The Effects of Responsible Investment: Financial Returns, Risk Reduction and Impact

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This report focuses on three key questions for responsible investors:

- Does responsible investment lead to outperformance or underperformance?
- Can responsible investing impact company behaviour?
- What is the optimal way to allocate an investment portfolio in a responsible way?

These questions are answered by constructing an equilibrium model of the financial economy in which active, neutral investors (with no knowledge or regard for environmental risk) and active, responsible investors (who take environmental risk into account) bid for shares in companies with varying levels of environmental risk.

The companies in turn are able to pay a cost to reduce their environmental risk. Companies choose the amount of reduction that they pay for so as to maximise their share price, as determined by demand for their shares from the active investors. In addition, several types of passive index investors are considered in the model including investors who follow a Divestment strategy, an Environmental Tracking (ET) index strategy and a combined Environmental Tracking and Divestment strategy.

Note that while environmental risk is the subject of this report, the results apply equally well to any extra-financial risk that may be considered by responsible investors.

Under realistic choices for the model parameters it is found that:

- Responsible investors, and index investors following responsible strategies, enjoy capital gains relative to neutral investors as the level of responsible investment increases.
- Responsible investing can have an impact on company behaviour, potentially leading to greatly reduced environmental risk in the economy.

- Among all practical responsible investment strategies considered in this report, the Environmental Tracking approach developed by ET Index Research exhibits the best characteristics.

Model

The model explored in this report builds on the seminal work of Heinkel, Kraus and Zechner (2001). To make the model realistic and relevant to actual investors, the setup outlined in the points below was used.

Company setup

The financial economy consists of investors and companies. There are *I* companies in the economy. The companies all have the same expected return, μ and standard financial risk (variance), σ^2. The correlation between the standard financial returns of different companies is a fixed parameter, ρ. The correlation and risk information can be mathematically summarized in the standard risk covariance matrix Σ.

Companies also have environmental risk, σ_E^2, so that each company i has total risk equal to the sum of its standard and environmental risks, $\sigma_{Total,i}^2 = \sigma^2 + \sigma_{E,i}^2$. The correlation between the environmental risks of different companies is ρ_E, and environmental risk is assumed to be uncorrelated with standard risk.

Each company's environmental risk exposure is driven by its individual level of environmental risk. Each company i is assigned an initial (prior to responsible investment) level of individual environmental risk given by:

$$\sigma_{e,i,0}^2 = a_0 \exp(\frac{b_{0i}}{I})$$

Here the parameters, a_0 and b_0, control the absolute level and the slope of the exponential curve of the environmental risk level across companies, respectively.

The curve of environmental risk levels across companies is shown in Figure 1.

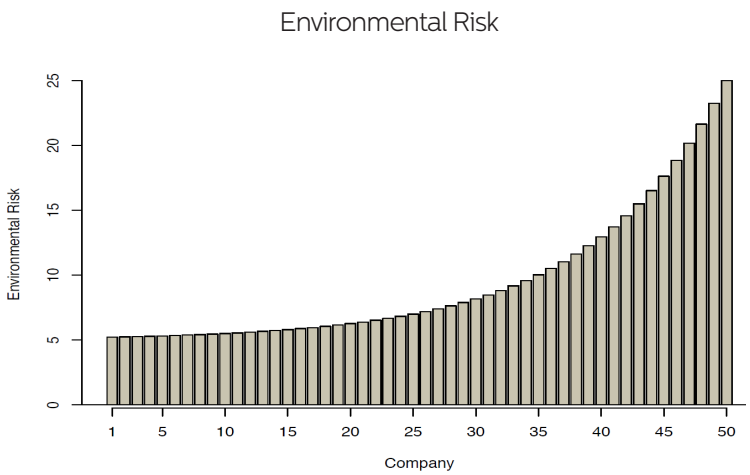

Figure 1: The initial total environmental risk of each company, prior to any risk reductions.

Risk reduction and costs

Companies may reduce their environmental risk for a cost by choosing a reduction parameter, $r_i \geq 0$, which reduces their individual environmental risk, $\sigma_{e,i}^2(r_i)$, but also their expected return, $\mu_i(r_i)$, in the following manner:

$$\sigma_{e,i}^2(r_i) = \sigma_{e,i,0}^2 \exp(-r_i)$$
$$\mu_i(r_i) = \mu - c_i r_i$$

Companies choose their risk reduction parameter, r_i, to maximize their share price. That is, a company is only willing to increase the value of its risk reduction parameter if the investors will value the resulting decrease in environmental risk more highly than the corresponding increase in costs that the company will incur. The investors will then be willing to pay more for the company's shares if the risk reduction parameter is increased.

The reduction cost parameter, c_i, for each company is set in proportion to the company's initial level of environmental risk:

$$c_i = c_0 \sigma_{e,i,0}^2$$

This ensures that companies with more environmental risk must pay greater absolute costs to reduce their risk.

Global risk and individual companies

The global nature of environmental risk is featured in the model in two ways:

1) Each company is exposed not only to the risks from its own environmental performance (and that of its supply chain), but also to the risk to the whole economy from the global sum of environmental risk that all companies create together. For example, consider that links have been drawn between the incidence of extreme weather events (which specifically affect the returns to insurance companies) and the global level of greenhouse gases (which is contributed to by every company).

2) If the global sum of environmental risks decreases, then the actual contribution of each company's environmental risk to its own financial risk will be smaller. For example, consider that if global greenhouse gas emissions were to suddenly drop dramatically, the various pressures on carbon-intensive businesses to lower their emissions would also decrease.

The above two ideas are incorporated into the model, in that each company's total environmental risk, $\sigma_{E,i}^2$, is defined as the sum of a fixed contribution, σ_{Global}^2, from the global risk, and a contribution from the individual risk of the relevant company, $\sigma_{e,i}^2(r_i)$, both multiplied by the level of global environmental risk relative to its initial level (prior to any company paying to reduce its risk), such that:

$$\sigma_{E,i}^2(r_i) = \left(\frac{\sum_i \sigma_{e,i}^2(r_i)}{\sum_i \sigma_{e,i}^2(0)} \right) (\sigma_{Global}^2 + \sigma_{e,i}^2(r_i))$$

The contribution of global environmental risk to each company's risk can be seen in Figure 1, as it defines a floor level of risk below which even the risk of the company with the lowest level of environmental risk (Company 1) cannot go.

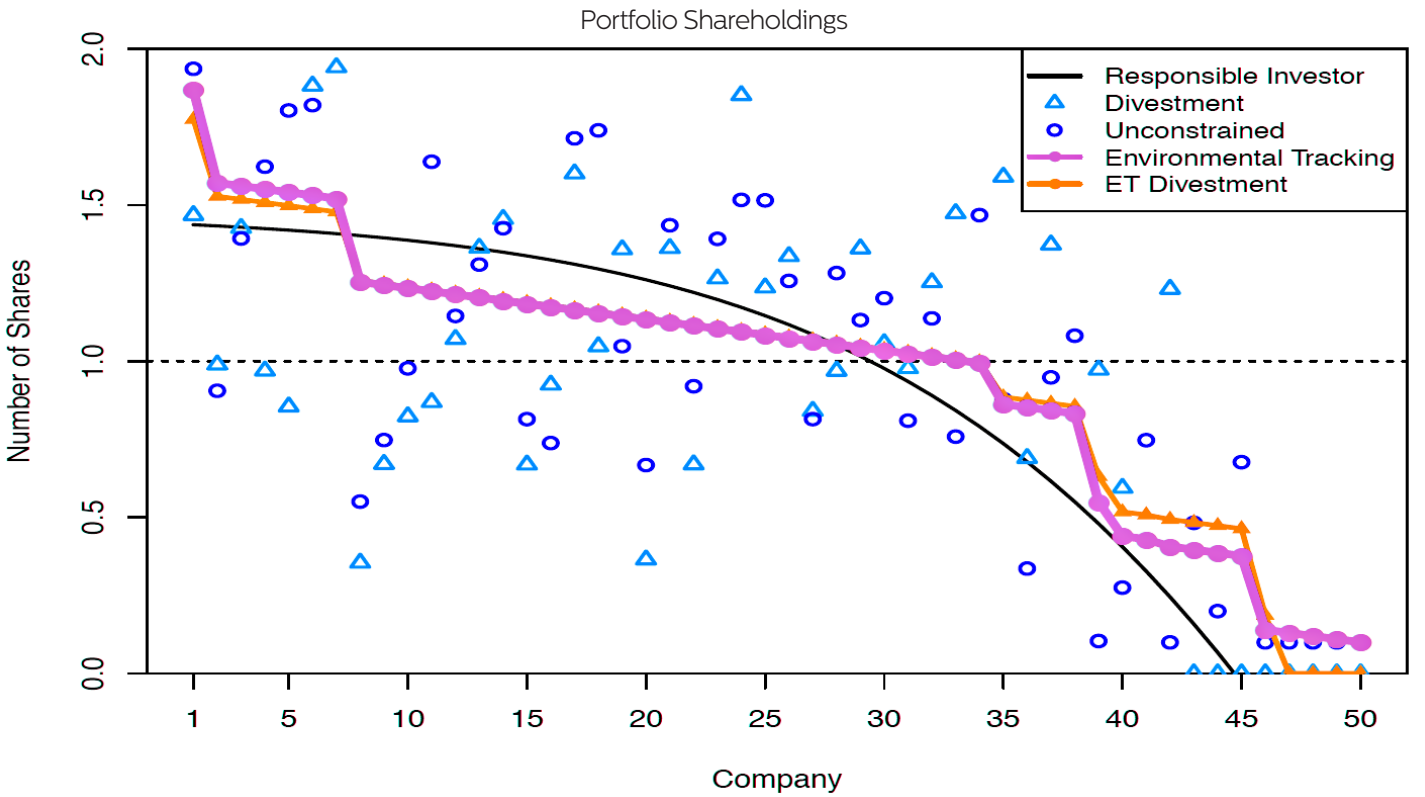

Figure 2: Typical portfolio shareholdings for each strategy. The market portfolio is to hold one share in each company.

Extensions of this model could allow for the companies to have different exposures to the global level of environmental risk. Companies are assumed to have the same exposure in this report for simplicity.

Investors

Each company issues one share for each investor in the economy. Thus, the "market portfolio", the portfolio that the average investor will hold, consists of one share in each company. However, any given investor may hold more or less than one share in each company.

A fraction, $0 \leq J \leq 1$, of investors are active investors, which means that they determine their own investment portfolio so as to maximize their own expected utility. The rest of the investors are passive index investors, which means that their investment portfolios are determined by an index provider (this is explained in more detail below).

Index investors may only hold long positions (that is, they must hold a non-negative number of shares of each company). Active investors are allowed to short sell (that is, they may hold a negative number of shares of any company).

A fraction, K_R, of active investors are "responsible investors", and the rest of active investors are "neutral investors".

Neutral investors only observe the standard risk of each company. Thus, they do not incorporate environmental risk information into the management of their portfolio.

Responsible investors observe both the standard risk and the environmental risk of each company. They incorporate environmental risk into their portfolio management strategy in the same way that they include standard risk in their investment decision making. This is the only difference between responsible investors and neutral investors considered in this report. However, as can be seen in Figure 2, this difference does lead to significant changes in shareholdings for the responsible investors.

Index Strategies

Index investors engage in responsible investment by following one of the responsible index strategies outlined below. Any index investor that does not follow one of the responsible index strategies simply holds the market portfolio. This is equivalent to all market-cap weighted index products, which make up the majority of index investment products today. The fraction of index investors holding the market portfolio is labelled K_M.

A fraction, K_D, of index investors follow a "Divestment" responsible index strategy, which means a strategy of divestment from (i.e. holding 0 shares in) the stocks with the greatest environmental risk until the net exposure to environmental risk has been reduced by more than 50%. The shareholdings of the rest of the portfolio are then adjusted so as to minimize tracking error with respect to the market portfolio. This strategy is representative of both divestment and best-in-class type indexes offered by real index providers. An example of portfolio shareholdings for a divestment strategy can be seen in Figure 2.

A fraction, K_{ET}, of index investors follow an "Environmental Tracking" responsible index strategy, which means a strategy that minimises tracking error with respect to the market portfolio with only three constraints:

1) That the total environmental risk exposure of the portfolio be reduced by 50%.

2) The minimum shareholding in any company is 0.1 shares (so as to differentiate this strategy from Divestment).

3) For each company the number of shares held must be greater than the number of shares held for any other company with more environmental risk.

This strategy is representative of the ET Low Carbon Index series created by ET Index based on the ET Carbon Rankings. An example of portfolio shareholdings for an Environmental Tracking strategy can be seen in Figure 2.

A fraction, K_U,of index investors follow an "Unconstrained" responsible index strategy, which means a strategy that attempts to minimize tracking error with respect to the market portfolio with only two constraints:

1) That the total environmental risk exposure of the portfolio be reduced by 50%.

2) The minimum shareholding in any company is 0.1 shares (so as to differentiate this strategy from Divestment).

This strategy is representative of some non-divestment indexes offered by real index providers. An example of portfolio shareholdings for an unconstrained strategy can be seen in Figure 2. The strategy is unconstrained in the sense that the number of shares held in each company in an unconstrained portfolio is not constrained to be in line with the environmental risk level of the company. This is as opposed to the Environmental Tracking strategies where companies with higher environmental risk will always be assigned lower portfolio shareholdings than companies with lower environmental risk (in other words the essence of Environmental Tracking is that shareholdings are 'constrained' by rankings based on environmental risk).

A fraction, K_{ETD}, of index investors follow an "ET Divestment" responsible index strategy, which means a strategy that combines the Environmental Tracking and Divestment strategies to minimize tracking error with respect to the market portfolio with two constraints:

1) That the total environmental risk exposure of the portfolio be reduced by 50%.

2) The number of shares held in any company must be greater than the number of shares held in any company with more environmental risk.

This is different from the Environmental Tracking strategy in that divestment is allowed. This strategy is representative of the ET Fossil Free Index series created by ET Index based on the ET Carbon Rankings. An example of portfolio shareholdings for an ET Divestment strategy can be seen in Figure 2.

Realistic information and the index provider

It is also important to include in the model the fact that in practice investors will only have imperfect information on the expected risks and returns of each company. No individual investor will have perfect information. In this model, though, the average active investor portfolio is derived assuming perfect information, as the active investors are assumed to be a large, diverse group of investors that when investing together lead to the same result in equilibrium as a single investor with perfect information. However, the same reasoning cannot apply to the index investors as in practice index investments are dominated by a handful of large players. Each of these players will have noise in the information that it uses to compute its index strategies. And due to the use of similar procedures this noise will often be correlated between index providers. Thus, in this model it is conservatively assumed that there is only one index provider that calculates the strategies for all the index investors.

The index provider makes a noisy estimate of the matrix of correlations between stocks in the economy. The correlation matrix is assumed to be equal to the true matrix plus random noise (to be mathematically precise, the standard risk covariance matrix Σ is perturbed by $dD'D$, where D is a matrix of values drawn from the standard normal distribution, so that the symmetric nature of the covariance matrix is preserved).

It is however still assumed that both the active investors and the index provider have perfect information on the level of environmental risk of each company.

Following Heinkel et al. (2001), each active investor, *j*, chooses their allocation, x_{ji}, to each stock, i , to maximize their utility function:

$$U_j = \sum_i x_{ji}(\mu_i(r_i) - P_i) - \frac{1}{2\tau}\sum_i \sum_k x_{ji}x_{jk}\sigma_{ik,j}(r_i, r_j)$$

where P_i is the price per share of company i, τ is the risk aversion parameter, and $\sigma_{ik,j}(r_i, r_j)$ is the covariance between returns of companies i and k as viewed by investor j.

Given a fixed percentage of responsible investors (among active investors) and responsible index investors (among index investors) all the investors determine their orders for shares in each company, and the companies decide how much to spend on reducing environmental risk until an equilibrium is reached and each company has a stable price per share. This equilibrium is determined by the market clearing condition: that for the equilibrium set of share prices the total demand for shares in each company (i.e. the holdings of all active and index investors) must equal the total supply (i.e. the number of shares each company has issued).

However, note that the equilibrium share prices and investor allocations change as the percentage of responsible investors and responsible index investors changes (that is, as the demand for shares with different environmental risk characteristics changes). The results of these changes are the focus of this report.

Choice of Parameters

The following parameter values were used:

- τ = 10 is a typical value for risk aversion (Ang, 2014).
- J = 85%, meaning that 15% of investors are passive index investors, is in line with observed levels of passive investment (Boston Consulting Group, 2015).
- σ^2 = 100 and μ=10 are consistent with Heinkel et al. (2001).
- ρ = 0.3 is a reasonable choice in line with average levels of correlations observed in the stock market globally over the last 25 years.

- $\rho_E = 0.5$ was chosen to reflect that the effects of environmental risk are likely to be more systematic and less diversifiable than standard risk (hence a higher correlation parameter than ρ above).
- The number of companies $I = 50$ was set simply to enable the computational solution of the model in a reasonable amount of time. The results were found to not vary significantly when tested with other numbers of companies.
- $\sigma^2_{Global} = 5$ (5% of the standard risk level σ^2) was set in order to include a non-trivial but still reasonable level of global environmental risk.
- The parameters which determine the distribution of environmental risk among the companies, $a_0 = 0.2$ and $b_0 = 4.6$, were set to give an exponential distribution to the level of environmental risk across companies, from very little (0.2% of standard risk) to a significant 20% of standard risk at the higher end. This reflects the distribution of carbon intensity levels observed in the ET Carbon Rankings. The resulting curve of environmental risk levels across companies is shown in Figure 1.
- The cost level parameter $c_0 = 0.1$ was set to give a level of reduction costs intended to be reasonable but conservative. With this parameter value the most environmentally risky company would have to spend 20% of profits to reduce its environmental risk by 63%. This compares conservatively to Heinkel et al. (2001), where all companies can eliminate 100% of their environmental risk for a cost of just 5% of their expected returns. This is conservative in this context because the greater the cost to reduce environmental risk the lower the impact responsible investors will have on the market. So, to provide a tougher test of the impact of responsible investors, greater costs are assumed for the average company in this report than in Heinkel et al. (2001)

The correlation noise parameter $d = \sqrt{0.1}$ was set such that the covariances were perturbed by noise with a standard deviation of 5% of the standard risk variances.

Except for the results shown in Question 5 in Section 4, it was maintained that $K_M = 1$, $K_D = K_{ET} = K_U = K_{ETD} = 0$, so that the results highlight the impact of responsible investors when index investors remain neutral. For Question 5, the index investors were alternately assigned 100% to each of the five index strategies (holding the market portfolio, Divestment, Unconstrained, Environmental Tracking, and ET Divestment), which enables Question 5 to show the different effects of different index strategies on global risk.

Results

The behaviour of the model as the number of responsible investors was increased from 0% to 100% was investigated to answer the following questions.

Question 1: How do the different investment strategies perform as the percentage of responsible investors increases?

As illustrated in Figure 3, as the percentage of responsible investors increases, responsible investors' portfolios enjoy capital gains (relative to investors in the market portfolio) as stocks start to be priced in line with responsible investors' expectations. The returns from this effect are greatest for the earliest responsible investors.

Capital gains also accrue to responsible index investors as the percentage of responsible investors increases. The Environmental

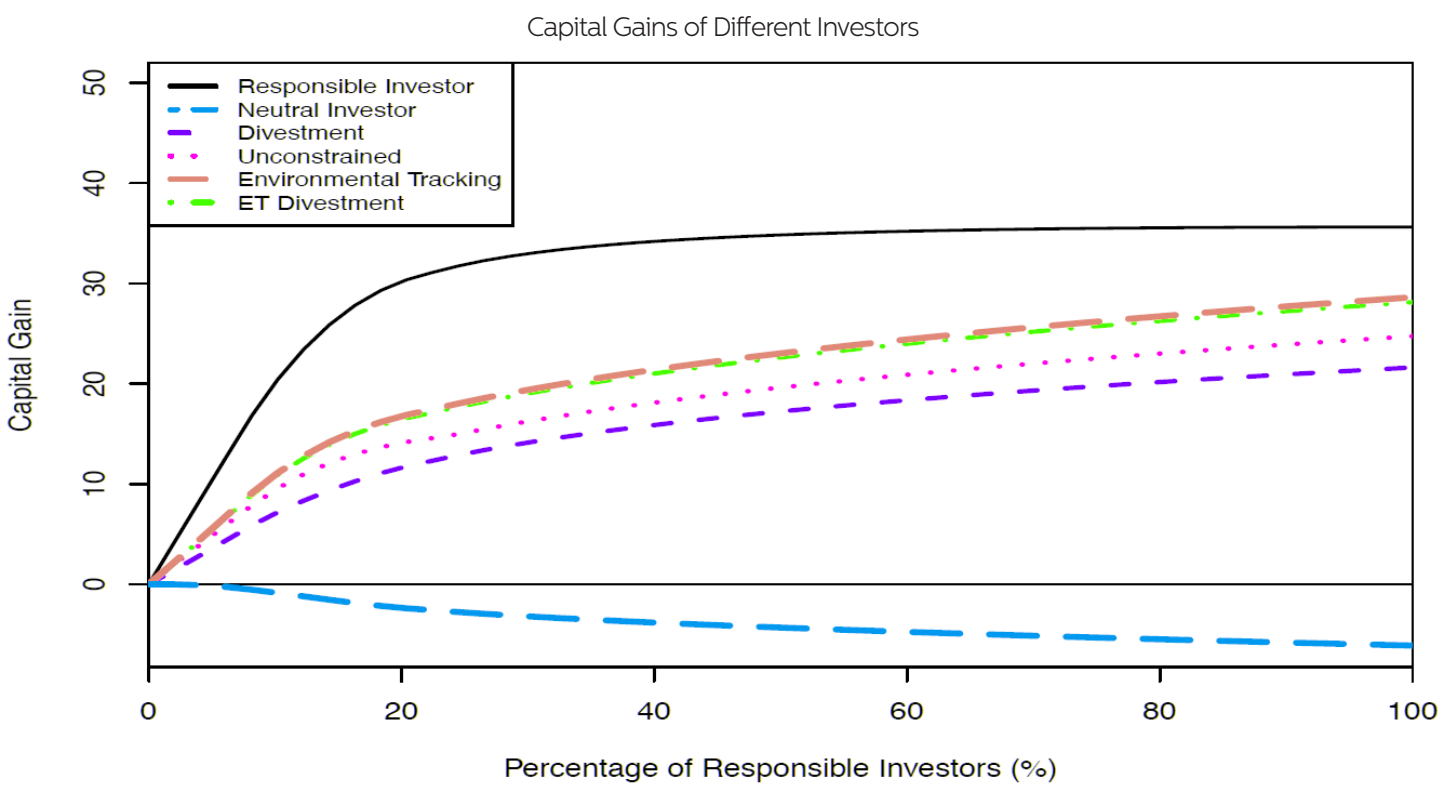

Figure 3: Cumulative capital gain of each strategy relative to simply holding the market portfolio, as the percentage of responsible investors (among active investors) increases from 0% to 100%.

Tracking and ET Divestment strategies experience the greatest capital gains of the index strategies. These gains are lower than the active responsible investor strategy, but the responsible investors' more extreme gains can be explained by the fact that they can take advantage of their lack of a short sale constraint (so they can bet more heavily against environmentally risky companies, and thus enhancing their returns).

Note that Figure 3 is the result when all index investors are assumed to hold the market portfolio. The results for different mixes of index investor strategies are similar.

Question 2: What do the shareholdings of the different investment strategies look like?

The portfolio for each strategy can be thought of in terms of the number of shares that is held in each company. Note that the market portfolio in this model consists of holding 1 share in each company. The tilt of a strategy's portfolio towards stocks with lower environmental risk can be assessed visually by looking at the strategy's shareholdings relative to the market portfolio.

The shareholdings of each responsible index strategy and the responsible investors' strategy are illustrated in Figure 2. These are the shareholdings when the percentage of responsible investors is still 0%, so that no company has made any risk reduction and each company's environmental risk is still as displayed in Figure 1.

The Unconstrained and Divestment approaches are clearly significantly perturbed by the small amount of noise that has been added to the correlation information used by the index provider. This occurs because the index provider is using their correlation information to produce a strategy that is optimal according to the information they have been given. However, as portfolio optimisation procedures can be very sensitive to the input information, when the noisy information is provided to the index provider's unconstrained optimisation model, a result arises that can appear to have little to do with the true environmental risk inherent in each company.

Despite the imperfect information available to the index provider, the Environmental Tracking and ET Divestment approaches maintain intuitive and reasonable share holdings (that is, the number of shares held in each company is in line with the environmental risk of the company). The Environmental Tracking-based strategies can achieve this because the shareholdings in each strategy are constrained to follow the rankings of the companies according to their environmental risk. This constraint provides order to the strategies' shareholdings, even though the Environmental Tracking strategies are also optimised to have low tracking error to the market portfolio.

Question 3: What do the expected returns of the different strategies look like, and how do they depend on the percentage of responsible investors?

Figure 4 shows the expected Sharpe ratio for each strategy as the percentage of responsible investors increases, in the case when index investors are assumed to hold only the market portfolio. The Sharpe ratio is a standard measure of risk-adjusted returns, equal to the expected return divided by the standard deviation of the expected returns.

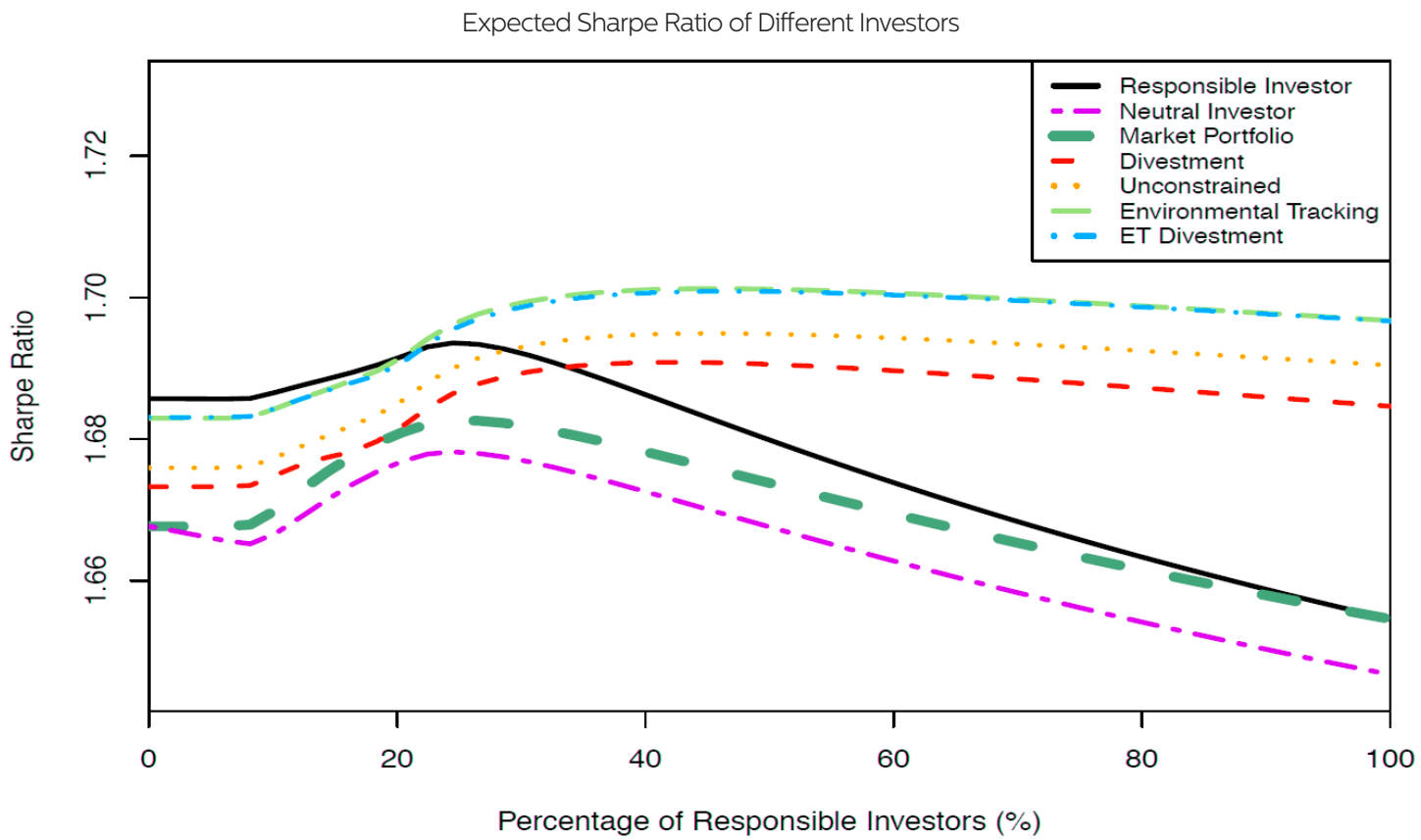

Figure 4: Expected Sharpe ratio of each strategy as the percentage of responsible investors (among active investors) increases from 0% to 100%.

The fact that the Sharpe ratios of all the responsible investment strategies are better than the neutral investor strategy makes sense as the responsible investment strategies take environmental risk into account. By not accounting for these risks, the neutral investor strategy is always missing out on information that could be used to improve its Sharpe ratio, and thus it will always have the lowest Sharpe ratio.

Similarly, the Market portfolio exhibits a lower Sharpe ratio than the responsible investor strategy when the percentage of responsible investors is low (so the market is dominated by investors that don't incorporate environmental risk information into their allocation). But the Market portfolio's Sharpe ratio converges to that of the responsible investor strategy as the percentage of responsible investors increases to 100% (when the Market portfolio becomes equal to the responsible investor portfolio).

The Environmental Tracking and ET Divestment strategies exhibit the highest Sharpe ratios. This appears to be because Environmental Tracking strategies can cut through the noise that has been added to the index provider's correlation information and still determine the (close to) optimal strategy when environmental risk is considered. As can be seen in Figure 2, the shareholdings in the Divestment and Unconstrained portfolios are heavily perturbed by the noise in the correlation matrix, and thus these strategies cannot expect to achieve an optimal Sharpe ratio. The shareholdings of the Environmental Tracking strategies, on the other hand, are clear and intuitive and the most similar to the responsible investor strategy shareholdings among all the index strategies.

The result that the Environmental Tracking strategies realise greater Sharpe ratios than even the responsible investor strategy, as the percentage of responsible investors increases, can be explained as the Environmental Tracking strategies can maintain a relatively aggressive strategy even as the percentage of responsible investors increases. However, as the percentage of responsible investors increases, the responsible investor strategy slowly starts to become the market portfolio and when this happens it can no longer be tilted towards lower environmental risk companies (which would help it maintain a higher Sharpe ratio).

Question 4: How do these results relate to theoretical "arbitrage" arguments that claim responsible investment will never be profitable or have impact?

Harmes (2011) contains an example of such an argument, where it is speculated that:

"The impression created is that ethically-motivated funds, including the large public defined-benefit pensions, would have sufficient assets to sell the shares of a company with poor environmental performance, causing the stock price to drop in a way that would create a real financial incentive for improved performance.

However, as basic financial theory indicates, this will simply not occur due to the existence of 'arbitrage.' Specifically, if a number of ethically-motivated investors sold-off the shares of a company with poor environmental performance, causing the stock price to drop, other investors would view that company as undervalued in market terms and would quickly purchase its shares causing the stock price to almost instantly return to its original value." (p. 114)

Harmes (2011) gives no reference to indicate where this argument comes from. It contains at least two major implicit assumptions:

- That neutral investors are massively, infinitely, more numerous than responsible investors, or that even if neutral investors are a minority they somehow have access to an infinite supply of capital with which to back their positions.
- That environmental performance is unrelated to financial performance, or that it is already fully reflected in current market prices, and thus that making use of environmental risk information will not enable responsible investors to outperform the market.

To treat this argument with mathematical discipline, in the context of the model of this report these assumptions could be translated into one (or a combination) of the assumptions discussed below.

It could be assumed that the fraction of responsible investors is zero ($K_R = 0$), as well as that all index investors only hold the market portfolio. In this case, responsible investors will of course have zero impact. However, if this is the only assumption, and environmental risk remains, then as shown in Figure 4, responsible investment still leads to improved risk-adjusted returns (as the first responsible investor, even when $K_R = 0$, enjoys a better Sharpe ratio than the neutral investors). Thus, it remains a rational strategy to implement.

It could also be assumed that the cost to companies to reduce environmental risk is extremely high. In this case, the responsible investors will again have zero impact as it is true that they will not be able to affect share prices sufficiently to lead to companies paying the cost to reduce environmental risk. However, as with the previous point, if this is the only assumption, and environmental risk remains, then as shown in Figure 4, responsible investment still leads to improved risk-adjusted returns. In fact, high costs will lead to environmental risks remaining large as companies won't invest in risk reduction. Because responsible investors will consider this enduring environmental risk, they will be able to generate better Sharpe ratios than neutral investors. Thus, responsible investment remains a rational strategy to implement. In addition, if the fraction of responsible investors does increase, then early responsible investors will still enjoy capital gains (as in Figure 3) despite having no initial impact on company behaviour.

Finally, it remains to make the assumption that environmental risk is zero (in the financial context of this report). This could be the case if either environmental performance has no relationship to financial performance or if environmental risk is fully contained within standard risk (i.e. it is "priced in"). In this case, it is true that the rational responsible investors of this report will invest according to the same share allocations as neutral investors and thus have zero impact and achieve exactly the same returns as neutral investors. And it is only this assumption that will lead to this null result for responsible investment, with or without the other assumptions reviewed above. However, this result depends on the strong assumption that environmental risk is exactly zero.

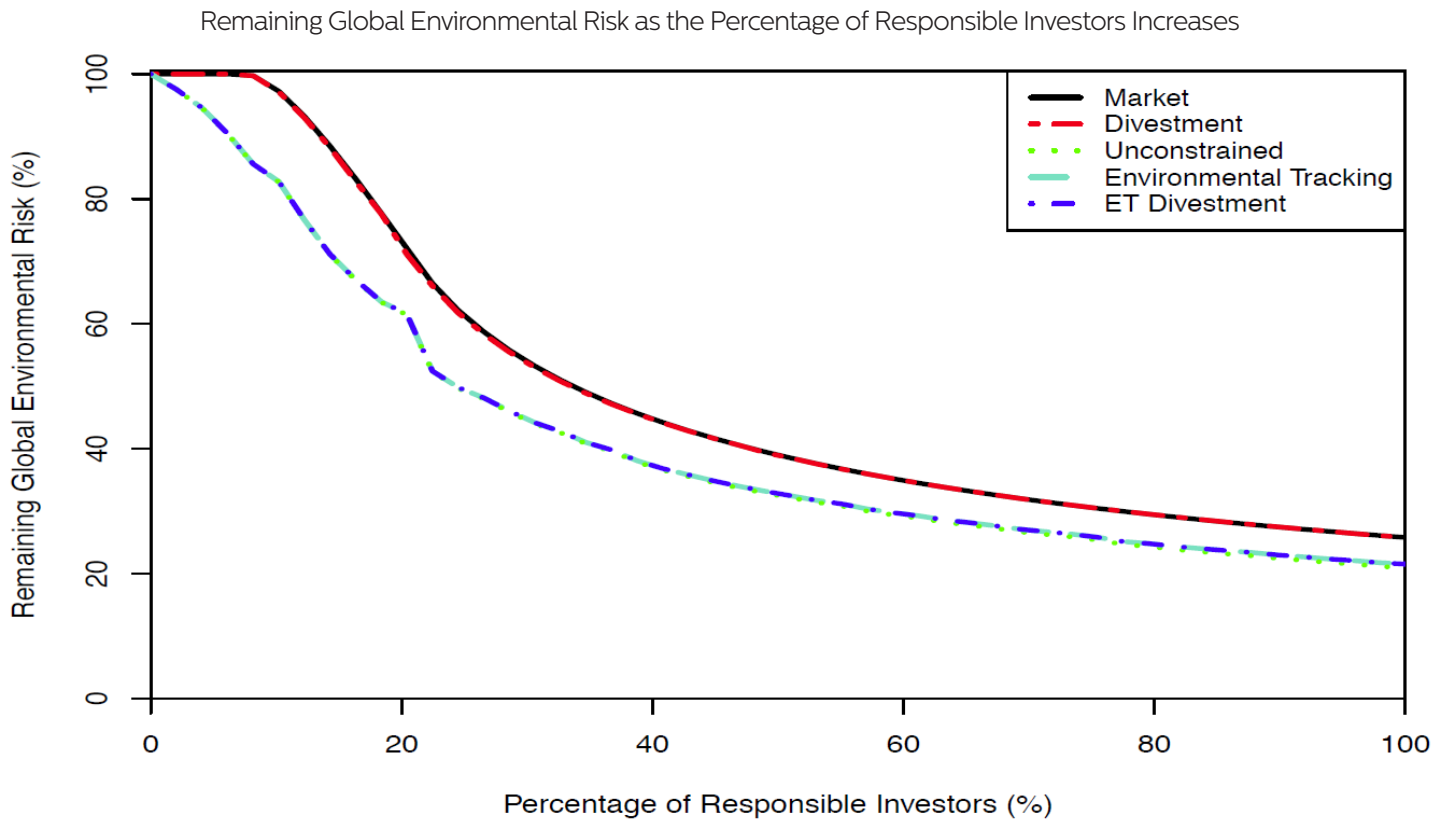

Figure 5: Remaining global environmental risk as the percentage of responsible investors (among active investors) increases from 0% to 100%. The five lines show the curve when index investors all follow one of the listed strategies.

Harmes (2011) contains a disciplined review of the forms that environmental risk can take, and the practical constraints that limit the ability of the market to have fully priced in these risks at the present time. The fact that environmental risks exist in the real economy, but that there are structural reasons to believe that these risks are not fully priced into the financial markets, suggests that environmental risk is not exactly zero.

Question 5: What impact do responsible investors have on the level of risk in the overall economy?

Figure 5 shows the level of global environmental risk as the percentage of responsible investors (among active investors) is increased from 0% to 100%, under 5 different scenarios where it is assumed that all index investors follow a single one of the 5 index strategies (holding the market portfolio, Divestment, Unconstrained, Environmental Tracking, and ET Divestment). That is, the fractions of index investors in each of these strategies (K_M,K_D,K_{ET},K_U,K_{ETD}) are each separately set equal to 1 (forcing the other fractions to 0) to produce one of the curves.

Firstly, these results show that responsible investors can have an impact as an increasing number of responsible investors leads to a dramatic drop in global environmental risk. This drop arises because responsible investors investment choices have convinced companies that it is worth paying the cost of environmental risk reduction.

Secondly, these results show that index strategies which consider environmental risk across all companies, and not just among the riskiest ones, have the greatest positive impact on global risk reduction. The Market and Divestment scenarios are bundled together on the right, while the Environmental Tracking, ET Divestment and Unconstrained strategies are all together on the left demonstrating much faster global risk reduction curves (in terms of the percentage of responsible investors required to achieve a given amount of global risk reduction). This is surprising as the Divestment strategy has been designed to have a level of environmental risk reduction greater than or equal to the other responsible index strategies (that is, 50% risk reduction). So, the reduction of environmental risk exposure of the Divestment strategy, and hence of its demand for environmentally risky shares, should result in similar price pressure to the other responsible index strategies and hence similar effects on the global risk reduction curve.

However, note that to truly reduce global risk by a large amount, even with the exponential shape of the risk curve in Figure 1 (which means that the riskiest companies account for a majority of global risk), all companies must elect to reduce their environmental risk. Further analysis of the results shows that it is the least environmentally risky companies who act first to reduce their risk, as while these companies do have low environmental risk levels, it is cheap for them to further reduce these risks relative to the riskiest companies (which have proportionally higher costs). Thus, the Divestment strategy, by not offering incentives to all companies (for example, commitments to invest more in a company's stock if it reduces its risk, like the Environmental Tracking strategy offers), does not offer greater incentives to the early, low-risk companies that begin the reduction in global risk. Thus, even if all index investors follow the Divestment strategy it does not accelerate the amount of global risk reduction as the percentage of responsible investors increases.

Figure 5 does show, however, that the adoption of the Environmental Tracking strategy by index investors (and of the other responsible index strategies that consider environmental risk across all companies), can accelerate the reduction in global risk levels that occurs as responsible investors become a larger percentage of the investor population.

Conclusion

In this report the model of Heinkel et al. (2001) has been extended to yield a (still) simple but realistic equilibrium model of the financial markets to assess the effect of responsible investors on the market.

The key findings are that:

- *Purely out of utility-maximizing self-interest on the part of both themselves and companies, responsible investors can create a significant decrease in global environmental risk.*
- *All responsible investment approaches, both active and index-based, enjoy capital gains as the percentage of responsible investors increases.*
- *In practical settings, Environmental Tracking approaches are the best performing strategies, both in terms of capital gains as the percentage of responsible investors increases and in terms of expected Sharpe ratio.*
- *All responsible investment strategies benefit most from increases in the percentage of responsible investors when this percentage is still small - thus investors considering responsible investment strategies should act now to maximise returns.*

Additionally, note that while not explored as an effect in this report, the clear signal sent by investors following an Environmental Tracking strategy makes these strategies an excellent tool for influencing both companies and other investors. This can complement other engagement activities that an investor pursues, and ultimately lead to a faster increase in the number of responsible investors and thus to earlier capital gains for the first investors to implement these strategies.

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Jonathan is the Chief Technical Officer and Head of Research of ET Index Research, a responsible investment strategy firm. With over a decade of international experience in finance, Jonathan's expertise is in portfolio management and risk modelling. Before joining ET Index Research he was at Credit Suisse where he completed the development and implementation of a global multi-asset class portfolio risk model. Previously he has worked at investment and trading houses in Europe, North America, Australia and Asia. Jonathan holds an MSc in Financial Mathematics from Stanford University, and a BSc (Honours) in Physics and Mathematics from the University of British Columbia. He is currently completing research towards a PhD in Finance at EDHEC Business School.