Fossil Fuel Divestment: A Costly and Ineffective Investment Strategy

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I. Introduction

1. In recent years, certain groups concerned with the potential effects of global climate change have urged institutions and other investors to divest from securities associated with companies that explore for, produce, market and/or exploit fossil fuels. Advocacy for fossil fuel divestment began in 2011 on college campuses like Swarthmore College in Pennsylvania and Hampshire College in Massachusetts, and in 2012, Seattle became the first municipal entity to commit to fossil fuel divestiture goals.[2]

2. Since then, varying degrees of divestment have been adopted by some other institutions, while being rejected by others. For instance, in May 2014, Stanford University's Board of Trustees announced that it would undertake a limited divestment, focused exclusively on coal mining companies, and in September 2014, the Rockefeller Brothers Fund announced that it planned to substantially reduce its investments in fossil fuel companies.[3] Fossil Free, a project of the environmental group 350.org and a leading advocate of divestment, claims that, during 2014, 181 institutions and local governments, along with 656 individuals, divested a total

1. My qualifications 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. Michelle Y. Raji (2014) "Timeline: Fossil Fuels Divestment," *Harvard Crimson*, October 2, 2014.
3. Michael Wines (2014) "Stanford to Purge $18 Billion Endowment of Coal Stock," *New York Times*, May 7, 2014; Michael Calia (2014) "Rockefeller Fund Seeks to Shed Fossil-Fuel Investments; Family, Whose Fortune is from Oil, Aims to Limit Bets on Coal, Tar Sands in its Fund," *Wall Street Journal*, September 22, 2014.

of $50 billion worth of assets.[4] Divestments by government entities, educational institutions, and philanthropic foundations constitute approximately 95 percent of these assets.[5]

3. By contrast, other institutions have resisted activists' calls for divestment. Trustees at American University voted in November 2014 to keep fossil fuel-related investments held in their endowment fund, indicating that divestment would double its annual management fees.[6] Harvard University, which holds the largest university endowment valued at more than $32 billion, has also opposed divestment. Harvard's President, Drew Faust, commented:

> "Divestment is likely to have negligible financial impact on the affected companies. And such a strategy would diminish the influence or voice we might have with this industry. Divestment pits concerned citizens and institutions against companies that have enormous capacity and responsibility to promote progress toward a more sustainable future."[7]

4. Public commentary about divestment has also increased substantially. A recent opinion piece in the *New York Times* advocated greater debate about divestment on college campuses. It suggested that the costs of divestment to investors would be "not much," and the potential benefits large, pointing to a divestiture campaign in the 1980s focused on Apartheid-era South African companies.[8]

5. Certainly, before divesting, investors and institutional fund managers should consider the costs of divestiture and the likelihood that divestiture will contribute meaningfully

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4. Fossil Free (2014) "Fossil Fuel Divestment: 2014 Accomplishments and Next Steps," http://gofossilfree.org/usa/wp-content/uploads/sites/6/2014/12/Divestment-Accomplishments-October-2014-Public.pdf.
5. Arabella Advisors (2014) "Measuring the Global Fossil Fuel Divestment Movement," September 2014, http://www.arabellaadvisors.com/research/measuring-the-global-fossil-fuel-divestment-movement/.
6. Jeffrey A. Sine, Chair, Board of Trustees (2014) "Memorandum to American University Community," November 21, 2014, http://www.american.edu/trustees/Announcement-November-21-2014.cfm.
7. Drew Faust, Harvard University Office of the President (2013) "Fossil Fuel Divestment Statement," October 3, 2013, http://www.harvard.edu/president/fossil-fuels.
8. Evan J. Mandery (2014) "The Missing Campus Climate Debate," *New York Times*, November 2, 2014.

to desirable environmental goals. In this report, I address these issues from the perspective of financial economics, relying on widely-accepted principles of the field, as well as the large literature on prior divestiture campaigns, including the South African case. I conclude that the costs to investors of fossil fuel divestiture are highly likely and substantial, while the potential benefits – to the extent there are any – are ill-defined and uncertain at best. Fossil fuel divestiture is therefore unlikely to pass a cost-benefit test, particularly compared with alternative ways investors who so desire can promote environmental goals.

II. Divestiture involves substantial costs for investors and others.

6. Investors seeking to comply with the goals of fossil fuel divestiture potentially incur three key types of costs, described here and discussed more fully below:

- Trading costs. Divestiture involves selling certain securities and presumably buying others, both of which involve payment of broker commissions and bid-ask spreads.
- Diversification costs. By restricting the securities that can be included in a portfolio, it is widely recognized that an investor loses the benefits of diversification, suffering lower investment returns for a given level of portfolio risk.
- Compliance costs. Investors must identify the specific securities to be divested from an existing portfolio. Moreover, because firms evolve over time and new investment opportunities arise, there will be ongoing compliance costs to ensure that the portfolio continues to meet the desired standards.

7. These costs reduce the returns of an institution's investments and thereby reduce the institution's ability to achieve its goals. As one article on university endowment spending by the Association of American Universities noted, "[b]y far the most common categories of endowment expenditures are scholarships and financial aid, faculty chairs and salaries and

academic support programs."[9] The article also states that "[m]any institutions with significant endowments are making college free for thousands of low- and moderate-income students."[10] According to one study, higher education operating budgets receive 8.8 percent of their funding annually from endowments.[11] A recent economic study of 24 years of university endowment data found that negative endowment returns lead to substantially lower payouts to fund university operations: "a 10 percent negative endowment return is associated with an 8.2 percent reduction in payouts."[12] The same study further found that "[a] negative endowment shock equivalent to 10 percent of a university's budget leads to a 4.9 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."[13] The costs imposed by divestment therefore have real impacts on institutions and those who rely upon them. I discuss each of these costs in detail below.

A. Trading Costs

8. Divestment generates trading costs for investors, including processing and execution costs. Trade processing costs include payments to investment professionals to manage and facilitate trades, as well as exchange fees and taxes involved in trading securities. These costs vary across traders, depending on the types of securities they hold and whether they have

9. "Myths About College and University Endowments," Association of American Universities, January 2009 (https://www.aau.edu/WorkArea/DownloadAsset.aspx?id=7792).
10. *Id.*
11. NACUBO (2013) "Educational Endowments' Investment Returns Averaged 11.7% in FY2013; Strong Improvement Over FY2012's -0.3%," Press Release, January 28, 2014, http://www.nacubo.org/Documents/EndowmentFiles/2013NCSEPressReleaseFinal.pdf.
12. 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.
13. *Id.*, at 933-34.

investment professionals in-house, but they are often substantial, with a recent study finding that institutional separate account fees for a large-cap domestic equity portfolio average 0.53 percent of assets.[14]

9. Execution costs include the payment of an effective bid-ask spread and any price impacts from a trade. The bid-ask spread is the difference between the price to sell a security and the price to buy the same security, with the latter typically being higher.[15] Financial economists typically recognize the bid-ask spread as the fee security dealers earn for supplying liquidity to traders.[16] An investor incurs costs relating to the bid-ask spread both on the sale of securities targeted for divestment (which would be sold at the relatively low bid price) and on the purchase of replacement securities (which would be bought at the relatively high ask price).

10. The price impact component of execution is "the price concession an investor may be forced to make for trading in in quantities greater than those associated with the posted bid or ask price."[17] In other words, to sell a large quantity of securities, an investor must offer a lower price, and to buy a large quantity of securities, an investor must pay a higher price. An academic study of large investment management firms indicates that the average price impact of trading for institutional investors is -0.35 percent of the price for sells and 1.0 percent for buys.[18]

11. A recent estimate from a widely-used source indicates that average processing and execution costs for an institutional equity investor are approximately $0.18 per $100 of

14. Investment Company Institute (2006) "Mutual Funds and Institutional Accounts: A Comparison," at p. 2.
15. Zvi Bodie, Alex Kane, and Alan J. Marcus (2014) *Investments, Tenth Edition*, McGraw-Hill Irwin, at p. 64.
16. John Y. Campbell, Andrew W. Lo, and A. Craig MacKinlay (1997) *The Econometrics of Financial Markets*, Princeton University Press, at p. 100.
17. Zvi Bodie, Alex Kane, and Alan J. Marcus (2014) *Investments, Tenth Edition*, McGraw-Hill Irwin, at p. 76.
18. Louis K.C. Chan & Josef Lakonishok (1995) "The Behavior of Stock Prices Around Institutional Trades," *Journal of Finance*, (4):1147-1174, at p. 1148.

trading activity.[19] The National Association of College and University Business Officers reports that university endowments hold approximately $23 billion in energy-related assets.[20] If all of these assets were divested, the benchmark described above would indicate a total cost for processing and execution alone of $40.2 million. If as described above, divestiture generated a 0.35 percent price impact for stock sales and a 1.0 percent impact for stock purchases, this additional price impact would add $308 million in trading costs.

B. Diversification Costs

12. Investors typically want returns that are both high and steady from period to period. However, there is a tradeoff between investment risk and return, with higher returns usually available only by taking on more risk. However, when an investor diversifies their portfolio by spreading their investment across more assets, it is widely recognized that the investor can avoid this tradeoff and achieve a higher average return without an increase in risk.[21] For the same reasons, restricting certain assets from a portfolio, as is required by a divestment policy, reduces the average expected return from the portfolio at a given level of risk.

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19. Elkins/McSherry Bundled VWAP Global Universe 4Q12 Estimates. This analysis is based on a survey of major institutional traders, and is commonly used in the financial economics literature. It includes a price impact of 0.04 percent. See, *e.g.*, Thomas, C.P., Warnock, F.E., & Wongswan, J. (2004) "The Performance of International Equity Portfolios," Board of Governors of the Federal Reserve System International Finance Discussion Papers, Number 817; Domowitz, I., Glen, J., & Madhavan, A., (2001) "Liquidity, Volatility, and Equity Trading Costs across Countries and Over Time," International Finance, 4(2):221-255.
20. According to 2013 NACUBO reports, the value of college endowments totaled more than $456,000,000,000 and endowments held approximately 5% of their assets in energy. Therefore, the value of energy assets was approximately $22,800,000,000. *See,* NACUBO, (2014) "U.S. and Canadian Institutions Listed by Fiscal Year 2013 Endowment Market Value and Change in Endowment Market Value from FY 2012 to FY 2013," Revised February 2014 and the 2013 NACUBO – Commonfund Study of Endowments.
21. Burton G. Malkiel (2011) *A Random Walk Down Wall Street: The Time-Tested Strategy for Successful Investing*, W.W. Norton & Co., at pp. 202-214. This result requires that the assets not be perfectly positively correlated with each other, as I describe below.

13. A standard way to evaluate the potential diversification benefits of any security or set of securities is to calculate the correlation of that security with the rest of the portfolio. The more uncorrelated a security is with the rest of the portfolio, the greater the diversification benefit it generates (and, by the same principle, the greater the cost associated with divesting that security). We analyzed the correlations between stocks in the energy sector – *i.e.*, those stocks most likely to be targets for divestment – and stocks in other sectors over the 50-year time frame 1965-2014. Claims that the performance costs of divestment are low typically focus on shorter time frames which can generate misleading results.[22]

14. Our data source on historical equity returns is the CRSP US Stock database, which is widely used in the academic community to study stock returns. In particular, this database contains all securities whose primary listings are on the NYSE, NYSE MKT (formerly known as Amex), NASDAQ, and ARCA exchanges. We included in our analysis all such securities that are assigned an SIC industry code by CRSP, using the most recent SIC code assigned to the security.

15. We identified each SIC code with one of 10 industry sectors, including the energy sector, based on the classification used in Fama and French (1997), updated to the current stock listings.[23] For each of the 10 sectors, we constructed a value-weighted index of all the stocks in our data and tracked those indices each day during the 50-year period 1965-2014.

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22. For example, in the aforementioned New York Times editorial, the author claims that "[s]ome research suggests that endowments would have performed better over the past decade had they excluded fossil-fuel companies." Evan J. Mandery (2014) "The Missing Campus Climate Debate," *New York Times*, November 2, 2014.

23. Eugene F. Fama and Kenneth R. French (1997) "Industry Costs of Equity," *Journal of Financial Economics*, 43(2):153-93. An update of this classification is provided at http://mba.tuck.dartmouth.edu/pages/faculty/ken.french/data_library.html.

16. The standard measure of correlation is the correlation coefficient, which ranges between -1.0 and +1.0.[24] A correlation coefficient of -1.0 indicates a security that is perfectly negatively correlated with the portfolio, such that whenever the portfolio's value increases, the security in question declines proportionally in value (and vice-versa). A correlation coefficient of +1.0 indicates a security that is perfectly positively correlated with the portfolio, such that whenever the portfolio's value increases, the security in question also increases proportionally in value (and vice-versa). A correlation coefficient of 0.0 means there is no statistical relationship between the portfolio's return and the return of the security in question.

17. For each of the ten sectors, we created a value-weighted stock price index for stocks in that sector and another value-weighted index of all stocks in the other nine sectors, and calculated the correlation between the returns of these two indices over the 1965-2014 period. Exhibit A shows the correlations between each sector and the rest of the market. Of the ten sectors, the energy sector has the lowest correlation with all other sectors, and therefore the largest potential diversification benefits relative to the other nine sectors. Moreover, the sector with the second lowest correlation with other sectors is the utility sector, another sector that includes many likely fossil fuel divestment targets. These results indicate the potential for substantial diversification costs associated with fossil fuel divestment.

18. To further quantify these costs, we also undertook an analysis of the reduction in the average return an investor who divested from the energy sector would have received over the 1965-2014 period, relative to the average return received by an investor who did not divest. Obviously, investors hold many different portfolios, and as discussed in the following section,

24. Burton G. Malkiel (2011) *A Random Walk Down Wall Street: The Time-Tested Strategy for Successful Investing*, W.W. Norton & Co., at p. 206.

there are numerous ways an investor could implement fossil fuel divestment. It would be impossible to precisely quantify the value of diversification for every possible investor and every possible divestment strategy. However, as a rough gauge of the overall magnitude of diversification costs, we estimated the reduction in returns to an investor who held the "market portfolio" – *i.e.*, the average equity investor in the market.

19. We also considered what is likely among the simplest and lowest compliance-cost strategies for divestment, namely excluding from the portfolio any stock of a company in the energy sector, as defined above. It is possible (although far from certain) that a more fine-tuned divestment strategy that distinguished between different companies within this sector, or which also identified select companies from other sectors like the auto industry, could have lower diversification losses, but, as discussed in the following section, compliance costs for such a strategy would also be higher.

20. Because returns on equities vary substantially over short periods of time, we analyzed the effect of divestiture over a very long historical period – as noted above, the fifty years from 1965 to 2014. It is possible that the future benefits of diversification will be larger or smaller than past effects, and moreover, the impact of divestiture can vary substantially depending on whether an investor happens to make trades during a downswing or upswing in the market or energy sector. Recent changes in global energy markets have exerted significant downward pressure on fossil fuel prices. For example, the Brent Crude Oil Index declined by nearly 50 percent from June 2014 to December 2014. As would be expected, these declines in underlying commodity prices have also been associated with declines in the share prices for many public companies engaged in the exploration and production of fossil fuels (the S&P 500 Energy Index declined by approximately 15% from June 2014 to December 2014). The fifty

year historical time period we examine as part of this analysis also captures other declines in crude oil markets including two where the price declined by 60 percent or more in a calendar year (1986 and 2008). Regardless of recent events, there is no way to reliably predict future returns in advance, and therefore, the best guide to the potential effects of diversification – and the standard approach of financial scholars and analysts to such questions – is to examine long-term averages.

21. Appendix B describes our methodology, which is summarized briefly here. We first constructed a value-weighted index of energy stock prices using the energy sector SIC codes, as discussed above. Separately, we also constructed a single value-weighted index of all non-energy stock prices across the other nine sectors. We then identified, based on the fifty year history for all of these stocks, the optimal portfolio ratio for the energy and non-energy indices that maximizes the overall average return, relative to the standard deviation – a standard measure of portfolio risk.

22. This optimal portfolio experienced an average annualized excess return over the 1965-2014 period of 6.5 percent, while the similarly-calculated return for the non-energy stock index was only 5.8 percent. This indicates a gross reduction in return of 0.7 percent per year due to divestment. However, this calculation is incomplete because it does not account for differences in risk between the two portfolios. Indeed, the optimal portfolio's standard deviation is higher, 16.2 percent, indicating greater volatility relative to the non-energy stock index's standard deviation of 15.7 percent.

23. Therefore, an investor who chose to divest would experience a lower return, but would also see the relative volatility of his portfolio decline. However, there is no reason why

divestiture alone would change an investor's attitude towards risk. As such, to appropriately compare divested and non-divested portfolios, we risk-adjusted the optimal equity portfolio to make it comparable to the divested non-energy stock index portfolio. Specifically, we allocated a share of the funds in the optimal portfolio including energy stocks to an essentially risk-free asset (a one-month U.S. Treasury bill), and adjusted this share to make the volatility of the optimal portfolio, measured by the standard deviation, equal to that of the non-energy stock index, which has a standard deviation of 15.7 percent.

24. After this adjustment, the optimal portfolio that includes energy stocks earned an average annualized excess return of 6.3 percent. While lower than the gross return calculated above, this is still substantially higher than the average return for the divested non-energy index portfolio, which is only 5.8 percent. This indicates a diversification cost from divesting energy stocks of approximately 0.5 percent per year, holding constant the volatility of the portfolio. Exhibit B shows the value over time of $100 invested on January 1, 1965 in each of these two portfolios. As of December 31, 2014, the $100 invested in the optimal risk-adjusted portfolio would have grown to about$14,600, whereas the $100 invested in the divested portfolio would have grown to only about$11,200, indicating a loss of 23 percent due to divestment.

C. Compliance Costs

25. Our discussion above assumed divestment of all energy stocks, and this would certainly be a simple divestiture strategy. However, actual divestiture strategies are typically far more sophisticated, consistent with the complexity of identifying the environmental impact of individual companies. For instance, the recent *New York Times* opinion article described above proposed that divestiture distinguish between fossil fuel companies: "[i]nvestment could be

contingent on a company's agreeing to curtail its political spending, report on climate change or include environmental experts on its board."[25] The Rockefeller Brothers Fund stated that its process of divestment would involve developing a "detailed plan" over a multi-year period.[26]

26. Investors seeking to pursue climate change sensitive investing would therefore most likely undertake a careful review to identify securities for divestiture, at a consequently substantial cost. These costs would likely be ongoing as individual companies' climate impacts evolve over time. For example, American University said "divesting from these companies would require that AU investments be withdrawn from index funds and commingled funds in favor of more actively managed funds [and] estimated this withdrawal would cause manager fees to double."[27]

27. It is easy to point at large energy companies as simple targets for divestment, but many of these companies are also leaders in the production of non-fossil-fuel energy and the development of green energy technology, so even in these apparently simple cases, investors would presumably want to exercise nuanced judgment. For instance, from 2000 – 2012, U.S. oil and natural gas companies invested approximately $11.4 billion in renewable sources of energy. This $11.4 billion contribution accounted for roughly 17 percent of the comparable total industry and federal government investment during this time period.[28]

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25. Evan J. Mandery (2014) "The Missing Campus Climate Debate," *New York Times*, November 2, 2014.
26. Michael Calia (2014) "Rockefeller Fund Seeks to Shed Fossil-Fuel Investments; Family, Whose Fortune is from Oil Aims to Limit Bets on Coal, Tar Sands in its Fund," *Wall Street Journal*, Sept. 22, 2014.
27. Jeffrey A. Sine, Chair, Board of Trustees (2014) "Memorandum to American University Community," November 21, 2014, http://www.american.edu/trustees/Announcement-November-21-2014.cfm.
28. Thomas Tanton.(2011) "Key Investments in Greenhouse Gas Mitigation Technologies from 2000 Through 2012 by Energy Firms, Other Industry and the Federal Government," T^2 & Associates, at p. 9.

28. Moreover, investors attempting to achieve environmental goals in their portfolio would also likely want to consider the appropriateness of other companies that produce products that are complements for fossil fuels, like automakers or construction companies, and companies that provide support and services for fossil fuel production, like banks that provide cash management and lines of credit. Effectively identifying divestiture targets in these cases requires a fuller understanding of the activities of these firms and how those activities may affect environmental outcomes.

29. Compliance costs associated with divestiture could, in principle, be reduced if recognized environmental experts could agree upon a unified set of target securities. The cost of obtaining and maintaining this expert analysis could then be allocated across many investors. However, at least for now, the lists of companies proposed as targets by major divestment campaigns diverge widely.

30. For instance, one of the most prominent divestment campaigns, Fossil Free, proposes investors divest from securities issued by companies on a list it calls the "Carbon Underground 200," which "identifies the top 100 public coal companies globally and the top public oil and gas companies globally, ranked by the potential carbon emissions content of their reported reserves."[29] Another group with similar views, the Political Economic Research Institute, has developed its own list of major polluters, the "Greenhouse 100 Polluters Index," which "identifies the top companies responsible for greenhouse gas emissions."[30] Exhibit C reports the top 10 U.S. companies on each of these two lists. Despite the apparently sympathetic goals of these two lists of companies, there is no overlap among even the top 10 firms.

29. *See*: http://fossilfreeindexes.com/the-carbon-underground-2014/.
30. *See*: http://www.peri.umass.edu/greenhouse100/.

31. Overall, among the 192 unique companies on the Carbon Underground 200, and the 88 unique companies on the Greenhouse 100 Polluters Index, only 11 companies appear on both lists.[31] This comparison illustrates the complexities that investors will likely need to consider when choosing to divest, and the consequently higher costs they will incur in doing so. Principled compliance with a climate change sensitive divestment strategy requires investors to make thoughtful judgments regarding the securities in their portfolio, and these judgments are not straightforward or automatic.[32]

32. Moreover, in addition to compliance costs associated with divestment, an investor would also presumably want to identify other acceptable securities for reinvestment. For instance, the fossil fuel divestment advocacy group Fossil Free proposes that, after divesting, investors should "focus a reinvestment strategy on renewable energy, energy efficiency, and climate mitigation and adaptation infrastructure."[33] However, there is again no simple expert consensus approach to doing so, and therefore, considerable efforts would be necessary to identify and support a given investment strategy. In particular, existing mutual funds that do indicate environmental concerns as a key objective vary widely in their holdings. Exhibit D illustrates the 10 largest security holdings of the five largest such funds by market capitalization. Thirty-one of the forty unique securities listed in Exhibit D appear in the top 10 security holdings

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31. To determine unique companies and the overlap between the two lists, Capital IQ was used to determine the parent company associated with the entities on each list.

32. For example, Trillium Asset Management, a supporter of the 350.org divestment campaign, offers clients several investment vehicles that hold equities in fossil fuel companies. In particular, its Large Cap Core fund lists EOG Resources, which is also listed on the Carbon Underground 200, as one of its top 10 holdings. *See*: http://www.trilliuminvest.com/wp-content/uploads/2014/10/Trillium-Large-Cap-Core-Fact-Sheet-Q3-2014.pdf. Trillium states that "[a]n important piece of Trillium's climate change strategy is to engage companies on climate change risks." *See*: http://www.trilliuminvest.com/wp-content/uploads/2013/01/Trillium-Fossil-Fuel-Free-Investing.pdf. However, they invest only in funds that meet certain "ESG" (environmental, social and governance) criteria. In other words, even an organization that supports divestment acknowledges that some fossil fuel firms meet its standard for companies that are "protecting the environment" and "exhibiting best practices." *See* http://www.trilliuminvest.com/approach-to-sri/esg-integration/.

33. *See*: http://gofossilfree.org/usa/your-roadmap-to-personal-divestment/.

of only one of these funds. This illustrates that additional costs will be incurred by investors in researching reinvestment opportunities.

33. Even if a reliable definition of target divestment securities and appropriate replacement investments could be identified today, compliance costs are still likely to be substantial and ongoing for investors. Over time, it is likely that the composition of portfolio companies' investments will evolve and their holdings and activity related to fossil fuels will change. Companies will drift between unacceptable and acceptable status according to various metrics, many of which are not reliably quantified and/or subjective in nature. Moreover, new potential investments will arise, which must be continually analyzed relative to the desired environmental objectives.

34. There are two ways for an investor to maintain ongoing portfolio compliance with divestment objectives. One is for the investor to manage the portfolio, continuously monitoring the activities of the companies within the portfolio to identify divergence from environmental objectives and adjusting the portfolio correspondingly. A second approach is to outsource this monitoring by holding a larger share of the portfolio in a mutual fund with "green" objectives; this essentially entrusts the mutual fund manager with the role of active management. Either approach involves costs that are likely to be substantial for most investors.

35. Financial literature has long associated active portfolio management, either individually or through a mutual fund manager, with a higher overall fee structure relative to passive strategies. In his 2008 Presidential Address to the American Financial Association, Kenneth R. French summarized a range of evidence indicating that the cost of active portfolio

management is a reduction in the average annual return on a portfolio of 0.67 percent per year.[34] Over a 10-year horizon, an initial portfolio of $1,000,000 would experience an average of over $67,000 in losses due to the cost of active management.

36. Dr. French's estimate reflects the overall average costs to investors who actively manage their portfolios for a wide range of reasons besides environmental concerns, and I am not aware of any estimates in the literature that focus on the costs of active management exclusively for the purposes of achieving environmental goals. Nevertheless, it is a broadly accepted principle of financial economics that active investing is costly and involves lower returns for most investors.[35]

37. Even so, management fees for mutual funds with an environmental focus appear to be, on average, greater than those funds without such a focus. Exhibit E-1 compares the 10 largest "green" mutual funds proposed by The Forum for Sustainable and Responsible Investment ("US SIF"), a group that seeks to advance investment practices that consider environmental criteria, with a set of the largest overall mutual funds in the market by assets under management (as reported by Bloomberg, L.P.).[36] On average, the US SIF green mutual funds reported an expense ratio of 0.95 percent of assets, approximately three times higher than

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34. This estimate includes certain transaction costs, which I discussed earlier in this report. http://www.afajof.org/details/video/2870801/2008-Presidential-Address.html.

35. For example, one prominent textbook states, "[p]roponents of the efficient market hypothesis often advocate passive as opposed to active investment strategies. The policy of passive investors is to buy and hold a broad-based market index. They expend resources neither on market research nor on frequent purchase and sale of stocks. Passive Strategies may be tailored to meet individual investor requirements." Zvi Bodie, Alex Kane, and Alan Marcus (2014) *Investments, Tenth Edition*, McGraw Hill/Irwin, at p. 380.

36. US SIF is one of the resources that divestment advocacy group Fossil Free proposes that investors use to identify appropriate re-investment assets. *See*: http://gofossilfree.org/usa/your-roadmap-to-personal-divestment/.

the average expense ratio of the 10 largest mutual funds, which was reported at only 0.32 percent over the same period (*see* Exhibit E-2).[37]

D. The overall cost of divestment is substantial.

38. While each of the individual costs discussed above is meaningful in isolation, taken together these costs have the potential to substantially impair the future value of endowments and other investor funds. For example, a 0.5 percent decrease in portfolio performance impact on the estimated $456 billion in university endowment assets would decrease annual growth by over $2 billion annually.[38] An increase in compliance costs of 1 percent on the estimated $23 billion of those endowments invested in energy stocks would further decrease annual growth by an additional $230 million.[39] A reduction in wealth of this magnitude could have a substantial impact on the ability of universities to achieve their goals, such as the research, scholarships and services that universities are able to offer. As noted by Harvard President Drew Faust,

> "Significantly constraining investment options risks significantly constraining investment returns. The endowment provides more than one-third of the funds we expend on University activities each year. Its strength and growth are crucial to our institutional ambitions — to the support we can offer students and faculty, to the intellectual opportunities we can provide, to the research we can advance."[40]

37. These calculations are based on the most recent data provided by Morningstar.
38. See, "U.S. and Canadian Institutions Listed by Fiscal Year 2013 Endowment Market Value and Change in Endowment Market Value from FY 2012 to FY 2013," Revised February 2014 (http://www.nacubo.org/Documents/EndowmentFiles/2013NCSEEndowmentMarket%20ValuesRevisedFeb142014.pdf).
39. *Id.*,.and The 2013 Commonwealth Study of College Endowments.
40. Drew Faust, Harvard University Office of the President (2013) "Fossil Fuel Divestment Statement," October 3, 2013, http://www.harvard.edu/president/fossil-fuels.

III. Divestiture is unlikely to impact equity values of divested companies or achieve other goals.

A. Divestiture is unlikely to impact equity values of divested companies.

39. The ostensible purpose of divestment would be to place capital market pressure on certain companies to reduce or change business operations that activists believe may harm the environment or impact climate change. However, basic and widely-accepted financial principles indicate that divestment is in fact highly unlikely to have any substantial effect on these companies.

40. Financial analysts typically represent the price of a stock as the present value of the expected returns to the company's investments.[41] In highly liquid markets, a company's stock price cannot diverge in any persistent, substantial way from this fundamental value, because otherwise, investors would have the opportunity to earn greater returns by buying or selling the stock, a process known as arbitrage. As one textbook puts it, "[t]he idea that market prices will move to rule out arbitrage opportunities is perhaps the most fundamental concept in capital market theory."[42]

41. This relationship between a company's stock price and its fundamental value in liquid markets means that divestment campaigns cannot materially affect stock prices and therefore cannot materially change a company's incentives to undertake certain activities or other investors' incentives to hold these companies in their portfolios. As an example, suppose a particular company's stock price is currently $100. While individual investors can and do differ

41. Richard A. Brealey, Stewart C. Myers, and Franklin Allen (2014) *Principles of Corporate Finance* (11th ed.), McGraw-Hill Irwin, pp. 80-84.

42. Zvi Bodie, Alex Kane, and Alan J. Marcus (2014) *Investments, Tenth Edition*, McGraw-Hill Irwin, at p. 328. *See also* Hal R. Varian (2014) *Intermediate Microeconomics* (9th ed.), W.W. Norton & Co., at p. 205 (stating, "[a]s long as there are people around looking for 'sure things' we would expect that well-functioning markets should quickly eliminate any opportunities for arbitrage.")

in their beliefs about a company's future profitability, the $100 price can be thought of as a market consensus view about the value of future profits and dividends for the company.

42. An investor who wishes to divest his portfolio of this stock would offer it for sale and (putting aside the bid-ask spread) be able to sell the stock for approximately $100 per share, with no reduction in the stock price, because if the stock price did decline, say to $95, other investors would be able to earn $5 per share in arbitrage profits. This would lead other investors to bid up the price back to $100. This is the simple logic of arbitrage that implies that divestiture cannot materially reduce equity values.[43]

43. As described above, institutions currently engaged in fossil fuel divestment are focused among the educational, philanthropic, and government sectors, and these institutions hold a very small share of stock in the targeted companies. Even a substantially more widespread adoption of divestment policies by these types of institutions would therefore have little or no effect on share prices. As noted above, for instance, available estimates indicate that college and university endowments have roughly $23 billion invested in energy and natural resources. This is less than 1 percent of the more than $3.8 trillion in total current market capitalization of the 200 companies on the Carbon Underground 200.[44]

B. Prior divestment campaigns have not impacted stock valuations.

44. The conclusion that divestiture campaigns are unlikely to affect targeted companies is confirmed by the experience of prior campaigns. During the 1980s, a major

43. In theory, it could be possible for divestment to affect the price of a security that was highly illiquid, because of the lack of arbitrageurs. However, the stocks of most major companies targeted by divestment campaigns are traded on exchanges and have liquid markets for their equity.

44. Total current market capitalization is calculated as of year-end (12/31/2014), sourced from available data on Bloomberg, L.P.

coordinated divestiture campaign targeted securities issued by companies with interests in South Africa, with the goal of supporting an end to Apartheid. By 1986, over 100 colleges and universities had adopted some form of South African divestment, as had the pension funds of several states, including New Jersey and California, and major companies, including Lotus Development and Levi-Strauss.[45] In addition to being widely adopted by many institutional investors, South African divestment is a far more narrowly-defined investment strategy with far less controversial goals than fossil fuel divestment. Therefore, South African divestment would be more likely to succeed in affecting change at the targeted companies.

45. Nevertheless, available evidence indicates that South African divestment had little or no impact on the stock prices of targeted companies. A 1996 article used an event study methodology to investigate whether South Africa divestiture announcements by major institutional investors, including municipalities, states, and universities, impacted stock returns of firms that chose to maintain their presence in South Africa during the 1983-1989 period.[46] The authors concluded that "[i]t appears that portfolio divestment announcements by major pension funds and endowment associations had no important impact on stock prices of firms doing business in South Africa."[47]

46. Another study examined the stock price reactions of firms with high levels of exposure in South Africa on 21 dates when pension funds announced policies of divestment.[48]

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45. William H. Kaempfer, James A. Lehman, and Anton D. Lowenberg (1987) "Divestment, Investment Sanctions, and Disinvestment: An Evaluation of Anti-Apartheid Policy Instruments," *International Organization* 41(3):457-73, at 460-461.
46. Laurian Casson Lyttle and O. Maurice Joy (1996) "The Stock Market Impact of Social Pressure: The South African Divestment Case," *Quarterly Review of Economics and Finance*, 36(4):507-527.
47. *Id*., at 519.
48. Siew Hong Teoh, Ivo Welch, and C. Paul Wazzan (1999) "The Effect of Socially Activist Investment Policies on the Financial Markets: Evidence from the South African Boycott," *Journal of Business* 72(1):35-89.

The authors found that these firms suffered no statistically significant effect on their stock prices on 16 of these 21 dates, experienced statistically significant and negative effects on three dates, and experienced statistically significant and positive effects on two dates.[49] On the basis of this evidence, they concluded that the evidence "does not indicate that the pension fund divestment announcement significantly hurt firms with major South African operations." In summary, they stated, "the announcement of legislative or shareholder pressure had *no* discernible effect on the valuation of banks and corporations with South African operations or on the South African financial markets."[50]

47. Another study that included a broader range of divestment campaigns, including those related to South Africa as well as others, concluded that "[d]ivestitures do not seem to motivate change" at targeted companies and "divestiture announcements resulted in no significant market responses."[51]

48. Even if, contrary to financial economic theory and all the available evidence, a divestiture campaign could effect change in the activities of target companies by lowering their stock prices, divestment proponents should consider the harm this reduction in stock prices would cause. For instance, ExxonMobil's common stock is among the most widely-held equity issues in the world. Its largest current shareholders are top investment managers and institutional

49. These results are based on the "Equal Weighted" model. Other models presented by the author, including "Sales Weighted," "Asset Weighted," and "Employee Weighted" indicate even fewer dates with statistically significant and negative effects. *Id*., at 64-67.
50. *Id*., at 68, 79 and 83.
51. Wallace N. Davison, III, Dan L. Worrell, & Abuzar El-Jelly (1995) "Influencing Managers to Change Unpopular Corporate Behavior Through Boycotts and Divestitures: A Stock Market Test," *Business & Society* 34(2):171-196, at pp. 171 & 190.

investors, including CalPERS, the New York State Common Retirement System, and both the New York and California Teachers' Retirement Systems.[52]

49. In fact, according to a study published in October 2014, pension funds are the largest category of owners of U.S. oil and natural gas companies, holding approximately 28.9 percent of all oil and natural gas company shares.[53] With individual investors holding an additional 36.6 percent of all shares (including shares held in IRAs), the study's analyses "show that middle-class households dominate the ownership of U.S. publicly-held oil and natural gas companies…[and] benefit from the industry's strong returns."[54] This same study estimates that pension plans and IRAs hold approximately $909 billion in oil and natural gas company stock. If divestment proponents were successful in reducing the returns on these investments by 1 percent each year, relative to what they would have been otherwise, retirees and other individual investors would lose more than $90 billion in value over the next 10 years.

C. Divestiture is unlikely to change social views regarding environmental goals.

50. The inability of divestment campaigns to directly affect company activity is understood, even by divestiture proponents. For instance, the divestiture proponent organization Fossil Free readily admits that divestment "[is not] primarily an economic strategy, but a moral and political one." Fossil Free acknowledges that divestment is a tactic primarily intended to "spark[] a big discussion," and "might not have an immediate impact on a fossil fuel company."[55] Similarly, leaders of Divest Harvard have stated that "[w]e do not expect

52. As of 9/30/2014. Data from Thomson Financial.
53. Robert J. Shapiro & Nam D. Pham (2014) "Who Owns America's Oil and Natural Gas Companies: A 2014 Update," Sonecon, at pp. 1-2.
54. *Id*,. at 2.
55. *See*: http://gofossilfree.org/usa/frequently-asked-questions/.

divestment to have a financial impact on fossil fuel companies … Divestment calls on citizens to build a powerful climate movement and pressure elected representatives to enact meaningful legislation."[56]

51. Obviously, climate change is one of the most controversial issues in public discourse today, and the range of opinions about it is very wide. Even ignoring the broader range of opinions and focusing solely on the economic debate, a recent survey of the economic literature concluded there was "considerable uncertainty about the economic impact of climate change," and "large estimated uncertainty about the social cost of carbon."[57] Of course, even if these debates could be resolved, there would still be vociferious debate about the appropriate role of governments and private actors in policymaking. No matter where one stands on the science, economics, and policy of the climate change debate, there is no basis to believe that divestment will help resolve these issues or push the debate materially in any productive direction.

52. Even for those strong believers in the need to address climate change, the divestiture proposition serves as more of a distraction than a contributor to public discourse designed to further real, meaningful solutions to the problem. As one such strong proponent, the President of Harvard University, has recognized:

> "While I share their belief in the importance of addressing climate change, I do not believe, nor do my colleagues on the Corporation, that university divestment from the fossil fuel industry is warranted or wise…Because I am deeply concerned about climate change, I also feel compelled to ask whether a focus on

56. Chloe Maxmin, Hannah Borowsky and StudentNation (2014) "The Time to Divest: A Response to Harvard President Drew Faust," *The Nation*, October 15, 2013.
57. Richard S. J. Toll (2009) "The Economic Effects of Climate Change," *Journal of Economic Perspectives* 23(2):29-51, at pp37, & 42.

> divestment does not in fact distract us from more effective measures, better aligned with our institutional capacities."[58]

53. Indeed, fossil fuel divestment is not needed to "spark[] a big discussion" about climate change, or generate increased public interest in climate change policymaking. The climate change debate is already a major part of the news and policy discussion in the United States and other countries. During 2013, climate change was the most commonly covered environmental story on the major networks' evening newscasts.[59]

54. The debate regarding climate change is also highly prominent in major newspapers. During 2014, 2,118 news articles in the five largest circulation newspapers in the United States referenced "climate change" or "global warming."[60] This is almost the same as the number of news articles in these papers that referenced "Ebola" (2,167 articles) and not much fewer than the number of news articles in these papers that referenced "Obamacare" or "Affordable Care Act" (2,727). The climate change debate has been prominent in public discourse for more than two decades, while the Ebola outbreak and health insurance legislation stories are far more temporary news events. Therefore, one would expect climate change stories to be less frequent; nevertheless, as these statistics show, climate change controversies are clearly not suffering from a lack of prominent news coverage, relative to other major news-generating stories.

D. Divestiture is unlikely to accomplish investment goals.

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58. Drew Faust, Harvard University Office of the President (2013) "Fossil Fuel Divestment Statement," October 3, 2013, http://www.harvard.edu/president/fossil-fuels.
59. Tyndall Report Year in Review, 2013, http://tyndallreport.com/yearinreview2013/environment/.
60. This study was performed using the Dow Jones / Factiva service, and covered the period December 31, 2013 through December 22, 2014. The newspapers included were: *Wall Street Journal*, *New York Times*, *USA Today*, *Los Angeles Times*, and *New York Daily News*.

55. Some proponents of divestment hold that fossil fuel company stocks are likely to suffer reductions in price over time, and therefore, that divestment is a successful investment strategy, regardless of its impact on environmental goals. For instance, Fossil Free claims that "investing in clean energy, efficiency, and other sustainable technologies can be even more profitable than fossil fuels."[61]

56. As discussed above, this claim is demonstrably false over the past 50 years. As we showed, over the 1965-2014 period, a portfolio including both an energy sector stock index and non-energy stocks experienced a 0.7 percent higher gross return, and a 0.5 percent higher risk-adjusted return, relative to a divested portfolio of only the non-energy stock index.

57. Of course, everyone is entitled to their own opinion about the future course of security prices, and it is certainly possible that, over some period, stocks of fossil fuel companies will underperform other stocks. But unless an investor has private information about these companies which is unavailable to other market participants (and I am not aware that any divestment proponents claim they do have such private information), there is no reason to assume that their current stock prices are "too high" or that they will inevitably decline.[62]

58. While there is a long-running and wide-ranging debate among academics about whether securities markets are "efficient" in one form or another, there is nevertheless widespread agreement that simple rules like "sell fossil fuel stocks" are not recipes for making

61. http://gofossilfree.org/usa/frequently-asked-questions/.

62. This applies to the discussion among some divestment advocates of "stranded assets," *i.e.*, company assets that could become uneconomical to exploit at some point in the future due to changes in market prices or future regulations related to climate change. Divestment advocates do not claim to have private information about these changes in prices or regulations that are not available to the investing public at large; therefore, current security prices already incorporate the market consensus view about stranded assets.

money. As one textbook puts it, "[t]he bulk of the evidence, however, suggests that any supposedly superior investment strategy should be taken with many grains of salt. The market is competitive *enough* that only differentially superior information or insight will earn money; the easy pickings have been picked."[63]

IV. Conclusion

59. The economic evidence demonstrates that fossil fuel divestment is a bad idea. The costs of divestment are clearly substantial. Trading costs like commissions are incurred in virtually every securities transaction. Costs associated with reductions in diversification are a bedrock principle of financial economics. Ongoing compliance costs mean that every future securities transaction will need to be analyzed for its environmental impact. These costs have real financial impacts on the returns generated by an investment portfolio, and therefore, real impacts on the ability of an educational institution to achieve its goals.

60. By contrast, any benefits from fossil fuel divestment are likely to be non-existent. There is no basis to believe that divestment can affect the stock prices or business decisions of targeted firms. Moreover, there is broad agreement among financial professionals and academics that simple investment rules like divestment from fossil fuel companies cannot generate superior returns. Finally, divestment seems unlikely to affect the public debate or provide an effective tool even for those who strongly feel the need to address climate change.

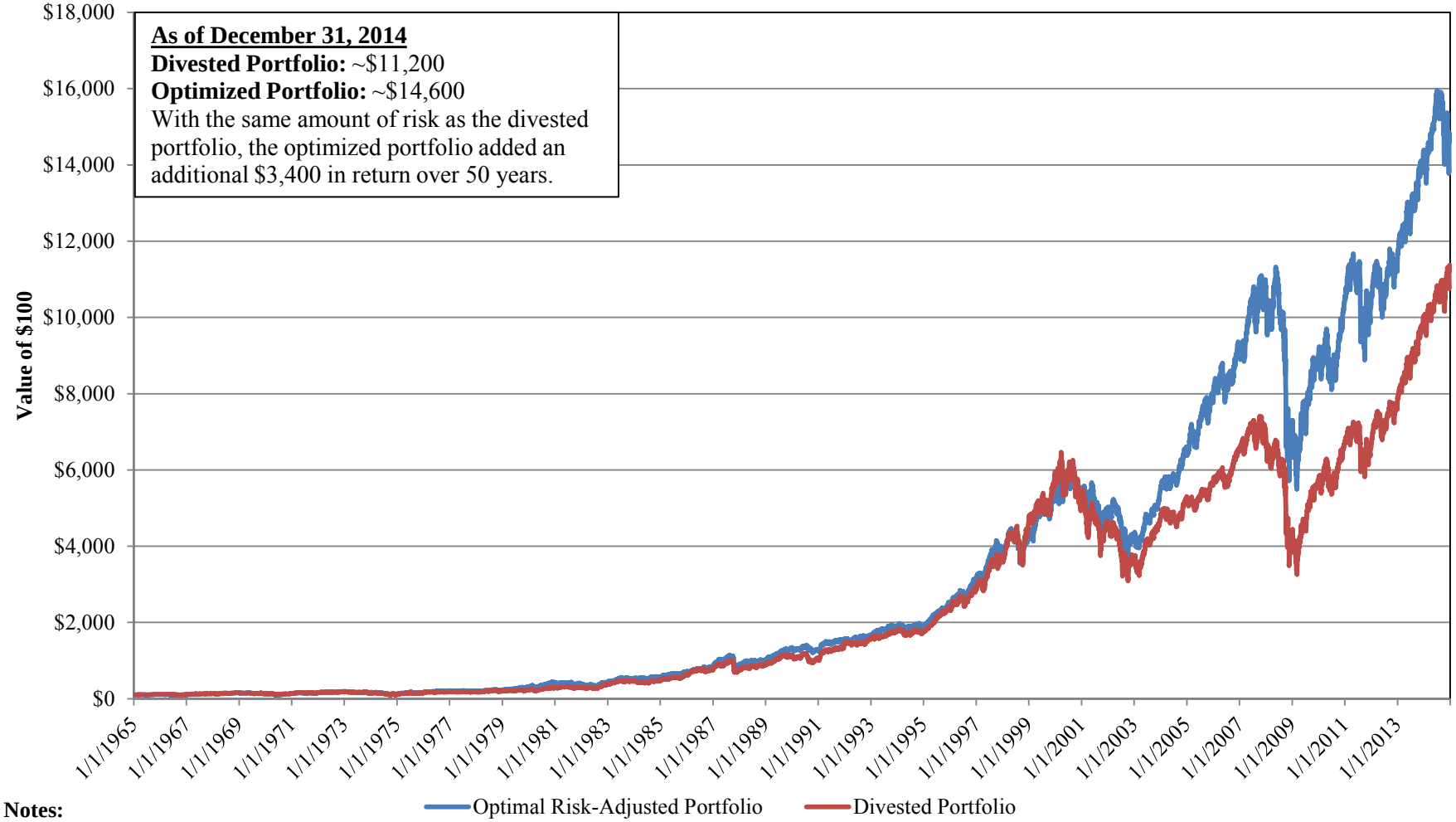
63. Zvi Bodie, Alex Kane, and Alan J. Marcus (2014) *Investments, Tenth Edition*, McGraw-Hill Irwin, at p. 380.

Exhibit A: Correlation of Each Sector With Other Nine Sectors

	Sector	Correlation
1.	Energy	0.6770
2.	Utilities	0.7046
3.	Healthcare	0.7744
4.	Telecommunications	0.8138
5.	Durables	0.8248
6.	High-Technology	0.8259
7.	Shops	0.8607
8.	Non-Durables	0.8642
9.	Other	0.9077
10.	Manufacturing	0.9183

Notes: For each sector, a value-weighted index of all stocks in that sector and a value weighted index of all stocks in the other nine sectors were created. The correlation between the excess returns of those two indices are shown in the Exhibit.
Source: CRSP.

Exhibit B: Optimal Risk-Adjusted Portfolio vs. Divested Portfolio
1965-2014



Notes:
[1] The indices are value-weighted by market capitalization.
[2] The Optimal Risk-Adjusted Portfolio is comprised of the energy index and 1-month Treasury bill, optimized by matching the standard deviation of the Divested Portfolio.
[3] The Divested Portfolio is comprised of only the non-energy index.
Sources: CRSP; Kenneth R. French.

Exhibit C. Top 10 Coal and Oil & Natural Gas Companies

	Carbon Underground 200	Greenhouse 100 Polluters Index
1.	Peabody Energy	American Electric Power
2.	ExxonMobil	Duke Energy
3.	Arch Coal	Southern Company
4.	Alpha Natural Resources	Berkshire Hathaway
5.	Chevron	Ameren
6.	Cloud Peak Energy	Luminant
7.	ConocoPhillips	FirstEnergy
8.	Consol Energy	AES
9.	Nacco Industries	Xcel Energy
10.	Alliance Resource Partners	Dominion Resources

Notes:

[1] The Carbon Underground 200 and Greenhouse 100 Polluters Index have been restricted to include only U.S. companies.

[2] All non-corporate entities have been removed.

Source: Carbon Underground 200; Bloomberg, L.P.; Political Economy Research Institute.

Exhibit D. Top 10 Holdings for Five Largest "Green" Mutual Funds

	Parnassus Core Equity Fund	Calvert Equity Portfolio	TIAA-CREF Social Choice Equity Fund	Neuberger Berman Socially Responsive Fund	Pax World Balanced Fund
1.	Allergan Inc.	**CVS Health Corp.**	Johnson & Johnson	Texas Instruments	**Apple Inc.**
2.	Applied Materials	**Apple Inc.**	Berkshire Hathaway Inc.	Newell Rubbermaid	BlackRock Inc.
3.	Motorola Solutions	**Gilead Sciences Inc.**	**Procter & Gamble Co.**	**American Express Co.**	UnitedHealth Group Inc.
4.	Pentair PLC	The Coca Cola Co.	Verizon Communications Inc.	Danaher Corp.	Becton Dickinson & Co.
5.	**Procter & Gamble Co.**	Costco Wholesale Corp.	International Business Machines Corp.	Progressive Corp.	Microsoft Corp.
6.	Iron Mountain Inc.	Visa Inc.	**Intel Corp.**	**Intercontinental Exchange Inc.**	Morgan Stanley
7.	**Qualcomm Inc.**	**Qualcomm Inc.**	**Merck & Co Inc.**	TJX Cos.	**Merck & Co Inc.**
8.	**Apple Inc.**	Lowe's Companies Inc.	**Gilead Sciences Inc.**	Robert Half International	Hess Corp.
9.	Mondelez International Inc.	**Intercontinental Exchange Inc.**	Google Inc. (Class A)	U.S. Bancorp	**American Express Co.**
10.	**CVS Health Corp.**	Wells Fargo & Company	Google Inc.	eBay Inc.	**Intel Corp.**

Note:
[1] Companies in bold appear in multiple mutual funds.
[2] Treasury holdings have been excluded.
[3] TIAA-CREF and Pax holdings data are as of 9/30/2014, the remaining holdings data are as of 11/30/2014.
Sources: The Forum for Sustainable and Responsible Investment (http://charts.ussif.org/mfpc/); GoFossilFree.org (http://gofossilfree.org/usa/your-roadmap-to-personal-divestment/); Parnassus (http://www.parnassus.com/parnassus-mutual-funds/core-equity/investor-shares/portfolio); Calvert (http://www.calvert.com/fundprofile.html?fund=919); TIAA-CREF (https://www.tiaa-cref.org/public/tcfpi/Investment/Profile?symbol=4530792); Neuberger Berman (http://www.nb.com/Pages/public/en-us/products/socially-responsive-fund.aspx); Pax (http://www.paxworld.com/system/storage/14/a0/3/773/fact_sheet_balancedfund.pdf).

Exhibit E-1. Associated Costs for 10 Largest Mutual Funds

	Fund	Expense Ratio
1.	Vanguard Total Stock Market Index Fund	0.17%
2.	Vanguard Institutional Index Fund	0.04%
3.	Vanguard 500 Index Fund	0.17%
4.	PIMCO Total Return Fund	0.46%
5.	The Growth Fund of America	0.66%
6.	Vanguard Prime Money Market Fund	0.14%
7.	Vanguard Total International Stock Index Fund	0.22%
8.	EuroPacific Growth Fund	0.84%
9.	J.P. Morgan Prime Money Market Fund	0.23%
10.	Fidelity Cash Reserves	0.28%
	Average	0.32%

Notes:

[1] The Bahana Liquid USD Fund was dropped because primary documents could not be located.

[2] "Expense Ratio" uses the most recent annual data from Morningstar.

Sources: Bloomberg, L.P.; Morningstar.

Exhibit E-2. Associated Costs for "Green" Mutual Funds

	Fund	Expense Ratio
1.	Parnassus Core Equity Fund	0.87%
2.	Calvert Equity Portfolio	1.11%
3.	TIAA-CREF Social Choice Equity	0.35%
4.	Neuberger Berman Socially Responsive Fund	1.12%
5.	Pax World Balanced Fund	0.91%
6.	Ariel Appreciation Fund	1.12%
7.	Ariel Fund	1.03%
8.	CRA Qualified Investment Fund	0.75%
9.	Domini Social Equity Fund	1.02%
10.	Calvert Balanced Portfolio	1.25%
	Average	0.95%

Notes:

[1] Where the Forum for Sustainable and Responsible Investment presents multiple investor classes of the same fund as having the same Assets Under Management, "Expense Ratio" is the average expense ratio across investor classes.

[2] "Expense Ratio" uses the most recent annual data from Morningstar.

Sources: The Forum for Sustainable and Responsible Investment; Morningstar.

APPENDIX A: KEY QUALIFICATIONS OF DANIEL R. FISCHEL

1. I am President of Compass Lexecon, a consulting firm that specializes in the application of economics to a variety of legal and regulatory issues. I am also the Lee and Brena Freeman Professor of Law and Business Emeritus at The University of Chicago Law School. I have served previously as Dean of The University of Chicago Law School, Director of the Law and Economics Program at The University of Chicago, and as Professor of Law and Business at The University of Chicago Graduate School of Business, the Kellogg School of Management at Northwestern University, and the Northwestern University Law School.

2. Both my research and my teaching have concerned the economics of corporate law and financial markets. I have published approximately fifty articles in leading legal and economics journals and am coauthor, with Judge Frank Easterbrook of the Seventh Circuit Court of Appeals, of the book *The Economic Structure of Corporate Law* (Harvard University Press, 1991). Courts of all levels, including the Supreme Court of the United States, have cited my articles as authoritative. My curriculum vitae, which contains a list of my publications, is available on the Compass Lexecon website at http://www.compasslexecon.com/.

3. I have served as a consultant or adviser on economic issues to, among others, the United States Department of Justice, the United States Securities and Exchange Commission, the National Association of Securities Dealers, the New York Stock Exchange, the Chicago Board of Trade, the Chicago Mercantile Exchange, the New York Mercantile Exchange, the United States Department of Labor, the Federal Deposit Insurance Corporation, the Resolution Trust Corporation, the Federal Housing Finance Agency, and the Federal Trade Commission.

4. I am a member of the American Economic Association and the American Finance Association. I am also a member of the Board of Governors of the Becker Friedman Institute at the University of Chicago and an Advisor to the Corporate Governance Project at Harvard University. I am also a former member of the Board of Directors of the Center for the Study of the Economy and the State at The University of Chicago, and former Chairman of the American Association of Law Schools' Section on Law and Economics. I have testified as an expert witness in multiple proceedings in federal and state courts across the country.

APPENDIX B: MEAN-VARIANCE ANALYSIS OF ENERGY STOCK DIVESTMENT

1. We make use of a common analytical framework used by financial analysts known as Mean-Variance Analysis.[1] We will show that by adding energy stocks to a market portfolio that is divested from the energy sector, one can achieve a substantially higher return over the 1965-2014 period without increasing the variance of the portfolio.

2. Mean-Variance Analysis reflects a typical investor's desire to build a portfolio that has high and stable returns, recognizing that there is a tradeoff between those two goals. Some investors are willing to accept a higher level of period-to-period volatility in returns, while others are not. The basic principle of Mean-Variance Analysis is that, for any given level of period-to-period volatility in portfolio return, an investor should choose the portfolio that maximizes average excess returns (relative to a "risk-free" asset, like U.S. Treasury bills). For example, if an investor is willing to accept a level of volatility in his portfolio such that the standard deviation in excess returns over time is 2 percent, then a portfolio with that 2 percent volatility measure and an average excess return of 3 percent is suboptimal if another portfolio with the same standard deviation but an average excess return of 4 percent exists.

3. Investors can achieve the maximum average return for a given volatility level by maximizing the "Sharpe Ratio" of the portfolio of risky assets, *i.e.*, excluding any risk-free assets.[2] The Sharpe Ratio is defined as:

$$\text{Sharpe Ratio} = \frac{Mean(Excess\ Returns)}{Standard\ Deviation(Excess\ Returns)},$$

1. *See*: Zvi Bodie, Alex Kane, and Alan J. Marcus (2014) *Investments, Tenth Edition*, McGraw-Hill Irwin, at p. 208.
2. *Id*., at pp. 134.

where excess returns is the calculated return of the portfolio relative to the return of the risk-free asset.

4. After selecting stocks to maximize the Sharpe Ratio, the investor can then add risk-free assets like U.S. Treasury bills to the portfolio to reduce its volatility as desired without reducing the Sharpe Ratio of the portfolio. In this way, the investor can achieve the highest expected return of the portfolio for a given level of volatility.

5. To estimate the diversification cost associated with restricting energy stocks from the portfolio, we constructed a value-weighted energy stock index from the CRSP database, as discussed in the text. Separately, we also constructed a single value-weighted index of all non-energy stocks in the other nine sectors. The means and standard deviations of the two indices over the 1965-2014 period are reported below in Table 1.

Table 1: Properties of Energy and Non-Energy Indices

Excess Returns	Non-Energy Index	Energy Index
Mean	5.77%	7.44%
Standard Deviation	15.71%	20.25%
Sharpe Ratio	0.3674	0.3674

Notes: "Energy" refers to the value-weighted index of all stocks in the Energy Sector. "Non-Energy" refers to the value-weighted index of all stocks not included in the Energy Sector.

Sources: CRSP; Kenneth R. French.

6. As can be seen in the Table, the Energy Index has higher average returns, but also a higher standard deviation, indicating greater volatility. Regardless of whether an investor is willing to take on greater volatility or not, including the Energy Index in the portfolio in at least some quantity generates diversification benefits because the Energy and Non-Energy indices are not perfectly correlated. In particular, the correlation coefficient between the two indices is 0.6770.To demonstrate this, we calculated the Sharpe Ratio for portfolios which combined the Energy Index and the Non-Energy Index with different weightings on each index. The portfolio including both energy and non-energy stocks that maximizes the Sharpe Ratio contains an allocation of 56.3 percent to the Non-Energy Index and 43.7 percent to the Energy Index. Table 2 below compares the Non-Energy index (*i.e.*, the divested portfolio) to the optimal portfolio including both indices.

Table 2: Properties of the Optimal Risky Portfolio

Excess Returns	Optimal Risky Portfolio	Divested Portfolio
Mean	6.50%	5.77%
Standard Deviation	16.20%	15.71%
Sharpe Ratio	0.4012	0.3674

Notes: Two value weighted indices were created: the first contains all energy stocks, and the second contains all non-energy stocks in CRSP. "Optimal Risky Portfolio" refers to the combination of the value weighted indices that maximizes Sharpe Ratio, and "Divested Portfolio" refers to the portfolio that contains only non-energy stocks.

Sources: CRSP; Kenneth R. French.

7. Consistent with our findings above regarding the Energy Index, the optimal portfolio including both indices has a higher average return, but also a higher standard deviation. We can now add a risk-free asset to the optimal portfolio including both indices until its volatility matches that of the divested portfolio. The risk-free asset for this analysis is the one-

month U.S. Treasury bill. As discussed above, the Sharpe Ratio of the portfolio is not affected by the addition of a risk-free asset. Specifically, by moving 3.04 percent of the combined energy and non-energy portfolio to the risk-free asset, the volatility of the portfolio can be made to match the volatility of the divested portfolio, with a standard deviation of 15.71 percent.

8. As shown in Table 3, despite having the same volatility as the divested portfolio, the portfolio that includes energy stocks earned an average return of 6.30 percent, whereas the divested portfolio earned an average return of only 5.77 percent. The difference between these two mean returns, 0.53 percent, is a measure of the portfolio diversification cost of divesting from energy stocks, holding portfolio volatility constant.

Table 3: Properties of the Optimal Risk-Adjusted Portfolio

Excess Returns	Optimal Risk-Adjusted Portfolio	Divested Portfolio
Mean	6.30%	5.77%
Standard Deviation	15.71%	15.71%
Sharpe Ratio	0.4012	0.3674

Notes: Two value weighted indices were created: the first contains all energy stocks, and the second contains all non-energy stocks in CRSP. "Optimal Risk-Adjusted Portfolio" refers to the combination of the value weighted indices and the risk free asset that maximizes Sharpe Ratio and matches the standard deviation of the Divested Portfolio, and "Divested Portfolio" refers to the portfolio that contains only non-energy stocks. The risk free return is the daily return of the treasury bills.
Sources: CRSP; Kenneth R. French.

9. While the above optimization shows that there is an allocation to energy stocks that improves portfolio performance, it should also be noted that the value weighted index created from all stocks in CRSP with an SIC code, *i.e.* the "market index," has a higher Sharpe

Ratio than the divested index considered above. Therefore, the market index will also provide a larger risk-adjusted return than the divested index. These results are reported in Table 4.

Table 4: Properties of Energy and Non-Energy Indices

Excess Returns	Non-Energy Index	Market Index
Mean	5.77%	5.86%
Standard Deviation	15.71%	15.70%
Sharpe Ratio	0.3674	0.3732

Notes: "Non-Energy" refers to the value-weighted index of all stocks not included in the Energy Sector. "Market" refers to the value-weighted index of all stocks in the CRSP database that were assigned an SIC code.
Sources: CRSP; Kenneth R. French.