Goal Directed Portfolio Management: The Case for Sustainability

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Sustainable investments help in the optimal use of natural resources for increasing the welfare of the current generation while not reducing benefits to the future generations, and preserving the global environment. Innovations in production technology in producing clean energy, and optimal use of recycling of the hazardous waste into usable energy are among approaches conducive to sustainable environment. Regulations that would limit the increase in hazardous waste appear to have helped in limiting pollution and optimal use of resources. Meanwhile, recent innovations in the capital markets are purported for mitigating global pollution. This is made possible by the trading of financial assets that allow risk sharing among industrial firms. In the presence of a ceiling or an upper limit for causing environmental hazards, firms with a more environmentally safe technology can sell their "rights to pollute" to the other firms. In this manner, the overall damage to the environment is at least within a given limit. It is speculated that the capital market by properly pricing the risk would help the more efficient firms to manage their cost and perhaps motivate other firms to follow suit. Nevertheless, the environmental threat is a case of a novel event for which historical information is unavailable. Especially relevant, the risk involved in environmental damages is governed by entropic laws of nature. Specifically, production in the real sector of the economy is a case of an increase in entropy as the use of raw materials is a case of turning the ordered state of nature into disorder. Similarly, such production processes are irreversible. That is, at best, one can limit the rise in global environmental risk.

INTRODUCTION

Portfolio management is concerned with a systematic approach for reaching desired goals while managing the risk involved. In this manner investable funds are allocated among competing classes of assets. Some investment portfolios are unconstrained in that the portfolio manager can select any asset and apply any trading rule. Constrained portfolios may include, but not be limited to, provisions in minimum and maximum allocation to an asset class, the coverage, degree of diversification, and special needs.

The inclusion of each constraint in a portfolio may affect the resulting outcome in terms of return and risk. One such constraint is inclusion of socially desired investments. The criteria for socially responsive investments have evolved and expanded globally over time. A recent example is the notion of sustainable investments. This is due to the various regulations, desire by stakeholders, developments of environmentally friendly technologies as well as the recent innovations in environmental financial contracts in organized capital markets. Equally important, environmentally friendly financial contracts may help business enterprises in pricing risk, transfer risk, and manage risk. In this manner, economic firms can manage their overall operating cost while pursuing environmentally safe activities.

Sustainability is about optimal use of natural resources not only for satisfying the current consumption needs but also to fulfill the needs of the future. This has been agreed upon among the nations, as recorded in United Nations Reports, as a basis for establishing a reasonable and meaningful portfolio of natural resources and energy across time, maintaining the needs of survival of both man and nature. In essence, sustainable consumption and investment in natural resources is purported to increase the welfare of the current generation while not reducing the welfare of the future generations, which is a case of Pareto optimality.

An example of environmental concerns is the climate change due to the rise in the temperature of the earth caused by emission of carbon dioxide or greenhouse gases. Similar hazards are the pollution in water and air. Individual and institutional investors should view conservation of earth as a part of their moral and ethical duties. The goal of sustainable or responsive investing is at the minimum, compliance with the rules and regulations in regards to preserving the environment. The survey of institutional investors by the CFA institute in 2015 revealed that some firms take the "first in class" approach to reduce the hazardous impacts of their production. The United Nations conference in 2015, known as the Paris Agreement, was a major step for countries around the world in recognizing the global risk of climate warming and the need for managing environmental hazards.

A firm that manages the environmental risk, and consequently its investors, may earn a reward for it. For example, there is a cost or penalty for pollution as industrial firms are regulated in that regard. As a result, some firms have pursued production techniques that reduce or may eliminate environmental hazards. Firms that do not have the capacity, or ability, to modernize their production process may be faced with an increase in their operating costs. As the goal of regulation is to limit the amount of the overall environmental hazards, the environmentally friendly firms which fall far below their limit of pollution can transfer their excess "right to pollute" to the other firms that far exceed their limit. Financial contracts have evolved in the organized financial markets for the purpose of trading and pricing of such "right to pollute." Environmentally friendly firms can thereby reduce their costs by selling the "right to pollute" to other industrial companies.

For example, consider two identical electric power generating companies whereby firm A uses 100% coal as input and pollutes the air while firm B uses 100% solar energy with minimal pollution. If both firms A and B are identically regulated, each is granted 100 "rights" to pollute during a given time. Firm A, however, may need 200 "rights" and will have to acquire the additional "rights" from the financial markets at a cost. Firm B will receive a monetary reward for being environmentally friendly and can thereby reduce its cost of capital. Sustainable reduction in the cost of capital for firm B, the environmentally friendly firm, may result in an increase in its overall market value.

While, it initially appears that there is no overall environmental benefit, one may want to consider that firm B has managed its risk, achieved a reduced cost of capital and has increased its chance of survival. In contrast, Firm A has transferred its risk to investors in the capital market who would require a reward for taking such risk. As the reward or the price of taking risk by investors in the market rises, the operating cost for firm A will rise to a point that would drive it out of business. Alternatively, as investors require a reward for taking risk, the cost associated with the "right to pollute" will continuously rise which should motivate the pollutant firm—firm A— to manage its pollution risk by acquiring environmentally safe operating procedures. The sustainable firm—firm B—on the other hand earns a reward from the financial market which would reduce its modernization costs. Thereby, the capital market by pricing the environmental risk can help in reducing environmental hazard. The rise in cost for non-responsive firms in the long run will result in an increase in their cost of capital and a reduction in their market value.

Establishment of environmental assets within a liquid market with active trading is explored in detail in Sandor, Clark, Kanakasabai and Marques (2014). A class of environmental assets, as established in 1982, is known as the cap and trade: this is possible if each firm has some limited quantity of "right to pollute." A firm with an efficient, environmentally friendly production system will naturally be less pollutant. Thereby, such property rights can be sold to others, generating periodic cash inflows which would reduce the cash outlays of a more efficient production system. Thereby, the government by limiting pollution, but accepting the minimum right to pollute, may help in reducing the cost of establishing a more efficient production system. In the long run, as the government continuously reduces the right to pollute, the prices for cap and trade, as marketable property rights, will rise which should motivate the adoption of an environmentally friendly production system across the firms.

As noted by Sandor, Clark, Kanakasabai and Marques (2014), cap and trade assets such as greenhouse gas or carbon dioxide, CO_2, and sulfur dioxide, SO_2, with derivative contracts, such as futures and options contracts, are available in the financial markets. In this manner, firms can buy the needed allowances for pollution, and further reserving those rights at current prices for later use through the futures contracts. As the authors note, the application of cap and trade due to the Clean Air Act of the 1990s has helped in the elimination of acid rain. As the supply of "right to pollute" declined, and its price rose, firms switched to environmentally safe production systems.

SUSTAINABILTY AND MARKET VALUE

The value of the firm depends on the discounted value of cash flows to the stockholders and the bondholders. Jensen (2002) notes that the goal of the firm should be to increase the total long term market value of the firm. Such an approach is consistent with environmental sustainability based on the empirical evidence. It is noted that sustainable firms appear to have a lower cost of equity capital as well as the cost of debt. Furthermore, there is evidence of reduction in the overall risk of environmentally efficient firms. Thus, the combination of the two would lead to a higher long run value for firms pursuing sustainable investments.

An indicator of firm value is the Tobin's Q ratio as the ratio of the market value of the firm to its replacement value. Dowall and Yeung (2000) show the effect of complying by stringent global environmental standards by applying the Tobin's Q ratio. The authors found that the Tobin's Q ratio of such firms were higher than those of comparable firms who did not meet the standards. Thereby, firms meeting the stringent global environmental standards appear to have an increase in their market value. The sample firms were taken from the Standard and Poor's composite index of 500 companies during 1994 – 1997. Stringent environmental standards were defined as the firm's internal standards that exceed both local country and U.S. standards. The authors applied Granger causality test for the relationship between environmental standards and the market value of the firm. The test design is based on the feedback and feed forward mechanisms as shown in equations (1) and (2).

Market value is a function of a) past changes in environmental standards, and
b) past changes in market value. (1)

Environmental standards are a function of a) past changes in environmental standards,
and b) past changes in market value (2)

The value of the firm, is in part, influenced by the rate of discount, or the cost of capital, that is applied to its future stream of cash flows, given its level of risk. Chava (2014) finds that environmental concerns about the firm and its products or services appear to lead to a higher cost of capital. The author used environmental profile of the firm, analysts' estimates of required return on common stock and the cost of borrowing during 1992 – 2007. In addition KLD screens, both positive and negative, were considered. Negative KLD screens included production of hazardous waste, pollution, and climate change concerns. Positive KLD screens included the use of innovative technology, and the production of clean energy. The author showed that the cost of equity capital or the required return on the part of stockholders, statistically and significantly rise and tend to be higher due to the uncertainty induced by the environmental hazards. Environmental strengths of the firms however, did not appear to result in a lower cost of equity capital. The required return on the part of the creditors or the rate of interest charged by banks was lower for firms with positive environmental factors and higher for firms with negative environmental behavior. The overall cost of capital by combining the cost of equity and the cost of debt, appear to be higher for firms with climate change concerns. It should be noted that a high cost of capital leads to a lower market value for the firm.

Similarly, Viehs (2015) shows that a one percent reduction in greenhouse gas emission leads to about half a million dollars reduction in annual cost of the bank loan. Klein (2015) finds that 70 percent of institutional investors view adherence to environmental factors as part of their fiduciary duties. Benson, Gupta and Mateti (2010) use the capital asset pricing model for comparing the monthly performance of Dow Jones Sustainability Index with the overall market which is constructed as the value-weighted return on all stocks in CRSP database during January 1999 - December 2009. The resulting beta is 0.9534 and is statistically significant. This shows that sustainable investments have below average volatility. The alpha is -0.001 and statistically insignificant, which shows slightly below average return. Alpha of zero signifies neutral or equilibrium return, in line with expectation. This empirical observation shows, in part, support for sustainable investment.

Eccles, Ioannou, and Serafein (2014) examine firm performance, in both accounting and market-based measures, of 180 matched samples with a similar structure and find that those firms that adopted sustainable criteria by 1993 had a better performance by 2009. Of the 180 companies, 90 were classified as high sustainability and 90 as low sustainability. The two samples were initially identical in terms of industry classification, sector accounting measures of size, and capital structure. The authors study the two sample firms for 18 years of performance and note that the high sustainability firms have excess return performance of 2.3 percent and 4.8 percent on an equally weighted and value weighted basis, respectively.

Value of the firm includes both the tangible assets as well as intangible assets. Intangible assets include, but may not be limited to, the reputation of the firm, its rights and loyalties as well as the quality of its management. Shameek and Cohen (2001) find that firms with a poor environmental behavior appear to induce a negative impact on the value of their intangible assets. The sample firms which were subset of the Standard and Poor's 500 stock index had an environmental liability of \$380 million in 1988-1989. Data are for 1989 with lagged values.

Alternatively, firms with a better environmental reputation tend to possess a higher intangible asset value. They found that a 10 percent reduction in chemical hazards results in \$34 million increase in market value. The research methodology was based on the Tobin's "Q" ratio as shown in equation (3).

$$Q = \text{Market value of assets} / \text{Replacement value of assets} \tag{3}$$

Noting that the market value consists of the tangible (TV) and intangible (IV) values of the firm, equation (3) can be expanded to equation (4) as follows.

$$Q = [\,(TV + IV) / TV\,] = 1 + (\,IV / TV\,). \tag{4}$$

That is, Tobin's "Q" ratio equals 1 plus the ratio of intangible to tangible asset values of the firm. The authors then measure environmental performance by both the aggregate pounds of toxic chemicals per dollar of revenue and the number of environmental litigation against the firm which may affect the value of the intangible assets of the firm.

SUSTAINABLE INVESTMENTS AND PERFORMANCE

Managing the environmental impacts of the firm appears to affect economic growth. Grossman and Krueger (1995) studied the impact of environmental indicators, including air pollution, the state of oxygen regime in river basins, fecal contamination of river basins, and contamination of river basins by heavy metals. The authors find that economic growth brings an initial deterioration, followed by improvement in environmental quality as well as overall economic growth, and does not cause deterioration in environmental quality in the longer time horizon. The authors note that "the productivity of our resources in production of goods and services is influenced by climate, rainfall, and the nutrients in the soil."

Environmental management appears to result in a better financial performance for the firm. Conversely, significant negative returns in the market may be as a result of negative environmental event. Klassen and McLaughlin (1996) note the role of product technology—the use of recycled materials and recycling—as well as process technology—inclusion of environmental control and hazard prevention. The research methodology includes event studies for measuring excess risk-adjusted return following an environmental event in the context of the single index model, while controlling for other factors such as, firm size, revenue, and the impact of time. The sample for the event study was carefully designed to exclude the follow up news on the event date during 1985-1991. Environmental events were identified as oil spills or chemical hazards, gas leak, and explosion. The authors found that environmental performance is tied to financial performance and conversely, negative market returns were the result of weak environmental management. Event study statistical design were used in the context of the market model as a return generating function as shown in equations (5) and (6).

$$R_i = a + b_i R_m \quad \text{and} \tag{5}$$

$$A_i = R_i - a - b_i R_m \tag{6}$$

Where, R_i denotes the estimated return and A_i is a measure of the abnormal return. The cumulative value of A_i would be cumulative abnormal return—CAR—over the time period of the event study window. Positive environmental events were during 1985-1991 and negative environmental events were during 1989-1990. Common stock data were taken from Center for Research in Securities Pricing (CRSP). The authors found a positive market gain and cost savings as a result of good environmental events. Conversely, negative environmental events were correlated with negative market performance and cost penalties.

Environmentally friendly firms should experience a better risk adjusted return. Barnett and Salomon (2005) show empirical evidence for curvilinear performance of socially responsive investments: initial decline in performance is followed by increasing risk-adjusted return. These results support their hypothesis that the socially responsive constrained optimization can achieve a reasonable risk-adjusted performance. In effect, the stakeholder theory and the mean-variance analysis can be combined in order to achieve an optimal portfolio of investments. Environmental constraints, however, appear to lead to a decrease in financial performance. The authors controlled for mutual fund age, total assets, and asset allocation, while examining the effects of labor relation, community involvement, and environment. Time horizon included 1972 – 2000.

Recognizing the costs of environmental hazards can help safeguarding an investment portfolio against risk. Andersson, Bolton, and Samama (2016), introduced an approach to build a de-carbonized index by dropping the high-carbon issues, while including investments with high correlation with the carbonized issues, and at the same time maintaining an optimal weight to fully track the Standard and Poor's index of 500 stocks. It was noted that during January 2007–November 2014 environmental services produced results comparable to the Standard and Poor's index of 500 companies, with similar volatility or risk. (5.02 percent for environmental services and 4.79 percent for the Standard and Poor's index of 500 stocks.) However, clean technology had an average return of about half as much as the Standard and Poor's 500 stock index together with higher volatility. The alternative energy, clean energy, and green energy had produced negative return with greater volatility than the Standard and Poor's 500 stock index.

Hoepner (2010), shows that the addition of environmental investments improves portfolio diversification by reducing its risk. Noting that the risk of a well-diversified portfolio is the covariance risk, Hoepner stresses the low or negative correlation between environmental firms and other business enterprises. Such low or negative correlations tend to reduce the average covariance risk of the overall portfolio. As a result, environmentally diversified investment portfolios can dominate other investments with a lower return, on a risk-adjusted basis.

Anderson, Bolton and Samama (2016), followed the approach of maintaining the overall risk of an investment portfolio equal to the benchmark risk, while at the same time managing the proportions invested in the portfolio in such a way that its return would track the benchmark return while lowering the carbon-related investments. They find that zero tracking error corresponds with about 50 percent holdings of carbon-related investments in this hedged portfolio. By noticing that the carbon risk is not priced in the market, the authors in effect establish an investment plan that has a free option on carbon investment. This is because when the carbon risk is recognized and is priced in the market, the hedged portfolio will outperform. Otherwise, the hedged portfolio and the benchmark will both have the same risk-adjusted returns. This strategy is purported to mitigate the risk of stranded assets, as it appears that only about half of the proven reserves of fossil fuel can be consumed without further damaging the earth.

ENTROPY AND SUSTAINABILITY

Global warming, as a threat to nature, is a novel event for which historical information is unavailable. Especially relevant, in the absence of a detailed and normal probability distribution of the possible outcomes, standard statistical analyses are not applicable. That is, we have not observed such a situation in the past and thereby, its occurrence will be highly surprising. Such a risk cannot be measured by standard deviation away from an average value.

The change and the range in the earth temperature, or pollution, in the future may be quite different from the past with varying distributions. Sargent (2014), notes that relative entropy is a measure of discrepancy between two probability distributions, (f_1, f_2). And the entropy of (f_1, f_2) denoted as "S" is shown in equation (7).

$$S = E \log (f_1 / f_2) = E (f_1 / f_2) \log (f_1 / f_2) \tag{7}$$

Where, "E" denotes expected value, "log" denotes the logarithm, and f_1 and f_2 represent the probability distributions before and after the occurrence of the event. As shown in equation (8), entropy is a measure of the change between two distributions of possible outcome. It should be noted that the entropy measures are independent of the form of the distribution of the outcome and that the standard normal distribution is simply a special case within this construct. Entropy is, in effect, a generalized measure of risk and includes the standard deviation as a special case.

$$S = E \log (f_1 / f_2) = E (f_1 / f_2) \log (f_1 / f_2) = E (f_1 / f_2) [\log (f_1) - \log (f_2)] \tag{8}$$

The value of the relative entropy is, in effect, a measure of divergence between the two probability distributions. A rise in the value of entropy reflects increased uncertainty in the system. That is, a higher degree of entropy is an indication of divergence of future state of nature from the past.

Georgescu-Roegen (1971) states that "The economy of biological process is governed by the entropy law, and not by the law of mechanics." Especially important, is to recognize the nature of uncertainty associated with a novel state of nature for which no historical information is available. Entropy is better known in thermodynamics as stated in the First Law and Second Law. According to the First Law of thermodynamics, the free, useful, and available energy turns into unavailable energy in the production process. However, the total amount of energy remains constant. For example, coal has available energy, and once it is burned, it turns into ashes while generating heat. The ashes however have no available energy to produce heat. In thermodynamic terms, the quality of energy in coal is in an ordered state, while for the case of the ashes, it is disordered. According to the Second Law of thermodynamics, the transition from the ordered state into a disordered one is a case of increasing entropy. Along the same line of thinking, the transition from coal to ashes, leading into an environmental waste and pollution, is a case of turning a low entropy state into a high entropy state.

Georgescu-Roegen refers to thermodynamics as the physics of economics value and notes that "economic life feeds on low entropy, as for example, lumber and copper are highly ordered structures." That is, low entropy is a necessary condition for usefulness. Accordingly, low entropy items are turned into high entropy items when used. In other words, we can use the energy only once and that the supply function is entropic in nature. Thereby, one needs to find an acceptable tradeoff between an increase in the utility of consumption and the rise in entropy of nature. This is a case of tradeoff between economics and the environment. Furthermore, as noted by Alfred Marshall (1924), the supply function is irreversible as we can use the raw materials only once.

As a result of new regulations and developments in the financial markets for trading of environmental assets, such as the cap and trade, pollution allowance rights can be sold by environmentally efficient firms through the financial market dealers, the proceeds of which can be used for establishing new environmentally friendly technologies such as scrubber facilities in order to transform greenhouse gasses into usable energy in the production system. However, regulation, and innovations in the capital markets can only help in reducing the rate of increase in the entropy of the universe. Similarly, improving the production system, for example, the use of scrubber facilities or other technological innovations for absorbing greenhouse gases, help in reducing the rate of increase in entropy of the universe, and hence reducing pollution, but more is needed to provide a remedy.

MANAGEMENT IMPLICATIONS

Global treaties in preserving the earth and for reducing hazardous wastes and pollution are positive steps in reducing risk to the earth and moving toward a more sustainable environment. Optimal use of natural resources should aim for not only the satisfaction of the current consumption but also to fulfill the needs of the future. Managers of economic firms appear to acknowledge the risk of environmental hazards by utilizing innovative environmentally friendly technologies. Recent developments in the financial markets can further help in reducing environmental hazards due to motivation of financial managers in reducing the cost of capital to the firm. Moreover, the environmental threat is a novel event for which historical information is not available. Especially relevant, the risk involved in environmental damages is governed by entropic laws of nature. Specifically, production in the real sector of the economy is a case of an increase in entropy as the use of raw materials is a case of turning the ordered state of nature into disorder. That is, the economic process is entropic and irreversible and by extension, the nature continually moves from an ordered state into a disordered one. It follows that in pursuit of a sustainable environment, one needs to reduce the degree of divergence between the future states of nature from its past.

Empirical evidence shows strong support for environmentally safe production technologies and sustainable investments. This is due to an increase in the market value of the firm, a reduction in annual cost of borrowing, as well as the overall cost of capital, and a better financial performance for the firm. In addition, it is found that safeguarding the nature is conducive to economic growth. Sustainable investment portfolios have further shown to have lower risk due to the low or negative correlation between environmental firms and other business enterprises, a useful property for investment portfolio diversification.

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