

**THE DIVESTMENT PENALTY:
ESTIMATING THE COSTS OF FOSSIL FUEL DIVESTMENT
TO SELECT UNIVERSITY ENDOWMENTS**

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I. BACKGROUND AND SUMMARY

1. In recent years, certain groups concerned with the potential effects of global climate change have urged colleges and universities to divest from securities associated with companies that explore for, produce, market and/or exploit fossil fuels. While a few universities have divested (either in whole or in part), most others have chosen not to do so and many have noted that divestment is likely to have little impact (financial or otherwise) on fossil fuel companies, while creating the potential for endowment shortfalls due to a lack of investment diversification and other costs.²

1. My credentials are described in Appendix A. I have been assisted in preparing this report by members of Compass Lexecon's professional staff. This study has been commissioned and financed by the Independent Petroleum Association of America (IPAA).

2. See, e.g., Andrew Karas (2013) "Swarthmore Pegs Cost of Divestment at \$200 Million Over 10 Years," *Swarthmore Daily Gazette* May 9, 2013, <http://daily.swarthmore.edu/?p=20404>, ("The estimate ... hinges on the argument that fund managers will refuse to select investments based on a particular client's company-by-company preferences. Dropping these fund managers, the College's endowment would have to be invested in special fossil fuel-free index funds, which are predicted to perform \$200 million worse over the next ten years than the College's current investments.") See also Jenna Butz (2014) "UT Rejects Proposal for Fossil Fuel Divestment," *The Daily Beacon* [University of Tennessee], January 23, 2014, <http://dailybeacon.webfactional.com/news/2014/jan/23/ut-rejects-proposal-fossil-fuel-divestment/>, (quoting letter from Board of Trustees stating, "Last year, 90 percent of the endowment's payout went to supportive scholarships, instruction, and research. Eliminating a broad segment of the market from investment could hinder future funding of these endeavors.") See also Jeffrey A. Sine (2014) "Memorandum re: Fall 2014 Board of Trustees Meeting -- Sustainability & Fossil Free Discussion and Decision," American University, November 21, 2014, <http://www.american.edu/trustees/Announcement-November-21-2014.cfm>, ("The committee asked the university's investment advisors, Cambridge Associates, to review how divestment from the Carbon 200 would impact risk adjusted investment returns. The Cambridge advisors could not provide assurance that divestment was unlikely to have an adverse effect. Moreover, divesting from these companies would require that AU investments be withdrawn from index funds and commingled funds in favor of more actively managed funds. Cambridge has estimated this withdrawal would cause manager fees to double, increasing from \$1.1 million to \$2.2 million per year.") See also Cheryl R. Holland (2013), Letter from Bryn Mawr Board of Trustees, August 2013, http://news.brynmawr.edu/files/2013/08/August_27_2013BMCDivest-1.pdf, ("While divestment would hurt the College financially, we don't believe it would have any impact on the companies targeted by your proposal.")

2. A recent study by my colleagues at Compass Lexecon examined, among other issues, the costs to investors from fossil fuel divestment.³ Based on a 50-year history of returns, that study concluded that the reduction in diversification associated with excluding energy securities from an average equity investor's portfolio would generate shortfalls of 50 basis points per year on a risk-adjusted basis, or 70 basis points per year on a gross basis.⁴ Over a 50-year time frame, the value of a divested portfolio would be 23 percent lower than a non-divested portfolio.⁵ These costs of reduced diversification are in addition to other costs of divestment, such as transaction costs associated with selling and buying securities and the costs of compliance with fossil fuel divestiture goals, both of which are often material as well.

3. Basic financial economics principles indicate that excluding classes of securities from an investment portfolio – particularly major classes like energy sector securities – will always reduce diversification and hence, generate at least some expected shortfall (on a risk-adjusted basis) relative to a portfolio without these exclusions (in addition to the transaction and compliance costs of divestment).⁶ The Compass Lexecon study discussed above estimated the costs for an equity investor who held the “market portfolio,” *i.e.*, the average equity investor in the market.⁷ But the magnitude of the shortfall experienced by a particular investor will depend on the particular types of securities held in the investor's portfolio before divesting.

4. In this study, I provide more tailored estimates of the costs of divestment for five prestigious American universities with large endowments: Columbia University, Harvard University, the Massachusetts Institute of Technology, New York University, and Yale

3. Daniel R. Fischel (2015) “Fossil Fuel Divestment: A Costly and Ineffective Investment Strategy,” Compass Lexecon, http://divestmentfacts.com/pdf/Fischel_Report.pdf.

4. *Id.*, at ¶¶22 & 24.

5. *Id.*, at ¶24.

6. Zvi Bodie, Alex Kane, and Alan J. Marcus (2014) *Investments, Tenth Edition*, McGraw-Hill Irwin, at p. 206.

7. Fischel (2015), *op. cit.*, at ¶18.

University. All five rank among the top 30 U.S. schools in total endowment assets and I understand all have also been targeted recently by divestment advocates.⁸

5. Universities do not generally provide the full details of all holdings in their endowments. To account for this, I proxy for the holdings of these five universities based on available information in the published reports of their endowments. These reports indicate that the endowments for these universities are currently allocated in up to seven broad asset classes, and cash. I proxy for the seven asset classes using the three largest mutual funds (or market indexes) in the U.S. in each asset class. I weight the asset classes according to available information from these universities regarding their actual or target allocations. Based on the specific mutual fund selected in each class, I am able to construct 2,187 portfolios for each university, which can serve as reasonable proxies for their actual endowment funds.

6. I calculate the average annual returns from each of these proxy portfolios over the past 20 years, and also calculate the average annual returns of a set of identical portfolios stripped of fossil fuel securities. I then compare the average risk-adjusted annual returns of each proxy portfolio with its corresponding divested portfolio in order to estimate the impact of divestment on a university's expected investment returns.

7. Consistent with basic financial economic principles, divestment almost always generates long-term investment shortfalls due to reduced diversification, and the shortfalls are typically substantial, given the size and importance of the energy sector being divested. Using a weighted average across the five universities, fully 91 percent of these proxy portfolios produce a risk-adjusted divestment penalty over the past 20 years that would generate a shortfall for the

8. National Association of College and University Business Officers (2015) "U.S. and Canadian Institutions Listed by Fiscal Year (FY) 2014 Endowment Market Value and Change in Endowment Market Value from FY2013 to FY2014 (Revised February 2015)," http://www.nacubo.org/Documents/EndowmentFiles/2014_Endowment_Market_Values_Revised2.27.15.pdf [Accessed August 3, 2015].

endowment fund. This indicates that, regardless of how successful my attempt to proxy for these schools' endowment holdings is, it is in any case very likely that the actual endowments would experience a shortfall due to divestment. Focusing on the five universities individually, the share of constructed portfolios for each university with a risk-adjusted shortfall is never less than 88 percent.

8. The mean risk-adjusted shortfall due to divestment for a weighted average across the five universities is approximately 0.23 percent per year, each year. This mean shortfall varies across the universities: 0.16 percent (Columbia), 0.30 percent (Harvard), 0.14 percent (MIT), 0.12 percent (NYU), and 0.21 percent (Yale). As applied to these schools' current endowments, shortfalls of this magnitude would translate to annual reductions in endowment value of \$14.43 million (Columbia), \$107.81 million (Harvard), \$17.75 million (MIT), \$4.16 million (NYU), and \$51.09 million (Yale). Therefore, these five schools alone stand to forfeit more than \$195 million in investment returns each year, without changing portfolio risk.

9. Since universities are typically long-term investors, it is appropriate to consider how annual shortfalls of the magnitude I estimate would aggregate to reduce a school's endowment value over time. Over a 50-year time frame, the mean shortfalls I calculate would reduce the size of an endowment by 12.07 percent for a weighted average across the five universities, and for individual universities, by 8.13 percent (Columbia), 15.94 percent (Harvard), 7.40 percent (MIT), 6.12 percent (NYU), and 11.27 percent (Yale).

10. On a gross (not risk-adjusted) basis, the mean annual shortfall due to divestment for a weighted average across universities is larger, 0.31 percent per year, and, for individual universities, the gross shortfalls are 0.24 percent (Columbia), 0.37 percent (Harvard), 0.19 percent (MIT), 0.17 percent (NYU), and 0.33 percent (Yale). Whether risk-adjusted or not,

reductions in investment returns of these magnitudes would likely have a meaningful impact on universities' ability to satisfy their institutional goals of research and education.

11. In Section II, I describe the methodology for selecting proxy portfolios and for estimating the cost of divestment. In Section III, I present the results of this methodology applied to actual data from the five universities and describe the potential effects of divestment. In Section IV, I respond to common objections regarding such calculations made by divestment activists.

II. METHODOLOGY

12. I first reviewed the most recently published endowment reports for each of the five universities.⁹ These reports do not provide information on specific holdings; however, they do provide information on the general asset classes in which endowment funds are held. I identified seven key asset classes (plus cash) that appear in these five universities' endowment reports, and these are indicated in Exhibit A.

13. For six of the seven asset classes, I identified the three largest (according to assets under management) existing mutual funds in the U.S. that focus on securities in that asset class. Because I am interested in observing the long-term returns from these funds, I restricted the set of proxy funds to those that have existed for at least 20 years (since March 1995).¹⁰ Each of the three funds in each of the six asset classes is reported in Exhibit A, along with summary statistics on the funds' excess returns (relative to three-month Treasuries) over the 1995 – 2015 period. I

9. The Trustees of Columbia University in the City of New York (2014) "Consolidated Financial Statements: June 30, 2014 and 2013"; Harvard Management Company, Inc. (2014) "September 2014 Annual Endowment Report: Message from the CEO"; Massachusetts Institute of Technology (2014) "Report of the Treasurer for the year ended June 30, 2014"; New York University (2014) "New York University Endowment Fund Summary"; Yale University, "The Yale Endowment: 2014".

10. Survivorship bias is unlikely to have a material effect on our results, since we focus on the *difference* between the returns of these proxy funds and the returns of otherwise-equivalent divested funds.

performed a similar search for proxies in the case of the “Absolute Return” asset class. Because this asset class is typically benchmarked to hedge fund returns, I used three major hedge fund indexes to proxy for returns, also reported in Exhibit A. Finally, for the “Cash and Cash Equivalents” category, I used a single proxy for returns, namely, 3-month U.S. Treasury Bills.

14. Morningstar provides periodic historical information on the detailed holdings of each of the three funds considered in each asset class. Because these funds are well-diversified, the number of different securities held over the 20-year period between 1995 and 2015 is very large. For each fund and at each date over the 20-year period between 1995 and 2015, I identified the subset of securities held by the fund that are associated with the coal, oil, and natural gas industries. These are the securities that I will remove to simulate the effect of divestment.

15. Coal, oil, and natural gas securities are identified by CUSIP information provided by Morningstar, linked to industry codes using standard securities databases.¹¹ Exhibit A reports the share of each fund that is identified with these industries. For the hedge fund indexes used to proxy for the “Absolute Returns” asset class, I assume no divestment; to the extent a university did divest from holdings in the Absolute Returns class, the actual impact of divestment may be larger than I estimate here.

16. Selecting one of three potential proxy funds for each of seven asset classes (plus one proxy for the “Cash and Cash Equivalents” class), there are 2,187 ($= 3^7$) ways to construct a portfolio that includes assets in each class. I constructed each of these portfolios and weighted

11. For each six-digit CUSIP (identifying a unique issuer for the security), I identified an SIC, GIC, or BIC code from the CRSP, Capital IQ, and Bloomberg databases. Energy industry SIC codes are 1200-1399, and 2900-2999. Energy industry GIC codes are 10000000-10999999. The Energy BIC code is 13, but not including subsector 1311. CUSIPs are available from Morningstar for 89 percent of holdings, and for such securities, I was able to identify industry information for 98 percent of equity securities and 97 percent of corporate bonds. CRSP 1962 US Stock and Indexes Database © 2015 The University of Chicago on behalf of its Center for Research in Security Prices (CRSP) at Chicago Booth.

the asset classes according to actual information from the five universities about their endowment allocations across asset classes. Harvard, MIT, and Yale provide detailed information about their asset allocation in each class.¹² Columbia and NYU also provide information, but in some cases, it is only at the level of broader asset classes (*e.g.*, the share of assets in “equities,” without any break-out between domestic and foreign equities). In such cases, I imputed the allocations within these broader classes based on the simple average of actual allocations at Harvard, MIT, and Yale. Exhibit B reports the asset allocation of each school across the eight asset classes.¹³

17. Thus, for each of the five universities, I have 2,187 portfolios, constructed with one proxy per asset class, and weighted across asset classes according to the proportions given in Exhibit B. I calculate average annual returns to each of these portfolios over March 1995 to March 2015, assuming a constant allocation across asset classes based on these weights (in other words, rebalancing the portfolio each year). I then calculate the average annual return over the same period for each portfolio, with coal, oil, and natural gas securities excluded (and with the portfolio value that would have been allocated to those securities re-allocated proportionally across all other assets in holdings).¹⁴

18. Given the annual returns for a portfolio and the returns of the corresponding divested portfolio, I calculate the gross difference in returns due to divestment. However, this

12. In the case of Harvard, only information on the university’s “Policy Portfolio” (*i.e.*, its target allocation) was provided.

13. The footnotes to Exhibit B indicate cases in which allocations were imputed within broad asset classes.

14. One could, of course, consider a wide range of alternative re-allocation approaches (including no re-allocation at all) which are beyond the scope of this study. Some divestment advocates may propose re-allocation to certain alternative energy securities. Since the alternative energy sector is much smaller than the conventional energy sector, this will typically involve substantially overweighting alternative energy in a portfolio, and consequently limiting the diversification potential for the portfolio. In any case, most or all of the major U.S. alternative energy securities have only existed for a few years, and so it is not possible to fully evaluate their risk-return profile and their effects on diversification based on historical evidence. Moreover, it is far from a simple task to clearly identify “green” securities, and attempts to do so may incur non-trivial compliance costs. *See* Fischel (2015) *op. cit.*, at ¶¶ 25-37.

gross calculation does not account for differences in risk between the two portfolios. To the extent that a university divests, but then adjusts its portfolio to maintain the previous level of risk, it is a *risk-adjusted* difference in return that is more relevant. To calculate a risk-adjusted measure, I first calculated the volatility of the excess returns of each portfolio and its corresponding divested portfolio (relative to a three-month Treasury Bill) over the 20-year period. I then re-allocated a portion of the divested portfolio to three-month Treasury Bills so that its volatility matches that of the non-divested portfolio (if the non-divested portfolio was more volatile, then this involved leveraging the divested portfolio by borrowing at the three month Treasury Bill rate). I then compared the returns of these two portfolios to estimate a risk-adjusted difference in returns due to divestment.

III. RESULTS

19. I applied the methodology described above to each university separately, as well as to a hypothetical endowment fund that encompasses all five universities (in other words, a weighted average across the five universities). For each university or the weighted average, I ranked the 2,187 constructed portfolios according to the calculated shortfall due to divestment, *i.e.*, the difference in gross or risk-adjusted average annual returns over 20 years. Exhibit C reports the mean and median shortfall across these 2,187 portfolios, as well as the 5th and 95th percentiles of shortfalls.

20. Positive numbers in Exhibit C indicate that a portfolio has a higher return than the corresponding divested portfolio, *i.e.*, there is a shortfall in returns due to divestment. Exhibit C shows that the vast majority of portfolios do have a shortfall. In the case of the weighted average across the five universities, 91 percent of the 2,187 portfolios have a risk-adjusted shortfall. On this basis, one can conclude that divestment is very likely to generate a shortfall for these

universities, despite the fact that we cannot observe their precise holdings. The share of the portfolios that have a risk-adjusted shortfall due to divestment varies from a low of 89 percent (Columbia, Yale) to a high of 96 percent (Harvard, MIT).

21. As reported in Exhibit C, the mean divested portfolio for the weighted average across the five universities has a 0.23 percent lower risk-adjusted return than the otherwise-equivalent non-divested portfolio. This mean shortfall varies across the universities: 0.16 percent (Columbia), 0.30 percent (Harvard), 0.14 percent (MIT), 0.12 percent (NYU), and 0.21 percent (Yale).

22. On a gross (not risk-adjusted) basis, Exhibit C indicates that the mean divestment penalty is even larger, 0.31 percent per year, for the weighted average across schools. Moreover, every single one (100 percent) of the 2,187 divested portfolios underperforms the otherwise-equivalent non-divested portfolio, both in the weighted average across universities and for each university individually. The mean gross shortfall for each university is 0.24 percent (Columbia), 0.37 percent (Harvard), 0.19 percent (MIT), 0.17 percent (NYU), and 0.33 percent (Yale).

23. Exhibit C also translates the mean estimated differences in annual returns into aggregated 20-year and 50-year declines in endowment fund value. Over a 50-year period, the mean annual risk-adjusted decline in returns of approximately 0.23 percent for a weighted average across the five universities would aggregate to reduce the value of an endowment by 12.07 percent. On a university-specific basis, the mean estimated shortfall would generate a reduction in the endowment value over 50 years of 8.13 percent (Columbia), 15.94 percent (Harvard), 7.40 percent (MIT), 6.12 percent (NYU), and 11.27 percent (Yale).

24. In order to provide a sense of the potential for actual reductions in endowment returns, Exhibit C also applies the mean estimated shortfall to the current value of the university's endowment. For instance, if Columbia suffered its mean 0.16 percent risk-adjusted

shortfall due to divestment, that would translate to a \$14.43 million reduction in the value of the endowment this year. Of course, there would be, on average, additional losses expected in every year, which would be larger than \$14.43 million if Columbia's endowment grew, as Columbia undoubtedly expects. Exhibit C indicates similar first-year expected shortfalls for other universities: \$107.81 million (Harvard), \$17.75 million (MIT), \$4.16 million (NYU), and \$51.09 million (Yale).

25. Sizeable declines in the endowment fund like those indicated in Exhibit C would likely have material impacts on a university's ability to achieve its institutional goals.

Specifically, endowments fund a material share of the operating budget for all five universities, and reductions in returns specifically harm key institutional objectives, such as funding research and student support, as illustrated in the following facts:

- *Columbia*. "The current endowment spending rule is based on two factors: first, the market value multiplied by a 5 percent target spending rate, which provides a response to market conditions; and second, the prior year's spending plus inflation, which ties spending increases to operating needs and cushions spending against market volatility ... In addition to the base spending rate described above, two additional payout components were approved as temporary measures by the Trustees in 2008. The first is an increase in annual spending of up to 1.75 percent of the prior year beginning market value of endowments that are designated for undergraduate financial aid support ... The second component is 0.70 percent of the prior year beginning market value for certain endowments in categories key to the University's current development efforts, primarily unrestricted endowment and endowments for financial aid and faculty support."¹⁵
- *Harvard*. "Over the last four decades, [Harvard Management Company] has delivered \$23.2 billion in distributions to the University. The proportion of the University's annual operating budget that is funded through endowment distributions has grown considerably over the years, now accounting for approximately 35%. This source of funding, which must be both reliable and growing, is increasingly important as the University faces decreasing federal research support and increasing economic pressures."¹⁶

15. Columbia University, "Notes to the Consolidated Financial Statements," *op. cit.*, at 23-24.

16. Harvard University, "Annual Endowment Report," *op. cit.*, at 3.

- *MIT*. “The positive operating performance has made it possible for the Institute to boldly pursue its mission and continue to invest in campus infrastructure to enable the work of MIT’s preeminent faculty, outstanding students, and future generations of learners on campus and beyond.”¹⁷ Support from investments generates 20 percent of operating revenues at MIT.¹⁸
- *NYU*. “NYU’s Endowment Fund provides a permanent source of capital and support to the University’s mission and programs ... Total distributions from the endowment represent approximately 4% of the annual operating budget.”¹⁹
- *Yale*. “Yale’s spending and investment policies provide substantial levels of cash flow to the operating budget for current scholars while preserving Endowment purchasing power for future generations.”²⁰ In particular, the endowment provided 33 percent of Yale’s operating income in 2014, including professorships, student scholarships, maintenance, and books.²¹

26. Of course, an endowment fund faced with a shortfall due to divestment could allocate additional funds to the operating budget in order to keep critical accounts like research and student support funded at current levels, but this would require the endowment fund to reduce its allocation to other activities and/or require reductions in the principal of the fund, leading to lower long-term investment returns.

27. A conclusion that a reduction in investment returns would have a harmful effect on the university is consistent with the general academic literature on university endowment funds, which finds that negative endowment returns lead to substantially lower payouts to fund university operations. One recent study concluded that “a 10 percent negative endowment return is associated with an 8.2 percent reduction in payouts.”²² The same study further found that “[a] negative endowment shock equivalent to 10 percent of a university’s budget leads to a 4.9

17. MIT, “Report of the Treasurer,” *op. cit.*, at 1.

18. *Id.*, at 4.

19. New York University Investments Office, “Frequently Asked Questions,” <http://www.nyu.edu/about/leadership-university-administration/office-of-the-president/office-of-the-executivevicepresident/finance-and-budget/investment-office.html> [accessed July 23, 2015].

20. Yale University, “The Yale Endowment: 2014,” *op. cit.*, at p. 2.

21. *Id.*, at p. 3.

22. Jeffrey R. Brown, Stephen G. Dimmock, Jun-Koo Kang, & Scott J. Weisbenner (2014) “How University Endowments Respond to Financial Market Shocks: Evidence and Implications,” *American Economic Review* 104(3):931-62, at 949.

percent reduction in the number of tenure-system faculty during the following year ... In addition to reducing tenure-system faculty, universities react to negative shocks by also cutting support employees (e.g., secretaries) and to some extent maintenance employees.”²³

28. Therefore, based on either the actual historical patterns of funding by these universities or the academic literature, it seems clear that a reduction in endowment fund returns as a consequence of divestment would have material impacts on an endowment’s ability to fund a university’s key institutional goals.

IV. RESPONSES TO COMMON OBJECTIONS

29. My analysis of the impact of divestment is based on the historical evidence of the last 20 years. Some divestment advocates argue that the future of the coal, oil, and gas sectors is not as bright as it has been in the past due to regulations or other market changes that will cause these firms to “strand” certain assets or otherwise experience lower profitability. I have no specific view about the likelihood of such outcomes, but as a criticism of my study, such speculation misses the point. My calculations of the declines in risk-adjusted returns depend on the historical ability of securities in the oil, gas, and coal sectors to hedge other securities. They do not depend critically on any claim that absolute returns in these sectors will be as high as they have been in the past.

30. In any case, it seems far from clear that, even as a speculative investment, oil, gas, and coal securities collectively are likely to be poor investments. First of all, even if the divestment advocates are correct that regulatory or market pressure on these firms will increase, it is very often the case that new regulations make the incumbent firms in an industry *more*

23. *Id.*, at 933-34.

profitable, not less so. This is because, even though compliance with regulations is costly, it also can serve to restrict entry and limit competition.²⁴ Moreover, firms can and do respond to regulations and changes in the market to maintain profitability, particularly when those regulations or changes are known well in advance, as divestment advocates claim they are.

31. In any case, if reductions in profits are in fact as likely as divestment advocates claim, that fact should already be incorporated into lower current security prices, so that future investment performance would not be improved by selling these securities.

32. Divestment advocates also claim that, whatever the costs of divestment, they are outweighed by the potential benefits of inducing changes at the companies in question that limit the effects of climate change. In fact, whereas divestiture has clear costs to the university communities, as I have demonstrated, it is very unclear there are any such benefits. Due to the plasticity of the capital markets and the diversity of investors worldwide, basic financial economic theory indicates that it is unlikely the divestiture movement, with or without any specific university's participation, will have any material effect on the cost of capital of the divested companies or any other relevant outcome. The history of prior divestment campaigns is consistent with this basic theory.²⁵

33. But what if divestment did somehow manage to put capital market pressure on the targeted companies? When a company faces an increase in its cost of capital, the response is to forego investment in marginal projects. At major energy companies, those marginal projects are unlikely to involve the bread-and-butter business of producing carbon-based fuels. Instead, what

24. A classic citation in a large literature is George J. Stigler (1971) "The Theory of Economic Regulation," *Bell Journal of Economics and Management Science* 3-21. These conclusions have found their way into standard textbooks as well. See, e.g., Dennis W. Carlton and Jeffrey M. Perloff (2005) *Modern Industrial Organization* (4th Ed.), Pearson Addison Wesley, at 687-91.

25. See Fischel (2015), *op. cit.*, at pp. 19 – 22 (summarizing the literature on South African and other divestment campaigns).

is more likely to be cut is research and development into more speculative investments, such as those involving alternative energy. In this way, divestment advocates might actually accomplish exactly the opposite of what they hope to achieve.

34. Some divestment advocates claim that, if prominent institutions like these universities divest, it will “send a message” to other market participants or governments that somehow spurs favorable action on climate change issues. Exactly how this would occur is unclear, and divestment advocates have not shown that divestment would not instead serve to polarize public debate further, nor have they shown that the market has reacted to past divestment announcements in ways they consider favorable to their goals.

35. Finally, from an economic perspective, the problem of climate change is ultimately based on a concern that the prices of carbon-based fuels are too low because they fail to reflect the full social costs of burning hydrocarbons, which includes the harms of extreme climate change. It is clearly beyond the scope of this research to summarize the debate about the appropriate price of carbon-based fuels, but assume, hypothetically, that the appropriate price is, in fact, much higher than the current market price. There is a broad consensus among economists that the appropriate response to such a problem is a tax on burning carbon (known as a “Pigouvian tax”).²⁶ I understand that some large energy companies themselves support a carbon tax.²⁷ Policy advocacy along such lines would be far more fruitful than divestment, which as I have demonstrated, has substantial costs and only vague, highly speculative benefits.

26. IGM Experts Panel (2011) “Carbon Tax,” University of Chicago Booth School of Business, http://www.igmchicago.org/igm-economic-experts-panel/poll-results?SurveyID=SV_9Rezb430SESUA4Y [accessed July 12, 2015].

27. “Even Big Oil Wants a Carbon Tax,” BloombergView, June 1, 2015. <http://www.bloombergview.com/articles/2015-06-01/even-big-oil-wants-a-carbon-tax> [accessed Aug. 18, 2015].

APPENDIX A: KEY QUALIFICATIONS OF BRADFORD CORNELL

1. I am currently a Visiting Professor of Financial Economics at the California Institute of Technology (“Caltech”). Previously, I was a Professor of Finance and Director of the Bank of America Research Center at the Anderson Graduate School of Management at the University of California, Los Angeles for 26 years.

2. I earned a master’s degree in Statistics from Stanford University in 1974 and earned my doctorate in Financial Economics from Stanford in 1975. I have served as an editor of numerous journals relating to business and finance and have written more than 100 articles and two books on finance and securities, including *Corporate Valuation: Tools for Effective Appraisal and Decision Making* (1993), published by McGraw-Hill, and *The Equity Risk Premium and the Long-Run Future of the Stock Market* (1999), published by John Wiley & Sons. To complement my academic writing, I have also authored articles for *The Wall Street Journal* and the *Los Angeles Times*.

3. My research has been widely recognized. In 1988, I was cited by the Financial Management Association as one of the ten most prolific authors in the field of finance. I have received prizes and grants for my research from the Chicago Board of Trade, the Chicago Mercantile Exchange, and the Institute for Quantitative Research in Finance. My article, “Corporate Stakeholders and Corporate Finance,” received the 1987 Distinguished Applied Research Award from the Financial Management Association. In 1999, I was awarded the I/B/E/S prize for empirical work in finance and accounting (with Wayne Landsman and Jennifer Conrad). Richard Roll and I received a Graham and Dodd Scroll Award in 2006 from the Financial Analyst Society for our work on delegated agent asset pricing theory. I won this award again in 2011 for my work on economic growth and equity investing. My paper entitled “Luck, Skill, and Investment Performance” in *The Journal of Portfolio Management* won an

Outstanding Article prize from the 11th Annual Bernstein Fabozzi/Jacobs Levy Awards. My work in valuation has also been cited and relied upon by the Delaware Court of Chancery.¹

4. I have also been active in my profession. I have served as a Vice President of the Western Finance Association. I am also a past Director of both the American Finance Association and the Western Finance Association. I have served as an Associate Editor of numerous professional journals, including *The Journal of Finance*, *The Journal of Futures Markets*, *The Journal of Financial Research* and *The Journal of International Business Studies*. I have served as a reviewer for nearly a dozen other professional journals.

5. My teaching and writing have focused on a number of different financial and economic issues, many of which are relevant to the subject matter of this report. I currently teach Applied Corporate Finance and Investment Banking at the California Institute of Technology. Examples of other classes I have taught over the course of my academic career include Corporate Valuation, the Law and Finance of Corporate Acquisitions and Restructurings, Corporate Financial Theory, and Security Valuation and Investments.

6. In addition to my teaching, writing, and research studies, I serve as a Senior Consultant to Compass Lexecon, an international consulting firm. In my position as a Senior Consultant, I advise business and legal clients on financial economic issues. Prior to joining Compass Lexecon in December 2011, I served as a Senior Consultant to Charles River Associates from March 1999 through December 2011. Between 1990 and March 1999, I operated FinEcon, a financial economic consulting company, through which I also advised business and legal clients on financial economic issues.

1. See, e.g., *Delaware Open MRI Radiology Associates, P.A. v. Kessler*, 898 A.2d 290, 331 n.102 (2006); *Andaloro v. PFPC Worldwide*, 2005 Del. Ch. LEXIS 125, at *71 n.75 (Del. Ch. Aug. 19, 2005).

7. I have served as a consultant and have given testimony for both plaintiffs and defendants in a variety of securities, regulatory and commercial lawsuits. During my many years of experience as an expert witness and consultant, I have provided economic analyses and expert testimony (again, for both plaintiffs and defendants) related to valuation, corporate finance, portfolio management, and damages issues.

Exhibit A
Endowment Asset Classes and Proxy Mutual Funds Considered

Asset Class	Proxy Funds Considered ¹	Excess Return (1995 - 2015) ²		Coal, Oil, and Gas Share of Holdings
		Mean	St. Dev.	
Domestic Equity	1. Vanguard Total Stock Market Index Fund	7.8%	15.6%	7.3%
	2. Vanguard Institutional Index Fund	7.6%	15.2%	8.5%
	3. Vanguard 500 Index Fund	7.4%	15.2%	8.5%
Foreign Equity	1. American EuroPacific Growth Fund	7.1%	16.1%	3.6%
	2. American Capital Income Builder	6.9%	9.7%	4.2%
	3. American Capital World Growth and Income Fund	8.8%	14.4%	5.0%
Private Equity	1. Fidelity Low-Priced Stock Fund	11.2%	15.1%	3.7%
	2. Columbia Acorn Fund	10.7%	17.2%	4.1%
	3. Neuberger Berman Genesis Fund	11.1%	15.1%	9.2%
Fixed Income	1. PIMCO Total Return Fund	4.4%	4.1%	0.2%
	2. Templeton Global Bond Fund	5.5%	7.2%	0.1%
	3. Vanguard Short-Term Investment Grade Fund	2.1%	2.2%	0.8%
Real Estate	1. DFA Real Estate Securities Portfolio	10.8%	20.4%	0.0%
	2. Cohen & Steers Realty Shares	11.3%	20.3%	0.0%
	3. Fidelity Real Estate Investment Portfolio	10.9%	21.0%	0.0%
Natural Resources	1. Van Eck Global Hard Assets Fund	8.9%	21.9%	39.1%
	2. Prudential Jennison Natural Resources Fund	10.3%	26.5%	40.5%
	3. Fidelity Advisor Energy Fund	9.2%	23.7%	68.1%
Absolute Returns	1. HFRI Fund Weighted Composite Index	6.1%	6.9%	0.0%
	2. Greenwich Global Hedge Fund Index	6.9%	6.9%	0.0%
	3. Credit Suisse Hedge Fund Index	6.5%	7.0%	0.0%
Cash	1. Three-Month Treasury Bills	0.0%	0.0%	0.0%

1. Three largest existing mutual funds that focus on specified asset class, according to assets under management. Fund asset class and assets under management from Bloomberg.

2. Calculated using monthly data from CRSP, Bloomberg, and Hedge Fund Research database. Excess Return is relative to the Three-Month Treasury Bill rate. Mean and Standard Deviation of excess returns are annualized.

Exhibit B
Estimated Current Asset Class Allocation

Asset Class	Estimated Allocation					
	Columbia ¹	Harvard ²	MIT ³	NYU ⁴	Yale ⁵	Wtd. Avg. ⁶
Domestic Equity	6.4%	11.0%	11.0%	17.4%	3.9%	8.8%
Foreign Equity	13.6%	22.0%	18.1%	36.6%	11.5%	18.2%
Private Equity	21.6%	18.0%	17.1%	13.4%	33.0%	22.3%
Fixed Income	4.0%	10.0%	1.4%	6.0%	4.9%	6.5%
Real Estate	12.0%	12.0%	16.2%	6.6%	17.6%	14.0%
Natural Resources	6.1%	11.0%	4.4%	3.4%	8.2%	8.4%
Absolute Returns	29.7%	16.0%	10.1%	10.6%	17.4%	16.8%
Cash	6.7%	0.0%	21.7%	6.0%	3.5%	5.1%

1. "Notes to the Consolidated Financial Statements for the Years Ended June 30, 2014 and 2013," at 14. "Global Equities" category is allocated between domestic and foreign equity based on proportional share of total equities in those categories reported for Harvard, MIT, and Yale (simple average). "Real Assets" category is allocated between real estate and natural resources based on proportional share of total in those categories reported for Harvard, MIT, and Yale (simple average).
2. "September 2014 Annual Endowment Report: Message from the CEO," at 2. Based on "Policy Portfolio," which is "a long-term target portfolio composed of the mix of assets that HMC and our Board judge to be the optimal fit with the University's needs." Foreign equity and emerging markets equity are both included in "Foreign Equity" category.
3. "Report of the Treasurer for the year ended June 30, 2014," at 15. Cash category includes U.S. Treasury and agency securities. "Real Assets" are assumed to be natural resources. Split-interest agreements, "Other" and derivatives categories are excluded from total.
4. "Endowment Fund Summary," at 1. "Fixed Income" category is allocated between fixed income and cash based on proportional share of total assets in these categories for Columbia, Harvard, MIT, and Yale. "Opportunities & Credit" category is allocated between private equity and absolute returns based on proportional share of total assets in these categories for Columbia, Harvard, MIT, and Yale. "Equity" category is allocated between domestic and foreign equity based on proportional share of total assets in these categories for Harvard, MIT, and Yale. "Real Assets" category is allocated between real estate and natural resources based on proportional share of total assets held in these categories by Harvard, MIT, and Yale.
5. "The Yale Endowment: 2014," at 4.
6. Weights based on total value of endowment at the end of most recent fiscal year. Columbia (\$9.2 billion), Harvard (\$36.4 billion), MIT (\$12.4 billion), NYU (\$3.5 billion), Yale (\$23.9 billion).

Exhibit C
Estimated Endowment Shortfall Due to Divestment
Over 2,187 Proxy Portfolios
(Positive Numbers Indicate Shortfall Due to Divestment)

	Share of Proxy Portfolios with Shortfall	Annual Shortfall per Year, 1995 - 2015 ¹				Total Shortfall Based on Mean ²		Current Annual Shortfall, in Dollars (\$MM) ³
		Mean	P5	Median	P95	20 Years	50 Years	
Risk-Adjusted Shortfall Due to Divestment								
Columbia	88.89%	0.16%	-0.06%	0.18%	0.33%	3.18%	8.13%	\$14.43
Harvard	96.30%	0.30%	0.03%	0.31%	0.54%	6.09%	15.94%	\$107.81
MIT	96.30%	0.14%	0.02%	0.14%	0.26%	2.90%	7.40%	\$17.75
NYU	94.28%	0.12%	0.00%	0.12%	0.23%	2.40%	6.12%	\$4.16
Yale	88.89%	0.21%	-0.09%	0.24%	0.44%	4.36%	11.27%	\$51.09
Wtd. Avg.	90.99%	0.23%	-0.02%	0.25%	0.44%	4.67%	12.07%	
Gross Shortfall Due to Divestment								
Columbia	100.00%	0.24%	0.20%	0.24%	0.27%	4.93%	12.78%	\$22.21
Harvard	100.00%	0.37%	0.30%	0.37%	0.42%	7.63%	20.17%	\$134.01
MIT	100.00%	0.19%	0.15%	0.19%	0.22%	3.89%	10.01%	\$23.73
NYU	100.00%	0.17%	0.12%	0.18%	0.22%	3.55%	9.12%	\$6.12
Yale	100.00%	0.33%	0.27%	0.33%	0.37%	6.75%	17.75%	\$78.22
Wtd. Avg.	100.00%	0.31%	0.26%	0.31%	0.35%	6.37%	16.70%	

1. Reflects average annual reduction in returns for a divested portfolio, relative to otherwise-equivalent undivested portfolio.

Calculations are over 2,187 proxy portfolios for each university, constructed as described in the text. Gross shortfall is unadjusted difference in average annual returns. Risk-adjusted shortfall is based on same calculation, performed on portfolios with equalized volatility of excess returns, as described in the text.

2. Calculated as mean annual shortfall, extrapolated over specified time period.

3. Mean annual shortfall applied to the total value of endowment at the end of most recent fiscal year: Columbia (\$9.2 billion), Harvard (\$36.4 billion), MIT (\$12.4 billion), NYU (\$3.5 billion), Yale (\$23.9 billion).