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28 April, 2020

REVIEW OF HEDGING CLIMATE RISK

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Introduction

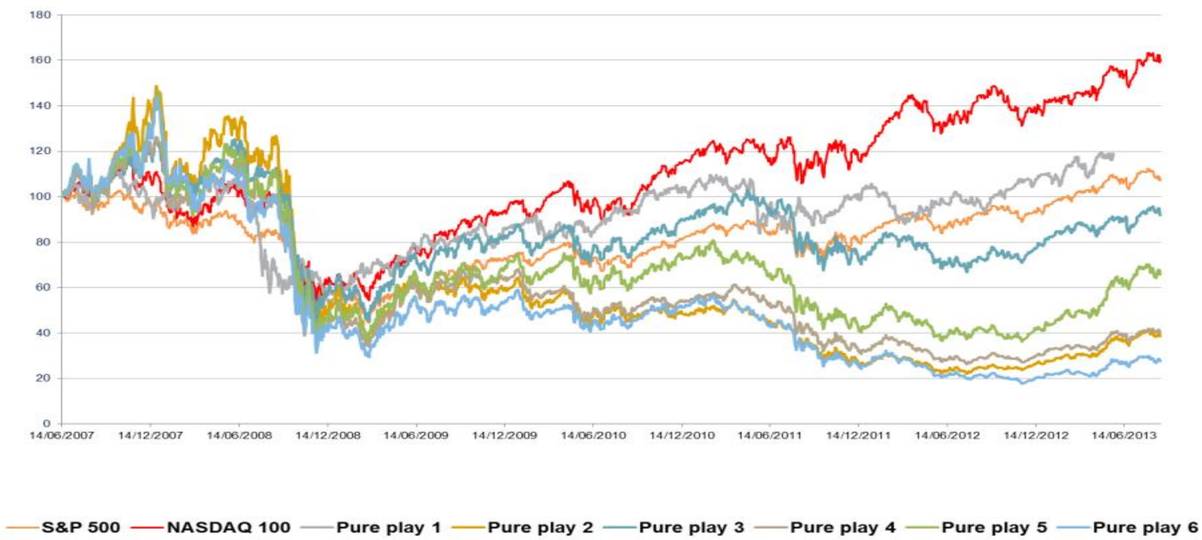
The scientific consensus on global warming is nearly unanimous and the evidence on rising global average temperatures is mounting. These debates on climate change poses a larger question about the financial tools that institutions will use to manage this climate risk. With the media also playing a prominent role, Investor awareness regarding climate risk has been raised and a handful of organizations are systematically measuring and reporting the carbon footprint of the largest publicly traded corporations. Based on these carbon footprint measures, a number of green indexes have been constructed by removing from standard indexes the composite shares of companies with the highest carbon footprint, and these green indexes have been marketed to investors as a simple strategy to reduce exposure to carbon risk.

The paper focused on developing a sustainability themed investing strategy that allows long-term passive investors to hedge climate risk and timing of climate mitigation policies risk without compromising financial returns, by maintaining a low tracking error with respect to benchmark indices. As it's not feasible to incorporate climate-related factors into entirely passive strategies, this is one amongst the several possible quasi passive approaches.

Review of Passive Strategies

Passive investing strategies allow three approaches, each predicated on a specific index product. First, a range of indices are designed using a tilting or best-in class approach, where climate-related metrics are used to reweight companies (tilting) and / or exclude worst performers (best-in class). These types of indices are offered by all major index providers. Alternatively, a number of indices use a sector or industry exclusion approach; for example, excluding fossil fuels or coal. Finally, indices may be "pure play"; for example limiting inclusion to clean tech companies or companies with climate-related revenues. The comparison between first and third indexes is that: pure play defines an investment mandate by applying a positive screen to include only climate-friendly companies. An example is a clean-tech index. Instead of seeking to influence companies, this strategy helps the growth of the green economy. As these indices don't respond to diversification constraints and offer no protection against the timing risk of climate change mitigation policies, they can be used for a small share of the equity portfolio as part of a broader diversified equity portfolio. While the carbon tilted or decarbonised indices preserve sector allocation, and use best-in-class or tilting approach based on GHG emissions (Greenhouse Gas emissions). This provides an incentive for companies to respond by improving their indicators (compare companies to their peers), and a low tracking error makes these approaches attractive for mainstream investors.

Below chart clearly shows that pure-play, "clean energy", indexes have underperformed the S&P 500 or the NASDAQ 100 since the onset of the financial crisis in 2008



Analysis of decarbonised indices and strategy evolution

As the decarbonised indices have outperformed the benchmark index so far maintaining a low tracking error, the basic point here is to keep an aggregate risk exposure similar to that of standard market benchmarks. Hence, Divestment of high-carbon-footprint stocks is the first step, and the second key step is to optimize the composition and weighting of the decarbonized index in order to minimize the tracking error (TE) with the reference benchmark index. One of the main challenges is the shortcomings of underlying data, particularly carbon metrics, used to compare companies. Decarbonised indices also do not address exposure to green technologies, which can lead to counterintuitive results. For instance, the MSCI ACWI Low Carbon Target Index underweights green technologies.

The following describes the strategy based on building a portfolio of companies that have a carbon footprint 50% smaller than benchmarks and have 50% less exposure to “stranded assets” (such as fossil fuel assets that have become non performing or obsolete as a result of legislation, decreased demand, or other factors).

First we analyze in greater detail the basic concept of a green index without relative market risk and the advantages and potential concerns with this investment strategy. The main idea behind a green index is to lend themselves more to bet on clean energy than a hedge against carbon risk.

So, the idea of low-TE green index is to construct a portfolio with fewer composite stocks than the benchmark, but with similar aggregate risk exposure than the benchmark index to all priced risk factors. The only major difference in aggregate risk exposure between the two indices would then be with respect to the carbon risk factor, which would be significantly lower for the green index. As long as carbon risk stays unpriced by the market, the two indices will generate similar returns (offer the same compensation for risk demanded by the investor), thus achieving no or minimal TE. But, once carbon risk is priced by the market the green index should start outperforming the benchmark index. Although it's more implausible that in some way financial markets currently price carbon risk excessively, it is only in this scenario that investors in the low-TE green fund would face lower financial returns than in the benchmark index.

The low-TE green index optimization problem

There are several possible formulations to construct the green index. We focus on two formulations, first one is to begin by eliminating high carbon footprint composite stocks with the objective of meeting a target carbon footprint reduction for the green index, and then to reweight the stocks that remain in the green index so as to minimize tracking error with the benchmark index. In the second, we do not exclude any constituent stocks from the benchmark index, and only seek to reduce the carbon intensity of the index by reweighting the stocks in the green portfolio.

a. Methodology

Formulation of first problem: Assume that there are 'N' constituent stocks in the benchmark index, first step is to assign weight to each stock in the index as:

W_i^b = market cap(i) / (Total market capitalization)

Next, rank each constituent company in decreasing order of carbon intensity, with company l = 1 having the highest carbon intensity and company l = N the lowest (each company is thus identified by two numbers [i,l] with the first number referring to the company's identity and the second its ranking in carbon intensity).

Finally the green portfolio can be constructed by choosing new weights from solving the minimization problem: Min TE = sd (R^g - R^b),

such that $w_j^g = 0$ for all j = 1,..k and $0 <= w_i^g$ for all i = k+1, …N, sd = standard deviation

The green index as per above is constructed by first excluding the k worst performers in terms of carbon intensity and reweighting the remaining stocks in the green portfolio so as to minimize TE, whatever the threshold k.

Formulation of Second problem: Replace the constraints $w_j^g = 0$ for all j = 1,..k with a constraint that the green portfolio's carbon intensity should be smaller than a given threshold: $\sum_{l=1 \ldots N} q_l w_l^g <= Q$

In both the problem formulations, the TE—given by estimated standard deviation of returns of the decarbonized portfolio from the benchmark—is estimated by using a multifactor model of aggregate risk This multifactor model significantly reduces computations, and the decomposition of individual stock returns into a weighted sum of common factor returns and specific returns provides a good approximation of individual stocks' expected returns.

Under the multifactor model, TE minimization problem has the following structure:

$$\text{Min}\left[\sqrt{\left(W^p - W^b\right)' \left(\boldsymbol{\beta}\boldsymbol{\Omega}_f\boldsymbol{\beta}' + \boldsymbol{\Delta}^{AR}\right)\left(W^p - W^b\right)}\right],$$

where

$w_l^g = 0$ for all $l = 1, \ldots, k$

$0 \le w_l^g$ for all $l = k+1, \ldots, N$

$\left(W^p - W^b\right) =$ the vector of the difference in portfolio weights of the decarbonized portfolio and the benchmark

$\boldsymbol{\Omega}_f =$ the variance–covariance matrix of factors

$\boldsymbol{\beta} =$ the matrix of factor exposures

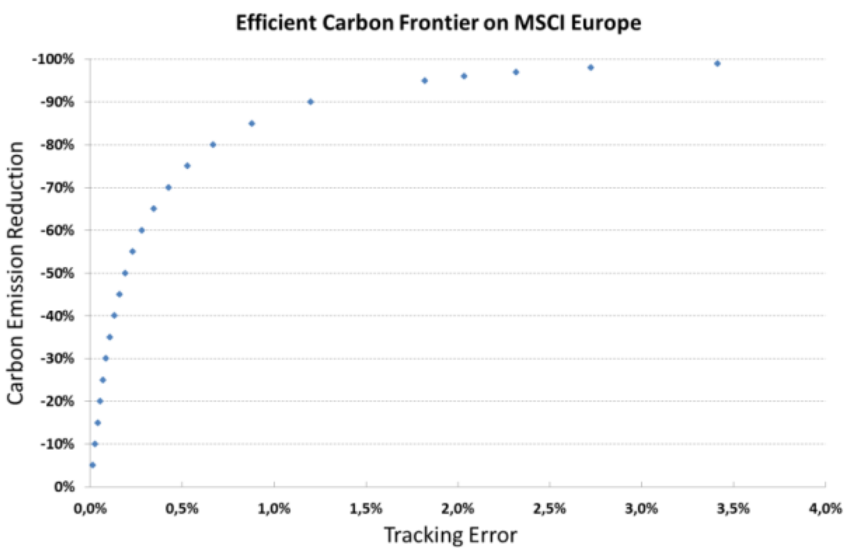
$\boldsymbol{\Delta}^{AR} =$ the diagonal matrix of specific risk variances

b. Risk mitigation benefits of low tracking error

To explore more systematically the potential benefits of achieving a bounded tracking error, multiple simulations were run with the pure optimization methodology to determine a TE-carbon efficiency frontier for the green index.

Given the performance numbers, we can observe that achieving a nearly 100% in carbon footprint would come at the price of a huge tracking error of more than 3.5%, and a large TE would expose investors in the green index to significant financial risk relative to the benchmark.

So, a good strategy can be to limit "TE budget" for say which delivers significant levels of carbon reduction, with a 1.2% of TE allowing a 90% carbon intensity reduction. This can lower the TE of the green index from 3.5% to 1.2%, and then even in the worst case scenario the green index would generate returns at least as high as the benchmark. (Below chart as of 31/05/2014)



Beyond Optimization: Methodological Considerations and Caveats

Design Tradeoffs

A number of other tradeoffs are involved in the design of this green index. There are three concerning questions: sector composition of the benchmark index, size of companies in the benchmark index and rate of change of a company's carbon footprint.

Firstly, a sector blind filtering out of companies by the size of their carbon footprint would result in an unbalanced green index that essentially excludes most Utilities and Materials companies and not much else (including the Energy sector). Obviously, such an unbalanced green index would have a very high tracking error and would not be very desirable. One simple way of addressing this issue, is to look at what the TE of the green portfolio is- for the different optimization problems and pick the procedure which yields the green index with the lowest TE

Secondly, as the largest companies are likely to be the companies with the largest carbon footprint, a filtering rule that excludes the stocks of companies with the largest carbon footprint will tend to be biased against the largest companies, which could result in a high tracking error for the green index. So, normalization of companies' carbon footprint approach can be appropriate, which would better select companies based on their energy efficiency. One simple, normalization would be to divide each company's carbon footprint by sales. Normalizations adapted by sector are preferable and could for example take the form of dividing CO2 emissions by: i) tons of output in the oil and gas sector; ii) sales*kilometer distance in the transport sector; iii) total GWh electricity production in the electric utility sector; iv) square footage of floor space in the housing sector; and v) total sales in the retail sector.

Finally, the green filter should take into account expected future reductions in carbon footprint resulting from current investments in energy efficiency and reduced reliance on fossil fuels. Similarly, the green filter should penalize more oil and gas companies that invest heavily in exploration with the goal of increasing their proven reserves, which increases the stranded asset risk for these companies. This would provide immediate incentives to companies with exceptionally high carbon footprint to engage in investments to reduce it and it would boost financial returns of the green index relative to the benchmark.

Caveats

As explained above, the outperformance of the low-TE green index is premised on the fact that carbon risk is currently not priced by financial markets.

First potential flaw in this climate risk hedging strategy is that financial markets currently overprice carbon risk. As this overpricing is corrected the low-TE green index would underperform the benchmark index. But such a degree of cynicism is irrational and is closer to a form of paranoia.

Second highly implausible scenario is that somehow the high carbon footprint companies of today will be the low carbon footprint companies of tomorrow. One explanation fo such a scenario could be that the high GHG emitters today have the most to gain from carbon sequestration and will therefore be the first to invest in this technology. If that were the case, the low-TE green index would underperform the benchmark precisely when carbon taxes are introduced.

Third, a more valid concern is whether companies' carbon footprints are currently correctly measured. Is there a built-in bias in the way carbon footprint is measured, or is the measure very noisy, so that investors could be exposed to a lot of carbon measurement risk? It has also been observed that for example, GHG emissions associated with hydraulic fracturing for shale gas are currently significantly underestimated, as the high methane emissions involved with the hydraulic fracturing process per se are not counted. Thus, what would appear as a welcome reduction in carbon footprint following the shift away from coal to shale gas according to some current carbon footprint measurements could just be an illusion. A green filter that relies on this biased carbon footprint measure, thus risks exposing investors to more rather than less carbon risk. There are three evident responses mentioned to this objection. First, drawing an analogy with credit markets, a biased or noisy measure of credit risk by credit rating agencies has never been a decisive reason for abolishing credit ratings altogether. Credit ratings have provided an essential reinforcement of credit markets for decades despite important imprecisions in their measurements of credit risk that have been pointed out by researchers of credit markets over time. Second, as with credit ratings, methodologies for measuring carbon footprint will improve over time, especially when the stakes involved in measuring carbon footprint correctly increase as a result of the role of these measures in any green filtering process. A third important response to this concern is that the design of the low-TE green index itself offers a protection against carbon footprint measurement risk, for if there is virtually no tracking error with the benchmark then investors in the low-TE green index are to some extent hedged against this risk. Finally, a somewhat more technical worry is that the stocks that are excluded from the low-TE green index could also be the more volatile stocks, as these stocks are the most sensitive to speculation about climate change and climate policy. If that is the case, then tracking error cannot be entirely eliminated, but that should not be a reason for not investing in the low-TE green index. On the contrary, the low-TE index will then also have a higher Sharpe ratio relative to the benchmark commensurate with the higher TE.

Recommendations on Green Index Investment - Implications for Public Policy

The low-TE green index investment strategy proposed stands on its own as a simple and effective hedging strategy against climate risk for passive long-term investors. But, it should also be emphasized that it is an important complement to public climate change mitigation policies. Governments have so far mostly focused on introducing policies to control or tax GHG emissions and to build broad international agreements for the global implementation of such policies. There has, of course, been considerable resistance to a broad multilateral agreement on long-term significant climate change mitigation, and most of the recent advances on climate policy have been the result of unilateral efforts by individual countries. As argued in the introduction, the difficulty for politicians is that they are asked to policies involving mostly "sell short-term pain for long-term gain" to their often myopic constituencies. Sometimes politicians have sought to frame climate mitigation policies as profitable long-run investments, and as strategic moves to put their economies in a first-mover position in a future renewable energy economy. They have, thus, provided subsidies to solar and wind energy sectors and thereby boosted a small business constituency in support of climate change mitigation policies.

Similarly, this low-TE green index can help boost support for climate change mitigation policies by a large fraction of the investor community. By encouraging investments in low-TE green indices by pension funds, insurance companies, university endowments and sovereign wealth funds, governments can build a potentially large constituency in support of climate change mitigation at no cost. Moreover, as more and more funds are allocated to such indices, stronger market incentives will materialize inducing the largest corporations in the world—the publicly traded companies—to invest in reductions of GHG emissions. This is all the more attractive that the encouragement of climate risk hedging can have real effects on reducing GHG emissions even before climate change mitigation policies are introduced. The mere expectation that such policies with be introduced will have an impact on the stock prices of the highest GHG emitters, and will reward those investors that have hedged climate risk by holding a low-TE green index. Finally, the very anticipation of the introduction of climate change mitigation policies will create immediate incentives to initiate a transition towards renewable energy.

Conclusion

To summarize, the strategy for hedging climate proposed is especially suitable for passive long-term investors. Rather than a risky bet on clean energy (at least in the short run), the designed green index with a minimal tracking error with respect to the benchmark index, offers passive investors a significantly reduced exposure to carbon risk, while at the same time allowing them to buy time and limit their exposure to the risk with respect to the timing of the implementation of climate policy and a carbon tax. Thus, a key change in this approach relative to other existing green indices is to move the focus away from the inevitable transition to renewable energy to concentrate more on the timing risk with respect to climate policy. This decarbonisation approach described for equity indexes can also be applied for corporate debt indexes which could be a good complement to green bonds. Although few factors not accounted for here are the high uncertainty associated with data at financial asset level, data volatility associated with external factors when normalizing and challenge of distinguishing relative climate friendliness within categories (e.g., gas vs. Coal).