategy policy for an endowment assuming an exogenous asset mix, while the second case focuses on the asset allocation problem taking into account the stochastic (i.e. random) nature of future donations.

But first, here is some background on the formal variables influencing the management of endowment funds. Let the current market value of the endowment fund be denoted by the symbol $V(i)$. The value of the fund will change continuously, both as a result of fluctuations in the financial market, as well ongoing spending (negative) and donations and contributions (positive). The authors denote current spending by the fund using the symbol $S(i)$ and future donations to the endowment with the symbol $D(i)$.

In the language of actuarial modeling, the future behavior of all three critical variables $V(i)$, $S(i)$ and $D(i)$ are stochastic (i.e. random) and must be described using a formal probability distribution. Of course, it is important to note that the asset allocation underlying the fund and the magnitude of spending give the manager some degree of control over the evolution of the fund.

A fourth and final quantity of interest is the current inflation-adjusted value of all previous donations and contributions, which is denoted by $R(i)$. Very few endowment funds explicitly link their spending policy to the current value of $R(i)$, but this is actually one of the suggestions advocated in the paper. A crude example of this link would be that if $R(i) < V(i)$, i.e. the current value of the fund is higher than the inflation-adjusted contributions, the fund should spend 6% of assets. And, if *R(i)* > *V(i)* the fund should only spend 3% of assets.

In any event, a probabilistic management policy would be formulated as follows: *The objective of the endowment fund should be to maximize current spending S(i), subject to the probability constraint that a pre-specified financial goal be achieved at least (1-ε)% of the time.*

The pre-specified goal can take on a variety of flexible guises. The goal can be to retain the real value of contributions *R(T)* at some rolling horizon number of years *T*, or to avoid 'drawing down' to some fraction of the real value of contributions γR(*i*) over the life of the fund. For example, a fund might adopt as its objective to maximize current spending so that in 30 years the fund is worth more than its original real contributions with a 90% chance. Or, it could maximize a spending rate subject to a constraint that it *not* go bankrupt with a 99% chance. Much more on this later.

To see how this would impact endowment spending policies and asset allocation, let us review how spending is normally determined.

Endowment Spending Policies.

Many large endowment funds such as Stanford and Yale University implement a spending policy that can be formally represented as follows.

$$S_i = (1-\lambda)S_{i-1} + \lambda(cA_i)$$

The symbol *S(i)* denotes the real level of spending in year i, the symbol *S(i-1)* denotes the real level of spending in the previous year, the constant c is a fixed fraction and *A(i)* denotes the arithmetic average value of the fund during the previous 3-5 years. Finally, the coefficient λ determines the weighting attributed to previous spending versus the recent value of the fund. For example, a fund might decide to spend 40% of last years spending plus 60% of 5% of the average value of the fund during the last 3 years.

The problems with this type of approach are numerous. First, it leaves unresolved the question of how to determine the appropriate level of the constant c. Is 6% to high? Is 3% to low? And second, linking to the average value of the fund over extended periods of time tends to overspend in down-markets, such as the last few years and under-spend in up years. Clearly, this formula is *ad hoc* and provides little guidance or feedback based on the risk level of the fund. For example, should endowments with greater variability in returns spend less? Can they afford to spend more? Nevertheless, it appears to be the most popular way of fixing spending, and the value of λ ranges from 40% to 60% in practice.

In contrast to the above approach -- under a probabilistic actuarial criteria -- the spending policy would be formulated as follows:

$$S_i = (1-\lambda)S_{i-1} + \lambda V_i \max[GM - \frac{K + \ln[R_i / V_i]}{T}, 0]$$

Despite the initial similarities, there are four new variables in the spending policy compared to the generic version practiced by most endowments. First, the logarithm of R(i)/V(i) captures the real deficit between the original contributions and the current value of the fund. Second, the variable GM denotes the expected geometric mean real growth rate of the fund. (e.g. a number between 3% and 7%). The letter K denotes a prudence constant which is on the order of magnitude of 1, but can actually range in value from 0.5 to 1.5 depending on the probability criteria determined by the endowment trusties. Finally, the letter T denotes the time horizon by which the probability criteria must be satisfied. All else being equal, a larger expected growth rate for the fund will increase spending, a higher prudence constant will reduce spending, a higher value of the fund V(i) relative to the current value of contributions will increase spending and a longer time horizon will increase spending. The magnitude of the prudence constant K will determine the probability of achieving a particular investment goal, and vice versa, specifying the desired probability criteria will force the prudence constant.

The interested reader is referred to the actual paper by Browne and Milevsky (2003) for a formal derivation and justification of this rule. In practice, the proposal is a weighted average of two separate sub-rules. The first sub-rule corresponds to the policy of spending a fixed real dollar-valued amount, while the second sub-rule is related to a fraction of the current market value of the endowment.

Numerical Example

Assume that the prudence constant K=1, the fund is expected to earn a geometric mean of 5.5% over time and the desired time horizon is T=30 years. This value of K corresponds to a 20% tolerance level of falling short of the real value of the fund in 30 years.

Now, if the endowment uses a weighting factor of λ=1, and the original value of the fund was \$100 while the current value of the fund is \$80 for example, then the fund is exhibiting a deficit of 22.3% in real terms. Therefore, the real spending rule would imply:

$$S_i = \$80 \max[0.055 - \tfrac{1+0.223}{30}, 0] = \$1.138,$$

in real terms. If, however, the endowment were to adopt a λ=0.40 weighting, and assuming that the previous year's spending was \$4.32 per \$100 originally invested principal, the formula would result in:

$$S_i = (1-0.4)\$4.32 + (0.4)\$80 \max[0.055 - \frac{1+0.223}{30}.0] = \$3.047$$

Now back to the λ=1 case, if the terminal horizon were to increase to T=50 years from T=30 years, the real spending rule would be:

$$S_i = \$80 \max[0.055 - \tfrac{1+0.223}{50}, 0] = \$2.442 ,$$

which is obviously more than $1.138 because the terminal horizon -- which is the point at which the fund must recuperate -- has been extended.

Motivated by the notion of actuarial smoothing for pension funds, the formula is amortizing any losses over an extended period of time, and spending investment gains -- above and beyond the geometric mean return -- over the same period. This, *de facto*, creates a reserve within the endowment fund which is then used to subsidize losses in bad periods.

Finally, if the terminal horizon is reduced to T=15 years, and λ=1, the real spending rule would be computed via:

$$S_i = \$80 \max[0.055 - \tfrac{1+0.223}{15}, 0] = \$0 ,$$

and the spending would be reduced to zero. This is because the fund can not afford to spend, and still achieve the financial objective within 15 years with a reasonable probability. Of course, using the weighted average version of the spending rule, by assuming that λ=0.40 for example, then only 40% weight would be placed on the above-mentioned zero spending, and the other 60% would be determined by the previous year's consumption

Finally, in the other direction, if the fund were to achieve a real value of 130 at time period *i*, the deficit/surplus value would be ln[100/130]= -0.262, which implies that the fund could afford to lose 26.2% and still retain real value. Naturally, it also implies the fund can afford to spend more in this period, and one obtains:

$$S_i = \$130 \max[0.055 - \tfrac{1+0.262}{30}, 0] = \$3.952$$

in real terms, when the terminal horizon is T=30 years and λ=1.

Some additional comparative statics from the model are as follows. When the endowment funds has a truly infinite horizon, the spending policy under a λ=1 weighting collapses to a product of the expected geometric mean and the current fund value. In the earlier GM=0.055 case, this would imply spending 5.5% of the fund value in each and every year. Note that under a finite horizon, real spending is usually constrained to be less than 5.5% of fund value. More on this later.

Table #2 traces the real and nominal fund value over the next (simulated) ten year period to illustrate how the realized rates of return would impact the spending policy. The (critical) parameters underlying the analysis is a 30-year investment horizon and a

25% shortfall tolerance level. Note that increasing either of these variable would act to increase spending, while decreasing them would reduce spending as per the relationship in the above equation.

For example, at the end of 2003 the endowment earns a real return of 1.6% whichj translated into a real value of $101.59 and a deficit of -1.6% relative to real value. (The deficit is negative since the fund is in a surplus position relative to the original contribution.) Thus, spending is $3.562 per original investment of $100. This policy will create a 20% chance of shortfall or a 75% of retaining real value after 30 years. But then, in the year 2007 the fund earns a -28.3% return which drives the real value of the fund to $61.75, per original investment of $100. The real deficit is 48.2% which translates into a spending of only $1.140 of assets. Next year the fund recovers to a real value of $70.14 and the spending is increased to $1.593 per $100 dollars.

Table #2: Endowment Management Under an Actuarial Approach
Year-by-Year Example of Spending Policy

Year	Real Return	Inflation Rate	Nominal Fund	Real Fund	Deficit	Real Spending
2003	1.6%	5.49%	$107.16	$101.59	-1.6%	$3.562
2004	9.7%	3.36%	$117.24	$107.52	-7.3%	$3.973
2005	9.3%	3.41%	$127.60	$113.17	-12.4%	$4.375
2006	-18.4%	8.80%	$108.92	$88.78	11.9%	$2.714
2007	-28.3%	12.20%	$84.99	$61.75	48.2%	$1.140
2008	15.7%	7.01%	$103.31	$70.14	35.5%	$1.593
2009	14.3%	4.81%	$120.97	$78.36	24.4%	$2.069
2010	-11.3%	6.77%	$111.55	$67.68	39.0%	$1.456
2011	-5.3%	9.03%	$112.69	$62.70	46.7%	$1.190
2012	-2.8%	13.31%	$121.71	$59.77	51.5%	$1.039

Note: Assuming the endowment fund starts at $100 in year 2003, and places a 100% weight on preservation of real value after 30 years, with a shortfall tolerance of 25%

Table #3 provides a summary of the result by directly linking the current value of the endowment fund -- relative to the real value of contributions – to the optimal spending policy. The following stylized facts emerge. First, the lower the tolerance for shortfall (in this case, retaining real value over time) the lower the spending rate. In fact, when the mark-to-market value of the fund is 70% of the original contributions, the spending is completely shut-off since there is a high probability the mandate of retaining real value will not be achieved. In contrast, when the fund is worth a 130% of the original real value, the fund can afford to spend 1.69% of assets in any given year with a 1% tolerance level, and 6.28% of assets with a 49% tolerance level. Intuitively, the less the fund is worth relative to original contributions and the lower the tolerance for shortfall, the lower the spending rate of the fund.

Table #3 can also be inverted to see the implications of following a particular spending policy over time. For example, when the fund is close to fair value – i.e. the fund is worth its accumulated contributions – then a 5.41% spending policy will only create a 51% of retaining real value in 30 years, which is a 49% shortfall rate. Indeed, the spending would have to be reduced to 3.03% of current fund assets to generate a 75% chance of retaining real value at a 30 year horizon.

It is quite sobering to learn that most endowment funds that are spending more than 5.5% of assets have less than a 50% chance of retaining real value over a 30 year horizon.

Table #3: Endowment Management Under an Actuarial Approach
The Optimal Current Spending Rate When….

Probability (ε) Tolerance	**Ratio of Fund Value *V(i)* to Inflation-adjusted Contributions *R(i)***			
	70%	***100%***	***110%***	***130%***
10%	0%	0.82%	0.82%	1.69%
25%	1.84%	3.03%	3.03%	3.91%
49%	4.20%	5.41%	5.72%	6.28%

Assuming expected growth of 5.5% real with 20% annual volatility.

Asset Allocation Decisions

The above-mentioned spending decision is but one example of how this kind of thinking can be applied to endowment fund management. Another example revolves around the question of future donations and their correlation with future investment returns. The underlying idea in this particular application is that future (stochastic) donations can be treated as a *shadow asset* class with their own risk and return properties. In other words, they can be relied upon to provide investment diversification. Endowments whose future donation flow is more stable, can allow themselves to take greater investment risk, and vice versa.

Table #4: Endowment Management Under an Actuarial Approach
Spending Depending on Correlation Between Donations and Investment Returns

Probability (ε) Tolerance	**Assumed Correlation**	**Net Spending Rate**	**Allocation to Stock Market**
5%	0%	2.9%	77%
5%	-25%	4.9%	78%
5%	25%	1.7%	76%
10%	0%	3.8%	100%
1%	0%	1.9%	50%
20%	0%	5.4%	143%

Assuming expected growth of 5.5% real with 20% annual volatility.

Table #4, which is reproduced from the Browne and Milevsky (2003) paper provides us with a variety of interesting insights about the implications of using an actuarial approach that links donations to future investment returns.

For example, if the endowment manager is willing to tolerate a 5% probability of ruin, then the optimal spending rate when future donations are uncorrelated with future investment returns is 2.9%. However, if donations exhibit a negative correlation with future investment returns, the fund can afford a higher 4.9% spending rate since the total asset allocation – both shadow and financial assets – have a lower volatility compared to the case where correlation is zero.

Likewise, Table #4 illustrates the relationship between a probability tolerance level and the actual asset allocation of the endowment fund. The lower the tolerance for shortfall (ruin in this case) the lower the optimal allocation to risky equity and the stock market. And, if the endowment is willing to tolerate a 20% chance of ruin, then the optimal allocation to risky equity exceeds 100%, which implies a certain amount of leverage.

Once again, by formulating the objectives of the endowment fund in terms of probability values and the odds of achieving certain long-term goals, the optimal asset allocation and spending policies form part of the solution set.

What else has been written on this topic?

In a 1974 special issue of the *American Economic Review*, Eisner (1974), Litvack, Malkiel and Quandt (1974), Nichols (1974) and Tobin (1974) debated whether University endowment managers were too conservative in their spending policy. Eisner (1974) felt that university administrators were encouraging investments in growth stocks, but on the other hand were only spending dividends and interest. Thus, he argued, the value of the endowment portfolio continued to grow, but the spending was limited to cash distributions. The debate centered around whether the real (after inflation) spending rate should be 5% - 6% of assets, or closer to the 3%-4% practiced by most of the educational institutions at which these academics were employed.

Litvack, Malkiel and Quandt (1974) discussed Princeton's historical spending policy and recommended a higher rate. Tobin (1974), disagreed as evident by the earlier quote. A further criticism of endowment spending was levied by Hansmann (1990), when he stated that: "prevailing endowment spending rules seem inconsistent with most reasonable objectives".

From a practitioner perspective, there have been a variety of reports that survey University endowment managers to determine their asset allocation and spending patterns. Some of these, such as Coiner (1990, 1992), Ennis and Williamson (1976), Williamson (1974, 1997) advocate a formal asset allocation and/or spending decision, but from a point of view quite different from the Milevsky and Browne (2003) model.

In the annual NACUBO survey -- which is a study conducted by TIAA-CREF analyzing 553 university endowment funds -- reveals a very heterogeneous approach to spending and asset allocation. Further to Table #1, amongst the largest 25 University endowments -- with assets from $1 billion to $25 billion -- the allocation to equity-based investments ranged from a low of 65% to a high of 90%.

Dybvig (1995, 1999) advocates a portfolio investment strategy that is meant to *protect* spending and prevent it from ever decreasing. This idea originates with the work by Black and Perold (1992), who developed the notion of constant portfolio insurance in a continuous-time setting. Despite the apparent similarity between the current Browne and Milevsky (2003) framework, Dybvig (1999) does not explicitly consider future contribution dynamics and their impact on spending policies as well as asset allocation. More importantly, his objective function is quite different from an actuarial probability approach.

Merton (1993) explicitly models the evolution of future donations, but falls short of calibrating his model, or, for that matter, providing any practical examples of optimal asset mixes. Merton (1993) does, however, make a number of general policy suggestions that resonate with earlier results.

Along similar lines, Grinold, Hopkins and Massy (1978) provided a linear control model for developing optimal strategies that stabilize budget growth by placing limits on the ratio of annual spending to the market value of the endowment. They calibrate their model to Stanford University's endowment and then derive various risk and return profiles.

In sum.

While no mathematical model can and should be trusted as a black box to drive real world decisions, the Browne and Milevsky (2003) paper provides insight into the endowment management process, even for those who have no intention of abandoning their current approach. They can be summarized as follows:

(1) Future donations must be treated as a *shadow asset* class in all investment decisions, akin to the inclusion of human capital within the context of personal asset allocation and retirement planning. Thus, although it would be anathema to suggest that future donations be spent before they are actually pledged or received by the endowment, they can still be relied upon to provide future diversification. Thus, for example, two different endowments of equal size might justifiably have completely different asset allocations if one’s future donations are highly correlated with the performance of the high tech industry (e.g. Stanford) while the other depends on the fortunes of the oil market (e.g. University of Texas.) Indeed this idea is not new, and Merton (1993) advocates endowments should undertake investment positions that actually hedge future operating costs of the University, such as faculty salaries. Thus, for example they might want to invest in local residential real estate so they could

provide wages indexed to a local standard of living, and thus remain competitive with other universities that might be located in cheaper cities.

(2) Spending and asset allocation decisions should form part of the solution set, and not the problem set. While this might initially sound like a cliché, trusties and managers should start by formulating broader mandates that weight current spending against preservation of fund value. They have to realize that these are competing objectives that create a perpetual internal tension. Once the decision makers have settled on the spending/preservation weighting, they can then 'solve' for the asset allocation and spending rate that satisfies those objectives. In other words, it is misguided to start the process by asking "what is a prudent spending rate?" Rather, a spending rate should fall out of the larger objectives themselves. While the need for a bigger picture might seem intuitive, it is actually at odds with how many spending rules are formulated in practice.

(3) Not withstanding the above discussion, the numerical results indicate that spending must be set substantially lower than the long-term growth rate of the portfolio, in order to produce an acceptable probability of preserving real value of the original donations. As a very crude rule of thumb, the spending rate must be set at 200 basis points lower than the expected growth rate of the fund itself in order to secure a less than 20% chance of having a negative real return after 20 years. Thus, if a fund is expected to grow by 6% in real terms -- a generous equity premium in today's environment -- spending should be set at less than 4% of *current assets*. Yet, 4% is the low-end of the spectrum amongst NACUBO's peer group.

(4) It seems the divergence in practice is much wider in the Endowment management business compared to the pension business. Some of the larger University endowment funds, such as Harvard for example, are managed virtually like a large hedge fund, while others have a 100% exposure to traded equity. The research undertaken in this paper calls out for establishing a broader set of best practices in the field.

Cited References and other related research:

Adams, R.H. (1977), "Endowment Funds are a Distinct Case," The Journal of Portfolio Management, Vol. 3(2), Winter, pg. 37-45.

Bader, L., S. Kogelman and M. Liebowitz (1996), Return Targets and Shortfall Risk, New York.

Basch, D.L. (1999), "Changes in the Endowment Spending of Private Colleges in the Early 1990s," Journal of Higher Education, Vol. 70(3), pg. 278-292.

Black, F. and A. Perold (1992), "Theory of Constant Proportions Portfolio Insurance," Journal of Economic Dynamics and Control, Vol. 16(3), pg. 403-426.

Browne, S. (1997), "Survival and Growth with Liabilities: Optimal Portfolio Strategies in Continuous Time," Mathematics of Operations Research, Vol. 22(2), pg. 468-493.

Browne, S. (1999), "The Risk and Rewards of Minimizing Shortfall Probability," Journal of Portfolio Management, Vol. 25(4), pg. 76-85.

Browne, S. (2000), "Risk Constrained Dynamic Active Portfolio Management", Mangement Science, Vol. 46(9), pg. 100-110.

Browne, S. and M. Milevsky (2003), “An Actuarial Approach to Endowment Asset Allocation and Spending Policies”, to be submitted.

Coiner, H.M. (1990), "The Lognormality of University Endowment in the Far Future and Its Implications," Economics of Education Review, Vol. 9(2), pg. 157-161.

Coiner, H.M. (1992), "How Large a Fraction on University Endowment May Be Safely Spent?", Journal of Higher Education Management, Vol 8(1), pg. 57-67.

Dunn, J.A. (1991), "How Colleges Should Handle Their Endowment", Planning for Higher Education, Vol. 19(3), pg. 32-37.

Dybvig, P.H. (1999), "Using Asset Allocation to Protect Spending", Financial Analysts Journal, January/February, pg. 49-62.

Eisner, R. (1974), "Endowment Income, Capital Gains and Inflation Accounting: Discussion," American Economic Review, Vol. 64 (May), pg. 438-41

Ennis, R. and J. P. Williamson (1976). "Spending Policy for Educational Endowments," Research and Publication Project at The Common Fund (January).

Ford Foundation Adviesory Committee on Endowment Management (1969, 1972), Managing Educational Endowments, New York City.

Grinold, R., D. Hopkins, and W. Massy (1978), "A Model for Long-Range University Budget Planning Under Uncertainty," The Bell Journal of Economics, 9 (Autumn): pg. 396-420

Hansmann, H. (1990), "Why Do Universities Have Endowments?" Journal of Legal Studies, Vol. 19 (January), pg. 3-42.

Klinger, D. (2001), "Preliminary Results of the 2000 NACUBO Endowment Study," NACUBO Business Officer, April 2001, pg. 24-31.

Liebowitz, M. and S. Kogelman (1991), "Asset Allocation under Shortfall Constraints", Journal of Portfolio Management, Vol. 17, 18-23.

Litvack, J., B. Malkiel, and R. Quandt (1974), "A Plan for the Definition of Endowment Income," American Economic Review, Vol. 64 (May): 433-42

Merton, R.C. (1993), "Optimal Investment Strategies for University Endowment Funds," in Studies of Supply and Demand in Higher Education, ed. C. T. Clotfelter and M. Rothschild, University of Chicago Press.

Merton, R.C. (1971), "Optimum Consumption and Portfolio Rules in a Continuous Time Model," Journal of Economic Theory, Vol. 3, pg. 373-413.

Nichols, D. (1974), "The Investment Income Formula of the American Economic Association," American Economic Review, Vol. 64 (May), pg. 420-6.

Oster, S.M. (2001), "The Effect of University Endowment Growth on Giving: Is There Evidence of Crowding Out?", Financing Higher Education Institutions in the 21st Century, Cornell Research Conference, May 2001.

Roy, A.D. (1952), "Safety First and the Holding of Assets," Econometrica, Vol. 21(1), pg. 431-449.

Spitz, W.T. (2001), "Challenging the Conventional Wisdom on Endowment Risk", NACUBO Business Officer, March 2001, pg. 31-33.

Tharp, C. (1997), "Growing the Endowment in a High-Risk Environment," Planning for Higher Education, Vol. 25, pg. 1-8.

Tobin, J. (1974), "What is Permanent Endowment Income?" American Economic Review, Vol. 64 (May), pg. 427-432

Williamson, J.P. (1974), "Endowment Funds: Income, Growth and Total Return," The Journal of Portfolio Management, Vol. 1(1), Fall, pg 74-79.

Williamson, J.P. (1997), "Should Endowment Funds Invest for Yield?", Journal of Portfolio Management, Vol. 3(2), pg. 37-45.