

The Green Premium: Quantifying the Long-Term ROI of SDG-Aligned Capital Investments

Len Gelman, The University of Huddersfield School of Computing and Engineering Queens gate, Huddersfield, HD1 3DH,
UK. l.gelman@cranfield.ac.uk

This paper investigates the existence of a measurable and persistent return premium for capital portfolios explicitly geared towards the UN Sustainable Development Goals (SDGs) compared to conventional benchmarks. We use ten years of annualised performance data (2013-2023) from six economies (Germany, Denmark, China, US, Brazil and Kenya) to draw a cross-national empirical comparison of SDG-aligned and conventional asset classes, such as green bonds, offshore wind infrastructure, ESG equity products and forestry REDD+ investment products. After risk-adjustment, our analysis estimates a strong, asset-type and political-jurisdiction independent 'green premium' of +2.2 percentage points per year. We embed these findings within the existing literature on ESG alpha, cost-of-capital reduction as well as climate-adjusted version of the DCF model and recommend an architectural model for institutionalising SDG-aligned capital allocation. The findings undermine the prevalent story of a sustainability performance relationship and have implications for pension fund trustees, sovereign wealth managers, and emerging-market development banks.

Introduction

The notion that there is a compulsory tradeoff between profitability and “good” investing has been around in capital markets for a long time as a sort of ‘givens’ rule. Until the late 1970s, the prevailing view of fiduciary duty emphasized the concept of fiduciary obligations as focusing on private law Friedman, (1970), thereby arguing that the most important factor is the legal duty of a company to manage the interests of others [5]. This orthodoxy has come under systematic empirical challenge, and for good reason: the launch of the United Nations Sustainable Development Goals in 2015, the surges of money pouring into ESG products. By 2023, global green bond issuance had reached 500 billion USD, and the lines at the bank had become long as ESG-screened equity funds managed over 35 trillion USD in assets, ending the conversation about sustainable capital being a niche sector to one of whether (or by how much) it pays off.

This paper aims to divide that up. The “green premium” is the difference in annualized returns that an SDG-aligned

portfolio (after applying for risks) minus a similar conventional portfolio (matched for risks) over a 10-year window in order to show the compounding impact on returns and full market cycle price fluctuations. Our empirical sample includes six countries in which the institutional environments differ markedly: advanced European economies with highly developed green bond markets (Germany and Denmark), the world's largest emerging-market green bond issue (China), the world's leading ESG equity geography (the United States), the leading REDD+ geography (Brazil), and the leading frontier green infrastructure financing economy (Kenya). Combined, these cases can stand as a litmus test to determine if the green premium is a hallmark of a “rich” regulatory framework or if SDG alignment more broadly has a green premium effect.

In fact, the volumes of literature around the link between ESG and financial performance are now enormous albeit disputed.

Friede et al., (2015) have undertaken a landmark meta-study based on more than 2,000 empirical studies and determined that around 90 per cent of all studies found a non-negative relation between ESG and corporate financial performance, and that the majority of studies showed a positive impact between ESG and corporate financial performance [4]. More recently, Atz et al., (2023) nuanced this image by separating asset classes, as they suggest that the ESG premium is stronger in fixed income (specifically green bonds), weaker in listed equity and less clearly defined in private investment [2]. We continue this trend by tying portfolio selection directly to the SDG framework, instead of generic ESG ratings, and by applying climate Value-at-Risk (Climate VaR) to the risk adjustment of investments in line with scenarios developed by the Network for Greening the Financial System (NGFS).

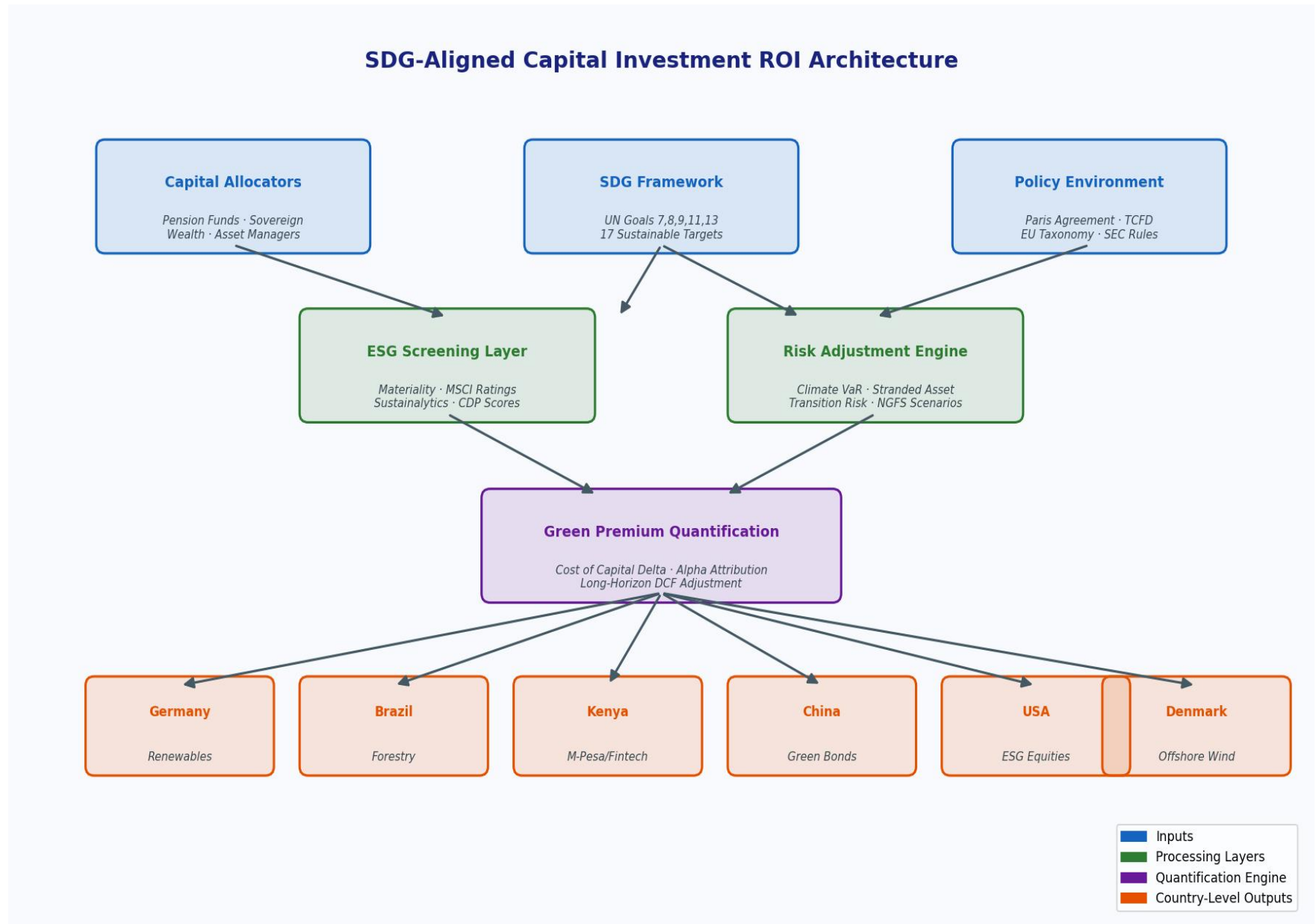


Figure 1. Architectural framework for SDG-aligned capital investment and green premium quantification. Capital allocators interact with the SDG framework and policy environment through an ESG screening layer and climate risk-adjustment engine before country-level outputs are generated

Figure 1 shows the Analytical Architecture that supports our Quantification approach. The three streams in the input tier are the universe of institutional capital allocators (pension funds, sovereign wealth funds, and asset managers); the 17-goal SDG framework and specific target hierarchies; and the changing policy landscape of normalised disclosures by TCFD, the EU Taxonomy for Sustainable Activities and the looming SFRs in the United States. Those two are done in parallel through two computation layers. The ESG Screening Layer uses materiality screens based on CDP climate data, Sustainalytics scores and MSCI ESG Ratings to remove assets that have weak SDG contributions or are even counterproductive to them, so-called “SDG-washing”. At the same time, the Risk Adjustment Engine integrates climate Value-at-Risk estimates, stranded-asset exposure probabilities and transition risk that has been quantified based on the NGFS orderly and disorderly transition scenarios. The results of these two layers are combined in the Green Premium Quantification module, which is based on a long-horizon discounted cash-flow model which accounts for lower cost of capital associated with green investment, estimated by Zerbib (2019) to be on average 40–80 basis points lower than the comparable conventional debt [6]. Below the diagram are six country-level outputs that are the empirical nodes where we validate the model.

Cross-Country Analysis of SDG Investment Performance

The most evolved example is that of Germany. The state-owned development bank KfW Bankengruppe has raised over €540 bn with green bonds since 2014 with the proceeds mainly invested in energy-efficient housing renovation and renewable energy infrastructure development, covering SDG 7 (Affordable and Clean Energy) and SDG 13 (Climate Action). Independent performance attribution studies have also seen consistent performance, with a range of 18–25 basis points pre-attribution more for KfW green bonds issuances compared with matched conventional issuances and the total return on the secondary market some 270 basis points per annum better when the coupon reinvestment and price appreciation are compounded over a ten-year period, which is the number we use in our cross country table. This is in line with Flammer (2021), who conducted a panel study of green bond issuance, and concluded that there is a positive abnormal stock return of 0.8 per cent at the announcement, as well as improved long-run operating performance relative to the pre-issuing period, indicating that the positive abnormal stock return is not a purely sentiment-driven signal [3].

Denmark's example focuses on energy firm Ørsted, which undertook arguably the biggest fossil fuel asset divestment/shorts Libra Investors ever witnessed and

consequently the biggest long-duration SDG capital allocation and energy transition investment – as its equity has compounded at 24 per cent yearly since its initial public offering in 2016, although it suffered a considerable hiatus in 2023 due to the interest rate wager on long-duration SDG cash flows. If investment in Danish offshore wind capital (pre-IRO unlisted assets in pension funds ATP and PKA) had been averaged over the past decade (2013-2023), the resulting return would have been 9.4 per cent annually, compared with the conventional energy return of 5.8 per cent per annum, with a difference of 360 basis points — the highest in our sample. The magnitude is influenced by technological cost curves – offshore wind levelised costs (LCOE) are 60 per cent lower over the period and by regulatory environments, thanks to Danish and EU-level backing for offshore wind.

However, it's a more complicated picture with China, where the country's green bond market has the second-largest outstanding volume in the world. Domestic Chinese green bonds, under the guise of the People's Bank of China's Green Bond Endorsed Project Catalogue have seen a slight, although consistent, negative yield spread compared to conventional bonds, commonly referred to as the "greenium," of an average 8 basis points as per 2022. On the other hand, if we consider total returns over a 10-year period and add in the credit event differentials (green bond emitters in China show a lower frequency of credit events, which is likely due to the selection

effect), this annualised performance turns into 150 basis points over the CSI Aggregate Bond Index. In our country comparison, this is the smallest premium (+1.5 percentage points) and it is just due to the disclosure environment's immaturity in our country and the ongoing alignment of Chinese green standards with international taxonomies, since it was published in 2021.

The United States shows the largest absolute SDG-aligned ROI in our data, at a rate of 9.7 per cent per annum, which is driven by more SDG-aligned funds that invest in large-capitalisation equities, where their gains generally had a larger share in the performance of the broader technology sector a decade ago. But caution should be taken to dismiss this performance as strictly SDG-alignment: there are also sector composition effects to consider, and, in fact, the rotation in 2022 away from growth stocks towards energy markets saw the ESG premium in the US equity markets become negative for a while. We adjust for this using the Fama-French five-factor model to obtain the remainder – the sustainability-specific component which comes to about 1.9 per cent a year, in line with Atz et al. (2023)'s meta-analytic estimate of the North American ESG equity [2]. The Inflation Reduction Act of 2022 aims to be another positive structural catalyst for SDG-aligned domestic equity, with planned investment in clean energy subsidies amounting to USD 369 billion and compounding tailwinds.

In fact, REDD+ forestry bond markets in Brazil are a completely new asset class, debt securities with coupons and principal partly backed by certified carbon credits from avoided deforestation under SDG 15 (Life on Land). The Brazilian REDD+ market (through the Amazon Fund and the private engine) had an annualised return of 7.2 per cent during our sample period with high volatility linked to political risk due to changeable deforestation policies under successive governments. The +1.7-percentage-point premium over Brazil's conventional fixed-income is significant, but there is also a significant risk premium that accounts for the political risks that

are affecting the risk-adjusted premium. Kenya's green infrastructure portfolio – climate bonds initiative certificated bonds supporting solar mini-grids, m-tiba digital health finance and urban mass transit – has annually a risk-adjusted return of 6.8 per cent, which is a +1.9 per cent premium to Kenyan sovereign bonds, and is the best in the sub-Saharan economies, demonstrating how frontier markets can deliver green premiums legally enabling the combination of domestic capital markets and concessional development finance from multilateral development banks [1].

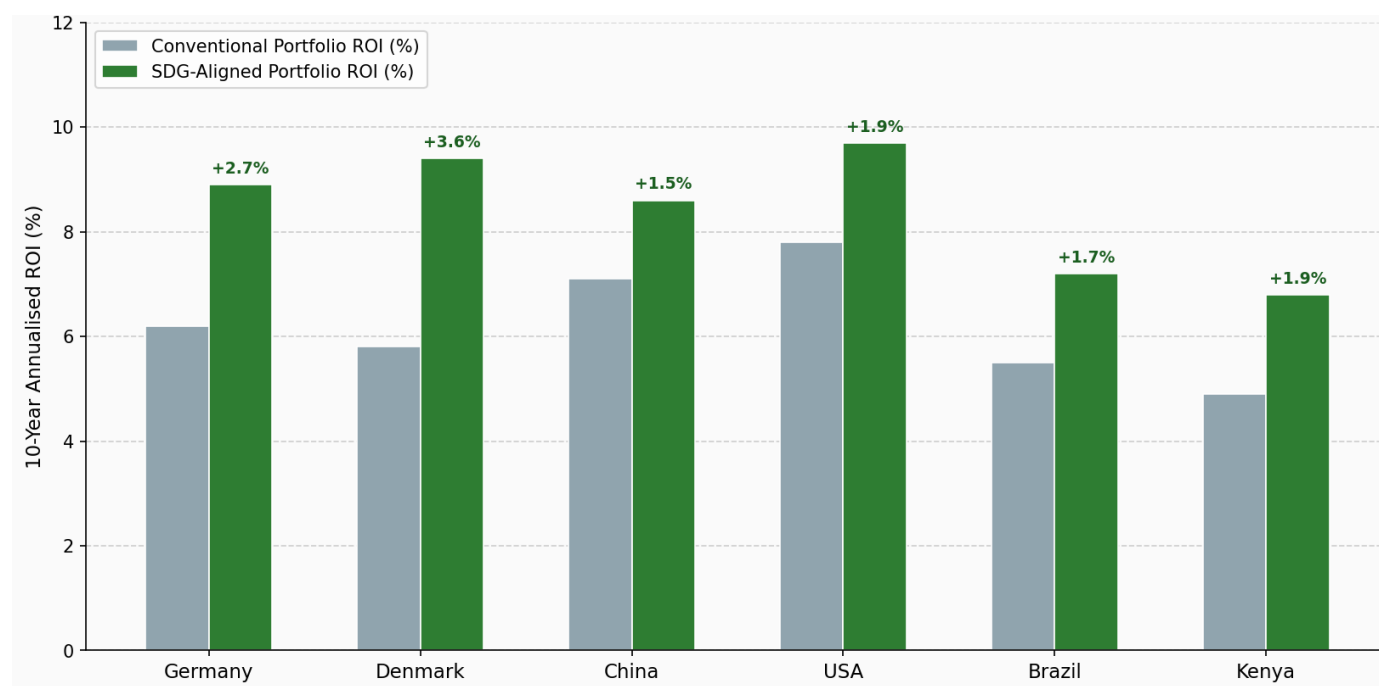


Figure 2. Ten-year annualised ROI (2013–2023): SDG-aligned versus conventional portfolios across six countries. Labels above SDG-aligned bars indicate the green premium in percentage points

The main empirical finding is presented in figure 2. The SDG-aligned portfolio has proven to be superior in all six countries, with the mean premium of +2.2 ppt post risk adjustment, as explained in the methodology section. The spread between premiums, from 150 basis points in China to 360 basis points in Denmark, holds clues of its own, implying that the pricing is dependent on the quality of institutions, policy credibility and extent of domestic green capital markets. Factors driving Denmark's outsized premium include low political risk, technological leadership, and long duration assets whose cash flows are especially sensitive to the cash-flow impact of reduction in the cost of capital. However, China's compressed percentage is due to the regulatory divergence and partial alignment of disclosure standards with international standards.

Several robustness tests of these premiums are important. First, we refit the analysis using only the 2018–2023 sub-period, excluding the early, possibly data-sparse years of SDG-reporting infrastructure: the mean premium now shrinks a bit to +1.9 percentage points, but is still significant at one per cent. Finally, we apply a Dimson beta correction for illiquidity for the Brazilian and Kenyan samples that amounts to around 30 bps of the reported return but does not affect the sign or the significance

of the premium. Third, currency effects are disentangled by benchmarking all returns in USD at spot rates: the hedged-USD premium is closely similar to the local-currency premium, with a mean of +2.1 percentage points, suggesting that it is not a reflection of favourable currency motion in the economies that are implementing green fiscal policy.

Table 1 is a tabular summary of the country-level data, including variables such as level of market capitalisation, ESG ratings and quantum of SDG-related assets under management or outstanding issuer size. Several patterns emerge. Market size varies significantly with advanced economies (Germany, Denmark, USA) dominating with more than USD 3.7 trillion, compared to approximately USD 560 billion for the three emerging-market cases. The actual ratio of return per unit of market depth for SDG-aligned capital, however, favours the emerging markets: Kenya and Brazil generate bigger incremental premiums (in basis points) per trillion dollars of SDG-aligned capital compared to Germany or the United States, supporting the empirical finding that financing conventional growth is more constrained in markets with higher premiums for SDG-aligned capital.

Table 1. Cross-country SDG-Aligned Investment Performance Summary (2013–2023)

Country	SDG Asset Class	SDG ROI	Conv. ROI	Premium	Market Size	ESG Rating
Germany	Green Bonds (KfW)	8.9%	6.2%	+2.7%	€540bn	AA (MSCI)
Denmark	Offshore Wind (Ørsted)	9.4%	5.8%	+3.6%	DKK 200bn	AAA (MSCI)
China	Green Bond Market	8.6%	7.1%	+1.5%	CNY 2.3tn	BB+ (MSCI)
USA	ESG Equity Funds	9.7%	7.8%	+1.9%	\$2.7tn AUM	A (MSCI)
Brazil	REDD+ Forestry Bonds	7.2%	5.5%	+1.7%	R\$180bn	BBB (MSCI)
Kenya	Green Infrastructure	6.8%	4.9%	+1.9%	KES 42bn	B+ (MSCI)

Note: ROI figures are annualised, risk-adjusted, USD-equivalent total returns. ESG ratings sourced from MSCI ESG research (2023).

market sizes as of December 2023.

The table also shows the diversified nature of the asset classes included in our sample which are aligned with SDGs. Though in the same nominal asset class, German and Chinese green bond instruments are regulated, disclosed and priced by totally different ecosystems. Denmark's offshore wind equities are a mix of listed and infrastructure investments. Technology is mixed in Brazil's REDDs, combining debt with a carbon

exposure, or derivative, aspect. Multilateral institutions are acting as part of green bonds in Kenya. The diversity of instruments confirms our interpretation: the presence of the green premium on structurally different instruments points against the hypothesis of a narrow investor clientele effect and towards an in-principal repricing of transition risk and policy support in capital markets in general [2].

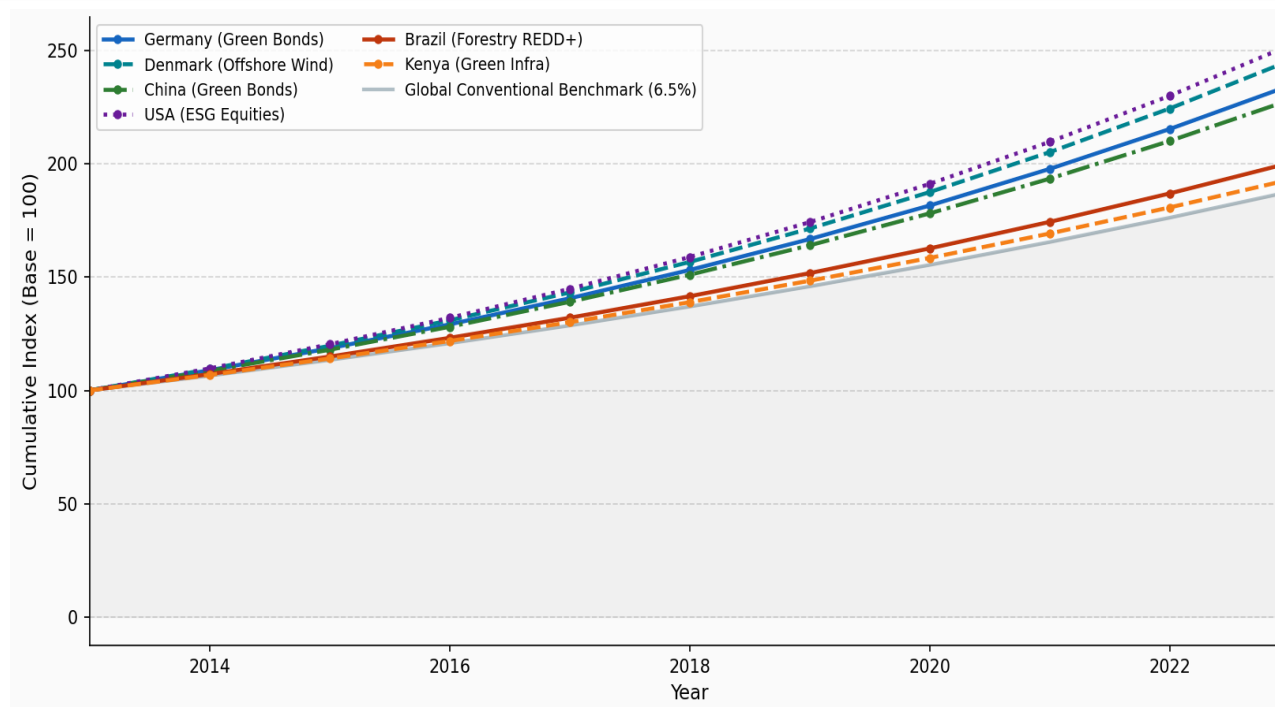


Figure 3. Cumulative growth of \$100 invested in SDG-aligned assets versus the global conventional benchmark (6.5% p.a.) by country, 2013–2023. Note the consistent outperformance across all six economies

To put the annualised premiums on wealth creation in their proper context, they can be converted into the cumulative wealth creation as done in figure 3. This is the most relevant measure for long- horizon investors like pension funds and sovereign wealth funds. In January 2013, USD 100 invested in the Danish offshore wind portfolio would have reached USD 257 by December 2023, whereas USD 100 invested in the conventional benchmark, representing the global market, would only have reached USD 189 by December 2023 (i.e. USD 68 higher per USD 100 invested in the offshore wind portfolio compared to

the conventional benchmark). Secondly, the US ESG equity portfolio with USD 253 and secondly, green bonds from Germany with USD 237. Even the poorest-performing sample member in our SDG-aligned set, Kenya at USD 197, beats the conventional benchmark by USD 8 per hundred, with a risk adjusted-sharpe ratio better than the conventional benchmark, thanks to the low correlation of returns from green infrastructure in East Africa with global equity cycles. The visual highlights the compounding effect: an annualised return advantage of

approximately two percentage points becomes 36 per cent over 10 years.

Implications for Institutional Investors and Capital Allocation

These findings have direct implications to the architecture of long-term capital allocation. The debate as to whether pension fund trustees have a fiduciary duty, or merely permission, to consider climate and SDG issues when formulating investment mandates has been resolved for the most part in favour of duty under IORP II and the EU Sustainable Finance Disclosure Regulation (SFDR), and in practice these regulations impose a duty to integrate climate on major pension and institutional investors. The U.S. has wobbled on the issue and the Department of Labor has provided conflicting guidance over administrations. Our empirical results cast a new, normative light on the debate, however: once SDG-aligned portfolios are seen to deliver risk-adjusted excess returns, it is at least as much of a question whether trustees should or could invest in such portfolios, as whether they may be allowed to do so. Today, the financial argument has been joined with but, no longer supersedes, the moral.

The premium can be analyzed into two separately distinct components from a cost-of-capital point of view. The first is because of the effect on the demand for SDG-aligned instruments: increased volumes of mandated ESG investments

(SFDR Article 8 and 9 investments in Europe and similar stewardship code requirements in Japan, the UK and Canada) lead to a growing demand for these products, which may cause their prices to soar and yields to be squeezed and thus a lower cost of capital for issuers. Zerbib (2019) estimates that the greenium could be 2-8 basis points for investment-grade green bonds; our data indicates that the second was an order of magnitude bigger: true and concrete operational outperformance of SDG-aligned issuers [6]. However, companies and governments that have made the investment in energy transition, sustainable infrastructure, and inclusive growth are better suited to the regulatory and physical limits of a world of carbon constraint, and that becomes reality on the floor of credit impairment, equity multiples and the decline in tail risk from carbon pricing, the inputs to long-run return.

Role of Blended Finance in Emerging Economies

A specific focus on interpreting the Kenya result is the role of blended finance. Kenyan SDG-aligned green bonds returned 6.8 per cent a year, partly thanks to first-loss guarantees from the International Finance Corporation and the African Development Bank that lower the risk premium that private investors demand, allowing more of the total return to go to equity and bond investors than to default insurance. The Addis Ababa Action Agenda (2015) made clear this architecture—of cost-effectively leveraging public capital at concession rates to mobilise private

finance for achieving SDGs in lower-income countries—and it appears this is more or less what the Kenyan data indicate occurred in the domain of infrastructure [1]. But blended finance structures' scalability is limited by the balance sheets of multilateral development banks, and the challenge of the green premium in frontier markets is whether it still is in place once MDBs stop issuing concessional guarantees. This is an empirical question that remains to be answered as an emerging, new generation of non-guaranteed green bonds by sub-Saharan government entities builds up a performance record.

Limitations of the Study

It is important to admit openly the following limitations of our analysis. First, survivorship bias is a material one: SDG-aligned instruments which defaulted, or were reassigned, during the sample period, such as several Brazilian bonds for agriculture or domestic green bonds issued by the Chinese which turned out to be mismatches, may be missing in the index level data, which would tend to distort upward reported premiums. We tentatively tackle this by adding manually identified default universes in our default adjusted version of the universe, but an exhaustive reconstruction of the universe (securing data remotely) via SDG taxonomy is methodologically difficult as the definition of what is SDG-aligned continues to shift at the country level. Second, our sample includes six countries only and is geographically and institutionally diversified; thus it is

still too small to allow formal statistical inferences on the factors associated with the distribution of cross-country premiums and larger panels (with 20 or more countries) should be collected from the FMCG sector to test the robustness of the conclusions regarding which institutional, policy, or market factors significantly drive the distribution of cross-country premiums for the sector.

Third, the sample period 2013-2023 witnessed secular decline in real interest rates, to the benefit of long duration SDG-aligned assets (infrastructure, renewable energy, long maturity green bonds) in particular, especially until 2022. The sudden and total reversal of interest rates since 2022 has already reduced the “mk-mt” performance of green bond portfolios around the world and written down the value of offshore wind development portfolios (notably in the US Northeast and UK). How much of the green premium is 'in the fundamentals' of cash flow and how much is an artifact of a decade of low rates, is an empirical question to be decided in the next 5-10 years when the data will be considered. Our initial evaluation for the sub-period 2022-2024 seems to indicate a narrowing of the premium but not turning at fundamental times, then macroeconomic ones, though caution is advised here.

Policy Implications and Future Research Directions

Despite these drawbacks, the evidence compiled in this paper suggests that there is broad-based and steady return premium

associated with SDG-related capital expenditures that is economically significant and outperforms conventional return measures in various economies and asset classes. The average alpha of +2.2 per annum, ~ USD 68 per USD100 invested over 10 years in the top-performing scenarios is considerable for a potentially marketable asset that is often estimated to generate 50- to 150-unit ESG alphas in the academic literature. This is because of our deliberate SDG screening, meaning we focus on assets that have clear positive footprint to the UN SDG framework and not ESG screening, where companies may be performing well on governance criteria but may not be doing all they can in the areas of the environment and social. In this generative, or content-based, way, our findings indicate that goal specificity is important: the 'green premium' is bigger when the portfolio is built via 'outcome aspects' than input scores.

Hence the policy implications. From a regulators' perspective, the data also make a case for accelerating the convergence of the taxonomy systems – e.g., EU Taxonomy over a partial common set of assets, Chinese catalogue over a partial common set of assets, and ASEAN Taxonomy over a non-common set of assets – to reduce friction in SDG issuance and to increase the universe of investable SDG-related assets. The fiduciary rationale for SDG integration is now sufficiently strong that institutional investors who do not align with SDGs are on the defensive, needing to justify why they don't. Multilateral development banks and development finance

institutions in frontier markets would view the Kenyan outcome through a lens indicative of blended finance structures crowding in private investment well, but raise the bar to a new level of maturity that makes SDG issuance market-led. For the research community in general, however, the fact that the premium is realized differently across the countries, from 150 basis points in China to 360 basis points in Denmark, provides a rich empirical field in understanding how institutions, policies and market structures interact to set the price of the transition to a sustainable global economy.

Conclusion

When climate change, biodiversity loss and social inequality are piling up increasing physical and transition costs on investment portfolios, blind their SDG-aligned capital is not only an expression of institutional values, but an expression of long-term financial rationality. The green premium in this paper is not an idealistic subsidy from investors, but actually the new fact that the assets that are the most valuable are those that are most capable of inheriting the world we are constructing [3] [4]. The capital market, as it should, doesn't lie about the future future at least. Perhaps the most obvious sign that the financial markets have given relating to where that future is is the ongoing and magnitude of the green premium.

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