Carbon negative leveraged investment strategies

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Abstract

   Measuring the impact of portfolio allocations in terms of non-pecuniary effects is becoming more mainstream in the financial industry. A logical extension to methodologies such as portfolio carbon footprinting is that more or less capital provisioning through leverage or short positions should have increased/negative non-financial effects as well. Focusing on climate impact, this paper develops a stylized model where investor capital allocations drive total economy carbon emissions, and derive the carbon footprint attributable to the investor. In the model, using leverage in the form of long-short short strategies, the investor can reduce or even make their footprint negative when their investment allocations drive (shifts of) cost-of-capital and full economy emissions reductions. In an empirical application using the iTraxx Main non-financial index, we demonstrate how a generic corporate bond exposure can achieve a zero or negative carbon footprint by using a leveraged long-short overlay. The findings should be useful in terms of repositioning traditional non-impact portfolios by using overlays as well as to validate and leverage already operational ESG strategies.

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1   Introduction

With the rapid growth of assets under management in various ESG strategies (see e.g. Bloomberg (2021)), the need to have a better measurement of exposures and impact is rising. Investors seek to quantify what risks are inherent in their investment portfolios due to trends such as climate change, but are also seeking to position investment decisions and products as having positive real economy impact predominantly in the area of carbon emissions. This has garnered the interest of regulators, requesting more formal documentation of claimed impact of investment products, such as in the European Unions Sustainable Finance Disclosure Regulation (SFDR).[3]

Sustainable investments are usually considered in a long-only, non-leveraged format, whereby there is a direct linear relationship between the size of the investment and the perceived 'good' or 'bad' achieved through the investment object's activities. A buyer of a green bond contributes to decarbonization and a buyer of a coal mine bond contributes to more CO_2 emissions. With the space evolving quickly, the marketplace has started to see the first few more complex investment vehicles, such as hedge funds, entering the fray. Two key portfolio components differentiate those vehicles from long-only type of investors: leverage and short positions.[4] These two factors are essentially ways to increase or decrease (alternatively invert) more standard risk exposures. Indeed, they can be described as one, as in its purest form leverage is constructed by selling short one asset and using the cash received from that transaction to invest in a long position in another assets.

This paper explores the implications from an ESG/impact dimension of the difference in the trade structures between the long-only and the leveraged investment strategy case, with focus on fixed income assets. The literature is not extensive on how to footprint non-leveraged portfolios and even less clear on how to handle financial leverage and shorting.[5] Erlandsson (2017) suggests a non-parametric approach using scoring for fixed income portfolios which accomodates more complex trades in an ESG context, for example long-short relative value and curve trades. The drawback with the scoring approach, however, is the lack of connection to real economy impact: such approaches tell little about the impact differential of allocating USD10mn or USD100mn to a particular strategy. This paper aims to complement the relative approach with an absolute approach, enabling the investor to understand and motivate the effect of using leverage on an investment strategy in terms of non-financial impact.

In the first section, the paper discussed general forms of carbon footprinting and the linkage between leveraged long positions having capital constraining effects elsewhere in the system, unless one is a central bank. We then proceed to build a small model of an economy where production of electricity and asso-

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[3]For a brief overview of the SFDR, see S&P (2021).

[4]We use hedge funds and long-only funds as stylized investment vehicles. In reality, there are many types of investment mandates with varying degrees of investment flexibility in between. Braunsteffer et al. (2019) provides an overview of European investment funds in the UCITS format and their usage of credit derivatives, as an illustration of the investor spectrum.

[5]In the industry, some parties are even excluding short positioning in general as part of their ESG strategy, for a discussion see Responible Investor (2020).

ciated emissions are driven by the investor's capital allocation, to illustrate how portfolio choices can have direct emissions effects. Using this model, we then argue in two different settings how a leveraged investor can have direct carbon negative effects vis-a-vis the non-leveraged investor. In the empirical section, we analyze a portfolio allocation in European corporate bonds and proxied by the iTraxx Main non-financial index, showing that a traditional long investor could significantly reduce their carbon footprint by using long-short overlays to the portfolio. The final section comments and concludes.

2 Traditional carbon footprinting

The first type of measurement of a portofolio's exposure, ie. 'footprint', links the investor's exposure to the generation of a perceived negative externality such as CO_2 emissions, with a basic formulation as[6]

Carbon footprint = Share of company's capital structure (%) * Company's CO_2 emissions

A traditional investor, only using her own capital, who invests equivalent to 5% of company X's capital structure [7] would consequently have a carbon footprint of 5% of X's carbon emissions as its carbon footprint. Then consider an unconstrained investor, who puts down her capital as collateral for borrowing another 100%, i.e. having a leverage factor of 2x. This investor would be able to buy a 10% stake in company X and analogously gets assigned a 10% carbon footprint of X's emissions from the investment. For now, we will assume that the leverage, the money over-invested so to speak, appears out of thin air and with no cost, either by magic or by central bank operations.

But what is the economy and impact implication of the leveraged investment that the unconstrained investors puts on? The leverage created by the investor injects more capital and effectively lowers the cost of capital[8] for company X's activities. Ceteris paribus, the company then observes a lower marginal cost of production and will thus produce more to maximize profits. This in turns means that X will increase the amount of CO_2 they emit.

Hypothetically, 'thin-air'-leverage could hence lead to large increases in CO_2 emissions, just by lowering cost-of-capital by companies and hence increasing their production.[9] It turns out that this may not as hypothetical after all. Quantitative easing, endemic in the post-GFC environment, has the explicit intention of increasing the demand for risky investments and thus to lower the

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[6]For an example, refer to the AP fund's methodology, available at `The Swedish Nations Pension (AP) Funds' common indicators for reporting the carbon footprint of investment portfolios`.

[7]Capital structure is loosely defined here as we lack a meaningful methodology to separate debt and equity in terms of attributing CO_2 emissions. This is further discussed below.

[8]Demand curve shifts to right means a higher price $\leftrightarrow$ lower yield, or cost, of capital.

[9]There is also a broader debate about whether limits to economic growth, analogously to what we mention here, must be applied in order to limit carbon emissions growth. Our views here should not be interpreted as a point in that debate.

cost of capital for companies and other economic agents on the production side of the economy. If you are an oil-producing company, such as the oil-major illustrated in Figure 1, the fact that you are facing long-dated financing costs (illustrated by the bond curve which is what is targeted by QE) that are below those considered by the non-QE markets (illustrated by the CDS curve) naturally lowers the cost of holding a big balance sheet. It also incentivizes to new developments, as lower cost-of-capital means that you have lower internal rate of return thresholds to approve new projects. Following the 2020 Covid-19 crisis with commensurate central bank corporate bond buying actions, global oil majors issued a large amount of bond capital at low rates (Financial Times, 2020), effectively allowing for retaining capital expenditure to fossil capital expenditure at a level that had not been viable without that financial support.

Figure 1: Sample EUR Cash (z-spreads) and CDS curve for an oil major. 11 August 2021.
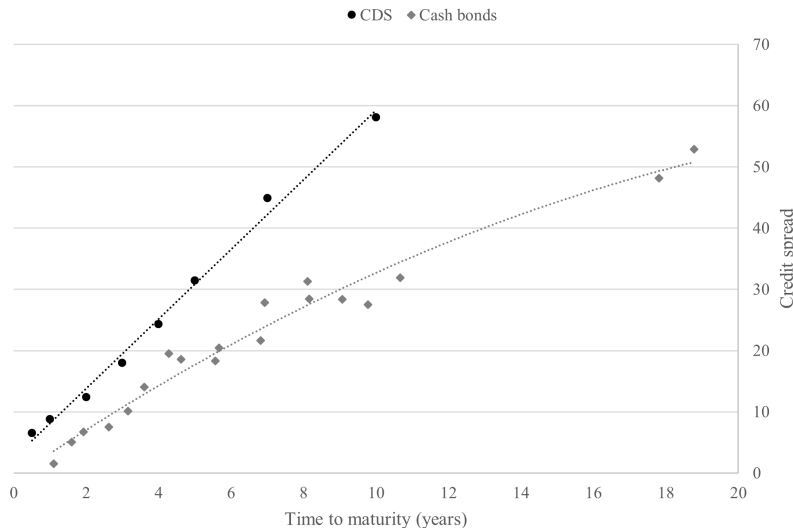
The point with QE is that is a type of thin-air leverage: it does not depend upon reducing capital anywhere else in the economy.[10] From a CO_2 emissions angle, one could thus argue that leverage generates more CO_2 emissions. This, however, only holds where leverage is created out of thin air, which is not what happens in a non-central-bank-based leveraged strategy. Such leverage will, in the limit, make capital scarcer somewhere else in the economy rather than appear from nowhere. In extremis, a hedge-fund getting large amounts of leverage through her prime-broker, will – given bank capital adequacy ratios – other balance sheet activities of the bank, thus creating an implicit short position in the investment projects the bank or its borrowers would otherwise pursue. In a recent example, one could argue that Credit Suisse might have been able to lend more money to other borrowers had it not allocated so much capital/risk to

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[10]We recognize the discussions around QE costs in terms of generational redistribution and similar topics. For the purposes of this paper, we will assume that QE has no cost.

now defunct Archegos hedge fund; see Wall St Journal (2021). For a more traditional fund, applying leverage may not have the same prime-brokerage effects, but rather effects on total risk-capacity of the fund itself through saturation of risk-limits within the investment mandate.

A more direct example on the accounting identities of private leverage would be how a leveraged fund raises cash through repo-ing Treasuries and the buying other assets for the (discounted/margined) proceeds. Effectively, the fund is short the government bond and long some other asset. If the government bond in question has a bigger carbon footprint than the other asset the fund is buying, then could make the argument that the investment is carbon-reductive even. This, in a more formalized approach, is a key point of this paper: it matters not only what investors invests in, but also what has been sold in order to purchase the new asset.

To illustrate broad leverage effects on an ESG factor such as carbon emissions, one could consider the case of reverse QE ('quantitative tightening'). A tightening of monetary conditions is essentially a deleveraging of the central bank's balance sheet and is posited to lead to a slower economic growth or outright contraction. A contractionary economic environment, ceteris paribus, leads to lower CO_2 emissions. Recently, central banks have started discussing various asset purchase programs in terms of climate impact, see Lagarde (2019). In today's market environment, a rapid normalization of interest rates would probably be the fastest way to reach quick carbon reductions, albeit due to reduction in growth rather than any energy transition occurring. As a comparison, Friedlingstein et al. (2020) estimated the reduction in fossil CO_2 emissions to -7% in 2020 as the COVID pandemic occurred with a resulting -3.5% global GDP growth (World Bank (2021)).

The discussion above as well as remaining sections will equate 'capital' with debt rather than equity. As noted, there is currently a lack of methodologies to separate the two when it comes of impact discussions such as carbon footprinting. In practice, if we are considering a company with 10Mtpa of CO_2e emissions, with an enterprise value[11] of USD100mn, where USD35mn is equity and USD65mn is debt, how do we split that CO_2 between debt and equity? Even within the debt structure, how does one attribute CO_2 between bonds of different maturities and seniority? Lacking a robust methodology for this, one runs a risk of either double-counting CO_2 or underestimating it.[12]

A focus solely on the debt side has two advantages beyond simplifying the analysis. First, debt has a direct link to the cost-of-capital of the companies that are being invested into. Whereas the equity assets class is dominated by secondary market transactions, especially in high carbon exposed companies, debt is continuously being re-issued as bonds and other instruments mature, making the primary market nature stronger. This in turns leads to more direct realignments of cost-of-capital with investor positions, see Sjöström and Erlandsson

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[11]We use a definition of enterprise value (EV) as the sum of equity market capitalization and outstanding debt less cash on balance sheet.

[12]For example, see Financial Times (2021) highlighting a pension fund with far-reaching equity divestments from high-CO_2 exposed companies was at the same time running large positions in the debt securities of the same type of companies.

(2020) for a further discussion. Second, debt markets have standardized derivative instruments in the form of credit default swaps (CDS) that trade on an individual company level, connects closely to direct cost-of-capital effects on companies and do not rely on operationally demanding repo operations. Intermediately sophisticated investors in credit will have access to CDS in some form, making leveraging strategies using CDS relatively straightforward to implement.

3   Carbon footprinting of leveraged investments

We start by considering a closed economy, one period model to study the effects of the long-short dimension of leverage. Start by assuming that we have two companies/assets: two electricity generators A and B, where A runs on coal and B runs on fossil gas. A emits 2 tonnes of carbon dioxide for every 1 unit of electricity it produces. B emits 1 tonne. Formally, these linear relationships are the production functions for the companies. We assume that the companies produce electricity according to their marginal access to capital, ie. if a company has access to 1 unit more of capital, they will produce 1 unit more electricity. We set both companies to produce 0.5 units of electricity in the case where they have no access to capital. This should be seen as some form of retained earnings/equity and reflects the tendency of companies to continue operating even with little access to outside capital. The total economy demand for electricity is fixed at 2 units. This leaves the economy to emit somewhere between 2 and 4 tonnes of CO_2.

Furthermore, assume that we have an investor with \$1 of capital that she uses to invest in either company, and in this way, the production of electricity from A or B will completely dependent upon the investor's preferences for respective company. If the investor invests more in the assets of company A, their access to capital allows them to produce more electricity with resulting CO_2 emissions.

We show the resultant quasilinear relationship between investments and CO_2 emissions in Figure 2. Note that we hold the demand for electricity constant. If the investor invests equally across the two assets, 50 cents in each, both A and B produce 1 unit of electricity: 0.5 units due to the capital provided by the investor and 0,5 units due to the zero-capital production level. A produces 2 tonnes of CO_2, and B produces 1 tonne, for a total economy CO_2 emissions burden of 3 tonnes.

Given the relationship in Figure 2, either company would stop production if an investor would short their assets, i.e. there would be a negative capital allocation to the tune of -50 cents. We can see that in the top panel of Figure 2 when the allocation of capital to A goes to -50 cents (x axis), production from A is shut down. Turning to the lower panel, we can then see at that point, total economy emissions are 2 tonnes, as only B is producing electricity. This is a gross leverage position: the net exposure of the investor's positions is 1 but the sum of absolute investments is \$2 (\$1.5 long position in B and -\$0.5 in A). The reverse is true: if we instead leverage up on investments in A, we can then drive the economy to emit a total of 4 tonnes.

Figure 2: Production of electricity (top) from the coal (A) and gas utility (B) on the basis of capital allocation to company A (implicitly cost of capital). Total economy carbon emissions (bottom). Y-axis reflects the amount of capital allocated to company A.
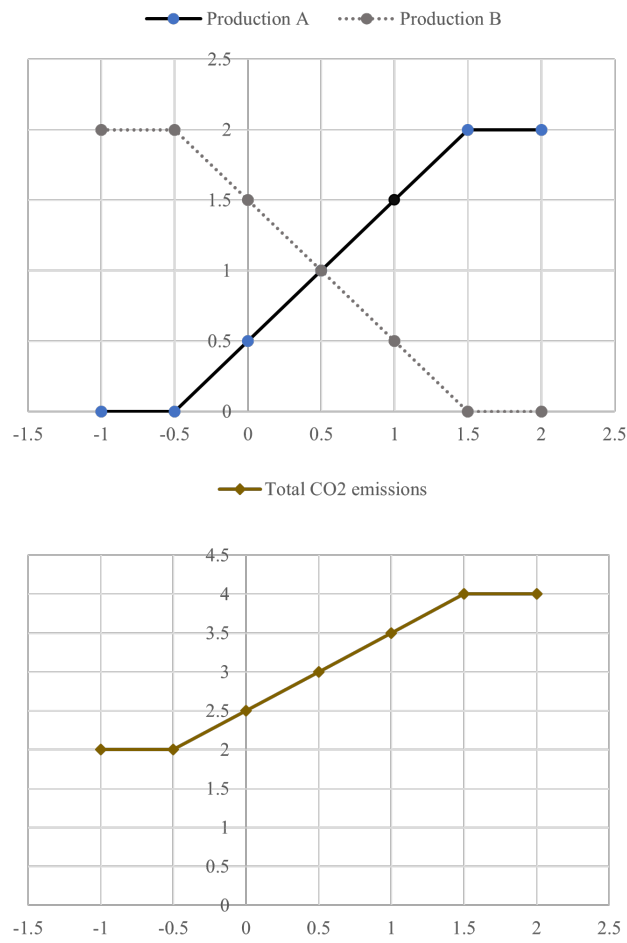
3.1 Inelastic demand and a rest-of-world function

We now consider a slightly bigger universe, where a third company C which is much bigger than A or B initially act as a buffer for any excess electricity generated between A and B. We do this in order to evaluate more dynamic effects of levering up the investor's balance sheet. Think of company C as an inert government utility, or as a non-reactive rest-of-market representation. As earlier, we assume that 1 unit of electricity generates 2 units of CO_2 for coal and 1 unit for gas. Company C has a 50/50 power mix meaning that its carbon footprint is 1.5 tonnes per unit of electricity. The total demand for electricity in the economy is 10 units.

Again, if the investor invests 50 cents in A and 50 cents in B, they will both produce 1 unit of electricity each. Company C will generate the rest, 8 units, to meet final demand. The resulting CO_2 emissions are 2 tonnes from A, 1 tonne from B and $8 \cdot 1.5 = 12$ tonnes from C. We refer to these amounts as ´initial state emisssions' (denoted by $*$). The investor's portfolio carbon footprint is 3 tonnes, and world emissions 15 tonnes.

Hence, if we look at a case of 2x long-only leverage, the investor invests \$1 in each of A and B,[13] they both generate 1.5 units of electricity, which means that C reduces production to 7 units. The total emissions of the economy stay constant, but the investor's carbon footprint rises in line with leverage, i.e. it goes up to 6 tonnes. So, from a closed economy perspective, the leverage does not affect total emissions, even if the investor is perceived to have a bigger responsibility for it in an absolute sense. There is naturally a book-keeping flip side to this, where the one 'responsible' for company's C carbon emissions sees a commensurate lowering of emissions by 2 tonnes. If we consider this a closed economy, however, the leverage for the levered investor would come from borrowing balance sheet from the one supplying capital to C's operations (most likely the government). So in the book-keeping approach, the investment portfolio and associated carbon footprint for the anonymous investor would reduce in line with how it has increased for the leveraged investor. Another perspective on this is to say that the investments of the leveraged investor has not had an effect on total emissions, hence one would argue that the investment strategy is net neutral on emissions.

We are now formalizing these relationships on the production and emissions side through a simple set of equations, to explore further dynamics when the leveraged investor alters the portfolio allocation between A and B and leverages up on that combination. First, we define the electricity production for the companies A and B:

$$G_i = \max\left(0, I^i \cdot PP^i + G_i^*\right) \tag{1}$$

where G_i^* refers to the initial state production of electricity for company i. PP_i refers to the production multiple relative to capital. We set this to 1 for all pro-

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[13]We will refer to this set-up as net leverage, ie. changing the total exposure to A and B to a number different than the original \$1 of capital that the investor has.

ducers, so that one more unit of capital leads to one more unit of production. This equation simply tells us that even without any investment allocated to it, the company will produce a certain initial state amount of electricity G_I^*. As in the earlier example, we assume that production without any investor capital will still go ahead, i.e. $G_I^* > 0$ If the capital allocation goes negative, i.e. the investor shorts the company, the production will fall but is naturally limited from below at zero.

As we are witnessing a closed economy with inelastic demand for electricity (ie. demand will always be the same), the large company C has its production defined by meeting the residual output needed after the small companies have produced:

$$G_C = G^* - G_A - G_B \tag{2}$$

where G^* refers to the whole economy production (=demand) of electricity in the initial state.

Carbon emissions a for each company is given by the factor E_k such that for $k \in (A, B, C)$:

$$CFP_k = G_k \cdot E_k \tag{3}$$

This means, for example, that the initial state emissions from company C is defined as:

$$CFP_C^* = G_C^* \cdot E_C \tag{4}$$

This small system the gives a portfolio carbon footprint of:

$$CFP_{pf} = (CFP_A^* - CFP_A) + (CFP_B^* - CFP_B) + (CFP_C^* - CFP_C) \tag{5}$$

The last term of that equation indicates that the portfolio assumes not only the direct footprint from its own holdings, but also from that of affecting the large company C production. We shall develop how that channel can become important in terms of leverage.

3.2 Investor leverage

The simplest case of investing, long-only, with no leverage is defined by:

$$I_k \geq 1; I_A + I_B = 1 \tag{6}$$

where I_k is the investment allocated to A and B respectively. $I = 1$ indicates a fully invested, non-leveraged portfolio.

Relaxing the first case, we define 'gross-levered' portfolio, where the portfolio can go long-short (I_k is allowed to go negative) but the net exposure sums to 1:

$$I_A + I_B = 1 \tag{7}$$

We define the amount of gross-leverage GL as $GL = \|I_A\| + \|I_B\|$. The gross-levered portfolio case is one that can be observed, for example, with certain pension funds, where the funds may not take on more net exposure than their AUM, but may implement shorts within their mandates without reducing total

risk.

A further case 'net-levered' portfolio is the portfolio that can only go long, but be more than fully invested such that:

$$I_k \geq 0; I_A + I_B = NL \tag{8}$$

where NL indicates the amount of net leverage of the portfolio. This would be the case with, for example, structured investments, where the added value of the product is to provide more than net exposure but not really take any relative value calls.

Finally, we consider an unconstrained investor portfolio (this would typically be defined as a 'hedge-fund') where neither gross- nor net-leverage is limited. The actual constraints on I_k for the hedge-fund will be in terms of the amount of leverage provided by prime-brokers which eventually will be constrained by potential regulatory constraints.

3.3   Emissions in an economy with a leveraged investor

Let us start by illustrating how the economy and emissions look in the case of net leverage = 100%, as seen in equation (7) so that that the investment in B plus the investment in A must sum to 1. We plot this in Figure 3.

The figure has three intervals of relevance:

$[-\infty < B < -0.5]$: There is no production in company B. Production in company C is below initial state due to crowding out from coal. Total emissions are above initial state and the marginal change of emissions is -0.5 per investment in B.

$[-0.5 < B < 1.5]$: There is production in both A and B and C is at initial state. Total emissions are above or below. Marginal change of emissions is 1 per investment in B.

$[1.5 < B < \infty]$: = There is no production in company A (coal). Production in company C is below initial state due to crowding out from gas. Total emissions are below initial state and the marginal change of emissions is -0.5 per investment in B.

From the bottom part of Figure 3, we can se how total economy emissions change on the basis of the decision of the investor. When the investor increases the weight of the portfolio allocated to B, the total emissions decline and vice versa. The rate of decline is dependent upon whether the allocation crowds out production at A or at C. As the dotted CO_2 reduction line in Figure 3 implies, the lowest emissions will only be achievable when the investor is allow to invest more than 100% ($I_B > 1$). In other words, leverage is required in order to minimize emissions.

Figure 4 illustrates how the absolute carbon footprint of the portfolio varies according to how much gross leverage the investor applies. For the case $[0 \leq B \leq 1]$,

Figure 3: Electricity output based on fund investment in company B. Fixed net leverage = 1.
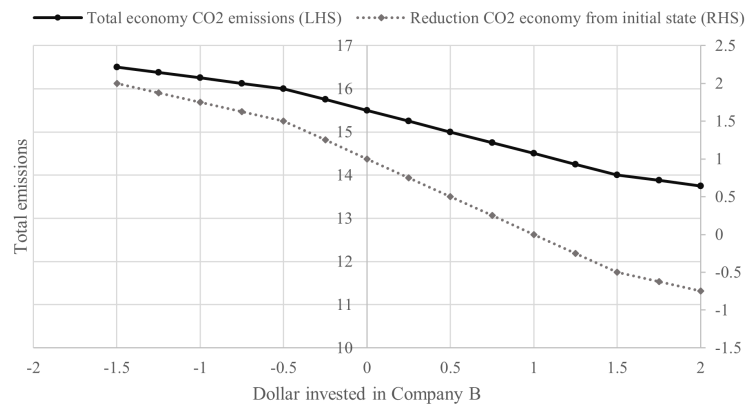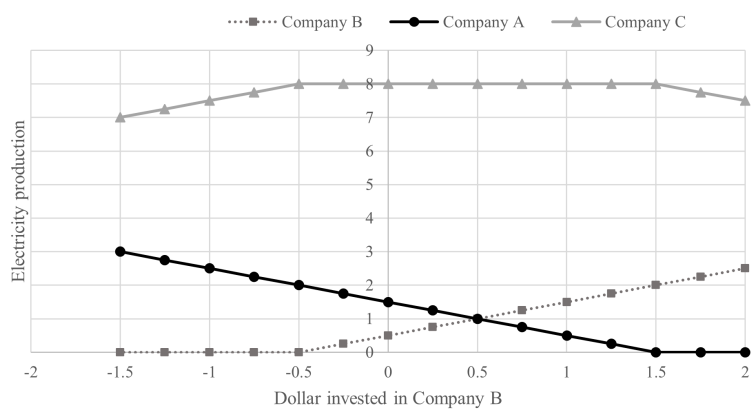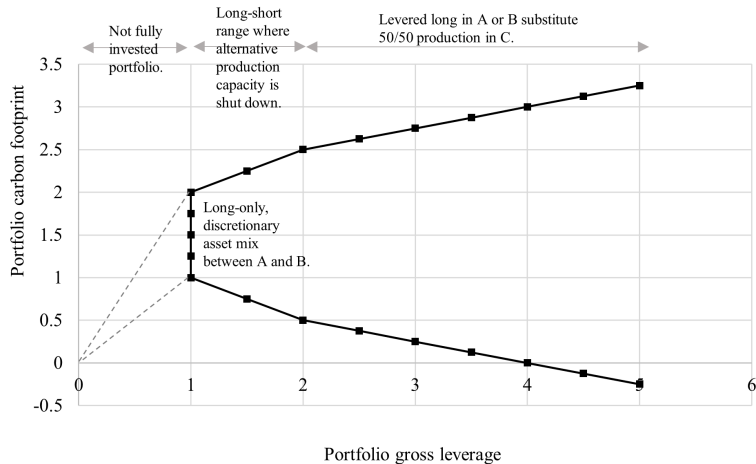
Figure 4: Portfolio carbon footprint set as a function of gross leverage. Net leverage = 1 when gross leverage ≥ 1.

we assume that net leverage is 1 and the exact footprint depends on the asset mix, as shown by the cone extending from the origin $(0,0)$ to $B = 1$ in the graph. In the area $[1 \leq B \leq 2]$, the marginal footprint effect is high, as in this interval the gross leverage of more than 1 implies shorting of the other producer A or B. For cases $\|B\| \geq 2$, the portfolio starts taking on the responsibility for production in C, where the marginal effect of applying leverage decreases.

This illustration further demonstrates how the leveraged strategy can actually reach a lower carbon impact than what is possible in the non-leveraged case. This hints at a possible strategy switch for an investor that can consider to either invest capital in a long-only fund ($\|B\| = 1$) or a hedge-fund with certain leverage constraints $[1 \leq \|B\| \leq 2]$ to actually reduce their carbon footprint by that switch. With an ever higher amount of leverage (e.g. $B = 4$) we see how it is possible to reach an allocation where the actual carbon footprint of the portfolio is zero.

We also let the graph illustrate the choice for the investor to not be fully invested, shown by the cone extending from the zero point $(0,0)$ to the 100% invested range. This area is where the investors decide to stay in cash rather than be fully invested. For example, an investor might want to halve their carbon footprint and do so through de-leveraging rather than levering up as earlier suggested. However, as we shall argue below, the deleveraging is essentially a divestment from the sector so that the assets go into another non-substitutable asset.

So far, we have considered a portfolio where the two assets are both contributing emissions: coal and gas. This leads to a somewhat counter-intuitive result that a leveraged investment into fossil gas could eventually, at higher de-

grees of leverage, lead to a neutral or even negative carbon footprint. However, with electricity demand set and all electricity generation needing to generate emissions, the investor gets credited for reducing emissions from the initial state. For example, in a case where gross leverage is 5, there is no production in A (investor short gets a minus 1 tonne credit), 3.5 units of production in B (and 3 tonnes emissions attributable to the investor), 6.5 units of production in C (with 9.75 tonnes of emissions). C is generating 2.25 tonnes less emissions in this case compared to the initial state, which also gets credited to the investor. Hence, the total portfolio carbon footprint becomes -1 + 3 - 2.25 = -0.25 tonnes of CO2.

To make a more realistic picture of the potential for carbon reduction for leverage, we now look at the same case but assuming that C holds a generation mix containing some non-fossil generation capacity, such as hydro, nuclear or renewables. With a 50% non-emitting mix into the portfolio of C, the company's carbon emissions per unit of electricity falls from 1.5 to 0.75 tonnes. We illustrate the commensurate carbon footprint of the leveraged investor in Figure 5. What comes out from the graphs is how the investor in this case is able to reduce her footprint by using up to 2x leverage, but that beyond that, the footprint starts to increase again. First, leverage is used to shut-down coal (reducing emissions), but once coal is down to zero, the investors starts accruing carbon footprint from being invested in a less carbon efficient company B compared to the general market mix available for C. From the perspective of an investor seeking to reduce her carbon footprint, fossil gas in this example is only good insofar it shuts down coal, but not after that.

Figure 5: Portfolio carbon footprint set as a function of gross leverage, in a case where residual generation capacity is partly zero-emission.
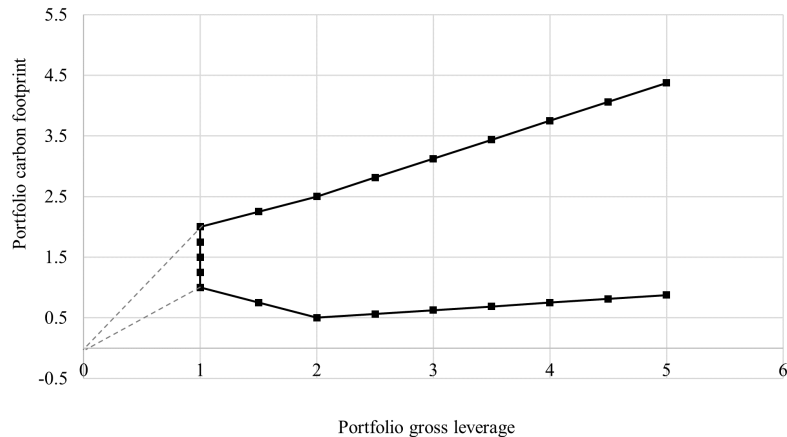
We now move on to the case where the leveraged investor also has access to zero emission investment opportunities. Figure 6 illustrates a case where the economy only has a coal generator (with CO_2-emissions of 2 tonnes per unit of

electricity) and a renewables generator (with CO_2 emissions of 0 tonnes). We assume that the buffer generator C has emissions of 0.75 tonnes per unit. It is clear that in this case, the portfolio carbon footprint can become negative, with the logic that if the investor supplies capital to renewables that crowd out fossil-based generation capacity, the investment impact is indeed carbon-reductive. Indeed, one can argue on the basis of this figure that leverage when applied to the investments in the zero-emission company is unequivocally positive in terms of the total carbon footprint.

Figure 6: Portfolio carbon footprint set in a coal vs renewables case.
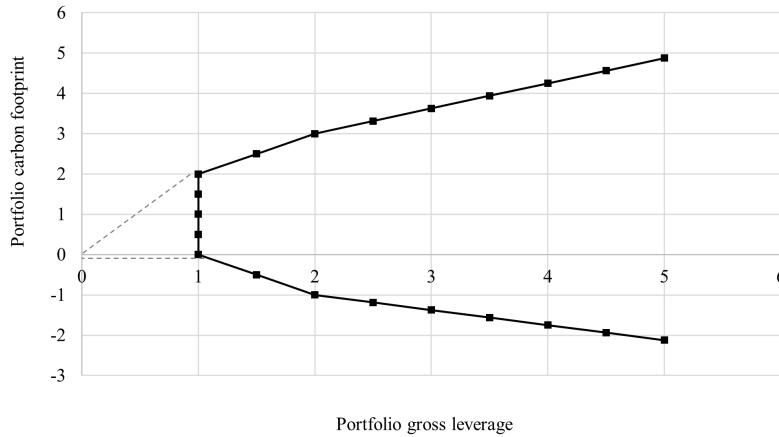
The key conclusion we draw from Figure 5 and 6 is that for an investor seeking to decarbonize, leverage can be quite useful when applied through long-short combinations, even in the case of two carbon emitting assets. When looking at combinations of non-emitting and emitting assets, the decarbonization can become quite powerful relative to long-only mixed asset portfolios.

The above analysis has rested upon a number of assumptions and simplification, which we discuss further below:

3.3.1 Asset substitutability

We have so far assumed a perfect substitutability of the output of A, B and C. Switching from one electricity provider to another will not make a difference to the users other than through the price paid. However, even with a product such as electricity, one will have to consider the substitutability between the products: assume for example that utility B runs on wind-power and will have less stability in supply of electricity compared to or C. Or, in a more extreme versions, B supplied something quite different from A and C, and investments into B actually leads to welfare losses for the consumers of electricity from A and C. From a portfolio management perspective, one could consider the switch

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between near-substitutes as a within-sector reallocation of capital, and the latter as a reallocation between different sectors.[14] Theoretically, a highly leveraged investor could thus drive welfare losses by shifting capital in a way that would be suboptimal to the utility of consumers in the economy, let us denote this the 'gilets jaunes'-case. Some perceived elite is redistributing financial resources (e.g. through taxation) for purposes of environmental good, but in doing so, they impose welfare losses on consumers in the economy.

Our simple model does not integrate non-perfect substitutability as presented above. One way to potentially do this would be to think of it as a taxation on company B, creating a wedge between the capital allocated to it and how that translates into actual economy output, thereby reducing the marginal impact of capital. The quantification of such a wedge should be an interesting topic for future research. However, we take the approach here of assuming it away by noting that on the other side of the total welfare equation, other externalities could also operate as to improve total welfare. In our examples, reducing negative climate effects as well as improving air quality through switching from A to B work as improvement in total welfare. For the consumer in a polluted city, having a slightly less reliable electricity supply versus semi-permanent respiratory challenges may very well already today be a trade-off the consumer is willing to make.

So we simply make the assumption that the non-substitutability (negative for total economic welfare) and reduced negative externality effects (positive for total economic welfare) are equal in magnitude in certain conditions. Non-substitutability can be fairly well incorporated in into asset valuations. The demand and hence pricing power for the underlying corporates will translate into different revenues and and consequently returns and valuations. On the other side, externalities – especially in CO_2-emissions terms – are often not priced-in to the same degree. However, our assumption would be more likely to hold in an environment of more fully priced externalities, which we hope will arrive in the not too distant future. Hence, our assumption may not be empirically verified as of today, but morally sound in the long run.

3.3.2 Investor substitutability

A common discussion in ESG investing, in particular in the equity class, is the one of "one's seller is another's buyer" where the intention is usually to highlight the futility of divesting, as there will be (almost) perfect substitutability on the investor side. 'Almost' should be the operative word here: the buyer will seek to transact at the lowest possible. And this lower price implies a higher return-on-capital requirement for the underlying company. However, the return on capital requirement also flows into the capital expenditure decisions of the underlying company. For example, Exxon is less likely to invest in fossil energy projects that have a return on investment lower than the company's return on

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[14]One can hypothesize and leave for future research that the asset substitutability has a near relationship with financial asset price correlation as well.

capital requirement.[15]

There are also frictions in asset markets that decrease investor substitutability. Let us exemplify by looking at positioning in Suncor (ticker SU CN, bond ticker SUCN), the biggest producer of oil from the controversial Canadian oil sands. Based on the most recent data, Fidelity Investments (FMR) holds 5.4% of the shares (31 Dec 2020), and Fidelity International (FIL) holds 5.3% (30 March 2021).[16] Each of these stakes is worth approximately USD1.6bn. The carbon footprint of the joint position (USD3.2bn) is 15.4 megatonnes CO_2e.[17] If we look at the top 20 holders of SU CN stock, they all hold 1% or more of the company with an aggregated ownership share of 48%. Such a relatively concentrated ownership in a controversial company suggest that there may be limits to investor substitutability in terms of the larger position holders.

We believe it is also worthwhile to note the nature of a leveraged (short) position. For example, Norge's Bank Investment Management ('the Oil fund') has recently divested from Suncor as a climate related exclusion.[18] If NBIM were to short Suncor, say to the tune of USD1.6bn, that position could effectively be negotiated with one of the Fidelity entities, whereby the Fidelity entity would sell their stake into the open market and have the income stream from the stake replaced by NBIM instead. The carbon footprint for the Fidelity entity would be unchanged, whereas NBIM could account for a carbon footprint reduction. The effect in this case in terms of share price and implied return on capital is likely to be negative, as there seems to be few players that would step in to take a 5% share beyond Fidelity and Royal Bank of Canada.[19]

The above discussion illustrates that it may be incorrect to assume perfect substitutability between investors. More quantitative measurements of the elasticity in terms of how much capital is required to affect the price of the security in this ESG contexts remains the topic of future research.

3.3.3 Multi-period settings

The model only considers a one-period t setting, whereas in a multi-period setting, the question of how to account for a negative carbon footprint in period $t+i$ should be considered. If the investor drove the economy to a low-emissions states in period t, does she retain the associated carbon reduction credit in $t+1$ if holding on to the same investment allocation? Note that we defined the

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[15]As argued elsewhere in this note, the linkage between debt securities and cost-of-capital is more direct than in equities. If Exxon pays 5% to borrow money, that sets a very naturaly lower bound IRR requirement on new investments.

[16]FIL is an independent spin-out of the international business of FMR. According to public sources, the founding Johnson family retains control of both entities, with an ownership of 49% of FMR and 40% of FIL.

[17]Data as of the company's own disclosures for 2020. We assume that the equity takes full responsibility for the emissions and sum Scope 1+2+3 emissions.

[18]Decision as per 13 May 2020, decision available here.

[19]Hypothetically, many of the domestic players such as RBC could be at the top of their risk limits with regards to Suncor. RBC currently holds a 5.1% stake. Near the top of a risk limit, the marginal propensity to take on additional (oil sands) risk should be lower than otherwise.

carbon-footprint as the change from some steady state emissions CFP_i^* in equation (5) earlier on. In finance linguistics, this becomes the matter of whether we are looking at a flow or stock perspective. We leave that analysis and discussion for future research.

Another dimensions of the multi-period discussion should be on the carbon footprinting of investments that lock in certain emissions levels over a long time, versus those that only produce them at time t. In our example above, we could integrate certain inertia in investments over several periods and then discount total emissions back to t and look for how that would impact the investor's carbon footprint. A practical exercise would be to compare the carbon footprint of investments into fossil gas, locking in long-term emissions, versus a combination of soon-to-be-shut coal and then zero emissions production for perpetuity. Again, such multi-period exercises are beyond the scope of this paper, but we believe it is an important dimension to consider at least by some rule of thumb also in early implementations.

Finally, we avoid the duration of capital investments in this analysis. The difference in terms of investing perpetual capital such as equity versus short-dated bonds and how this then feeds back into the dynamics of the investment allocations and refinancing of the companies over multiple periods is not trivial and should be further studied.

4   Empirical application: A carbon negative credit portfolio

We now turn to a portfolio implementation to look at how a leveraged portfolio could turn carbon-negative. We focus on the fixed income market, where there is a clearer link between positioning in the securities and the actual cost of capital for the issuer. For simplicity, we assume an investor with a mandate to invest in EUR corporate credit risk. This means that exposure is built vis-a-vis the non-financial sector only. For proxy of this, we use the iTraxx Main non-financial index which is constructed from the component parts iTraxx Main and iTraxx SenFin index.[20]Given the liquidity of those two indexes, the implied non-fin component can be built with ease and relatively low transaction costs.

We split the Non-Fin index into two sub-components, which we call the Blue and Grey indexes. The grey index refers to a set of names subjectively decided to be in carbon-intensive sectors with a potential substitutability, i.e. names that with higher cost-of-capital would be inclined to reduce emissions and/or see demand shift quicker to alternative products. The blue index refers to all other companies. Summary metrics for the Non-Fin index, and its blue and grey subcomponents are available in Table 1. The full list of individual credits and associated data is available in Figure 7.

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[20]For construction of the iTraxx Europe (generally known as iTraxx Main) and non-financial index, see Markit (2018). The full iTraxx Main index consists of 125 equally weighted single name CDS wiht identical maturities.

Table 1: Summary statistics on the Grey and Blue iTraxx non-financial sub-portfolios. CDS spreads refers to 5y on-the-run CDS spreads. CO_2 in million tonnes Scope 1+ Scope 2 reported emissions. EV = enterprise value in EURmn.

Measure	CDS Spread	CO_2 Mt	EV	CO_2/EV
Grey				
Average	59	41.2	77	0.83
Median	56	31.4	62	0.34
Sum		495	927	
Blue				
Average	47	5.1	59	0.12
Median	42	1.2	37	0.02
Sum		414	4568	

We indicate carbon-footprint of the companies and sub-indices based on CO_2 (Scope 1+2)[21] divided by Enterprise Value (EV, equity + debt – cash on balance sheet). The literature tends to use carbon-intensity measured as CO_2 / $ of revenue or sales, but in we believe the EV denominator is sometimes more useful. For example, with new net-zero commitments, many companies (as illustrated in Ostrovnaya et al (2021)) set targets of intensity where they assume unchanged CO_2 absolute emissions but increasing sales volume. This is also reflected by investors often focusing on carbon intensity of their portfolios: in effect this can lead investors to invest in companies targeting increased CO_2 emissions albeit lower than their projected revenue growth. However, atmospheric CO_2 concentrations are independent upon the level of economic activity, which in a company should be proxied by its revenue generation, but dependent upon absolute amounts of emissions. Again, in the context of leveraging an investment strategy, using a relative measure such as carbon intensity rather than an absolute measure is problematic.

Another intuitive reason to use EV is that we are looking at a context of investors allocating capital to these entities. The EV measure is an indicator of how much capital the market is allocating to the company through equity and bonds. This puts a relationship between the model we have in the previous section and the actual traded entity's capital base: what we have earlier referred to as investments in company A and B can be equalized with enterprise value in this context. If a company has a high CO_2 / EV ratio, then every investor dollar (=fraction of EV) has a higher potential CO_2 impact and responsibility.

Given the statistics in the table, we see that the EV of the Grey index is approximately EUR0.9trn and for the Blue index EUR4.6trn. The associated CO_2 emissions are 0.5 gigatonnes and 0.4 gigatonnes[22] respectively. In our single investor economy, we would thus see this as an investor with a EUR5.5trn portfolio and carbon footprint of 0.9 gigatonnes.

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[21]We recognize the imperfections of just looking at only Scope 1 and 2, but lacking consistent Scope 3 data makes any other approach impracticable at the time being.

[22]For reference, 1 gigatonne (Gt)= 1,000 megatonnes (Mt). Remaining carbon budget as per the IPCC6 report is around 500Gt. Annual fossil related emissions are around 40Gt. As a rule of thumb, a coal plant of moderate size emits around 10Mt per annum.

Figure 7: Issuers in the Grey and Blue indexes with associated statistics. June 2021.

Grey index

Reference entity	Spread	CO2	EV	CO2/EV	Reference entity	Spread	CO2	EV	CO2/EV
BASF SE	29	20.9	77.3	0.3	Repsol SA	63	22.5	29.4	0.8
BP PLC	54	45.5	126.7	0.4	Royal Dutch Shell PLC	44	72.0	197.5	0.4
Eni SpA	57	38.5	55.6	0.7	TotalEnergies SE	35	39.0	141.4	0.3
Equinor ASA	24	13.5	68.1	0.2	Anglo American PLC	99	16.1	52.8	0.3
HeidelbergCement AG	77	74.3	22.6	3.3	Cie de Saint-Gobain	43	11.2	37.3	0.3
Holcim Ltd	66	117.0	41.3	2.8	Glencore International AG	118	24.3	76.7	0.3

Blue index

Reference entity	Spread	CO2	EV	CO2/EV	Reference entity	Spread	CO2	EV	CO2/EV
Airbus SE	58	0.8	52.0	0.0	Koninklijke DSM NV	23	1.2	17.3	0.0
Volvo AB	43	0.3	22.2	0.0	Koninklijke KPN NV	112	0.3	83.5	0.0
Akzo Nobel NV	31	0.2	17.5	0.0	Air Liquide SA	N.A.	27.5	7.0	0.3
Alstom SA	44	0.1	207.1	0.0	LANXESS AG	53	2.9	N.A.	0.4
Anheuser-Busch InBev SA/N	53	4.7	139.5	0.0	Louis Dreyfus Co BV	N.A.	N.A.	N.A.	N.A.
AstraZeneca PLC	29	0.4	N.A.	0.0	LVMH	27	0.2	71.9	0.0
ELO SACA	73	1.4	25.2	N.A.	National Grid PLC	35	6.5	37.6	0.1
BAE Systems PLC	51	0.5	83.7	0.0	Naturgy Energy Group SA	47	15.5	332.9	0.4
Bayer AG	62	3.8	106.2	0.0	Nestle SA	17	5.3	13.9	0.0
Bayerische Motoren Werke	43	1.9	N.A.	0.0	Next PLC	84	0.1	63.4	0.0
Bertelsmann SE & Co KGaA	29	1.0	18.1	N/A	Orange SA	38	1.3	7.9	0.0
Bouygues SA	37	2.7	122.5	0.2	Pearson PLC	56	0.0	56.4	0.0
British American Tobacco P	73	0.8	45.1	0.0	Pernod Ricard SA	26	0.3	2.5	0.0
British Telecommunication	63	0.2	26.3	0.0	PostNL NV	32	0.0	16.4	0.0
Carlsberg Breweries AS	25	0.6	27.4	0.0	Publicis Groupe SA	58	0.0	119.0	0.0
Carrefour SA	47	1.7	8.1	0.1	Sanofi	23	0.8	7.1	0.0
Centrica PLC	83	1.9	18.3	0.2	SES SA	83	0.0	142.4	0.0
CNH Industrial NV	84	0.4	27.5	0.0	Siemens AG	28	1.3	37.1	0.0
Cie Financiere Michelin SA	37	2.5	35.4	0.1	Sky Ltd	20	2.0	14.1	0.1
Compass Group PLC	32	0.1	29.7	0.0	Smurfit Kappa Acquisitions UL	N.A.	2.2	15.5	0.2
Continental AG	73	1.0	63.3	0.0	Sodexo SA	38	0.1	15.8	0.0
Daimler AG	51	2.5	51.4	0.0	Solvay SA	45	10.3	29.3	0.6
Danone SA	26	1.1	83.7	0.0	SSE PLC	44	8.9	26.8	0.3
Deutsche Post AG	24	7.3	255.4	0.1	STMicroelectronics NV	31	1.1	15.4	0.0
Deutsche Telekom AG	39	2.5	112.1	0.0	Stora Enso Oyj	N.A.	3.0	76.7	0.2
Diageo PLC	26	0.7	59.9	0.0	Telefonica SA	64	0.7	7.6	0.0
E.ON SE	36	8.1	36.7	0.1	Telekom Austria AG	26	0.3	31.8	0.0
EDP Finance BV	55	15.2	85.7	0.4	Telenor ASA	25	1.2	24.6	0.0
Electricite de France SA	50	19.0	148.3	0.2	Telia Co AB	28	0.1	34.3	0.0
Enel SpA	54	46.7	55.5	0.3	Tesco PLC	65	2.8	42.7	0.1
Engie SA	37	54.0	34.1	1.0	Unibail-Rodamco-Westfield SE	109	0.1	154.5	0.0
Experian Finance PLC	27	0.0	52.3	0.0	Unilever Finance Netherlands	N.A.	0.8	17.3	0.0
Stellantis NV	117	2.9	30.4	0.1	United Utilities PLC	38	0.1	28.5	0.0
Fortum Oyj	47	49.8	115.4	1.6	Veolia Environnement SA	36	30.0	78.3	1.1
GlaxoSmithKline PLC	27	15.9	73.5	0.1	Vinci SA	36	2.2	39.5	0.0
Heineken NV	26	1.4	37.2	0.0	Vivendi SE	68	0.0	97.7	0.0
Henkel AG & Co KGaA	20	0.5	5.4	0.0	Vodafone Group PLC	51	1.9	114.9	0.0
HOCHTIEF AG	102	2.7	121.3	0.5	Volkswagen AG	61	7.1	9.8	0.1
Iberdrola SA	40	15.1	30.6	0.1	Wendel SE	63	0.0	24.8	0.0
Imperial Brands PLC	84	0.2	99.3	0.0	Wolters Kluwer NV	23	0.0	17.5	0.0
Kering SA	24	0.0	39.9	0.0	WPP 2005 Ltd	64	0.1	N.A.	0.0
Kon. Ahold Delhaize NV	28	3.0	30.1	0.1					

Now consider the case of an investor owning a EUR1bn credit portfolio. Assuming that this traditional long-only investor takes a 1x (100% exposure) position to the traditional Non-Fin index, this results in a carbon footprint of 165 kilotonnes (Kt). If the investor only invests in the Blue/Grey index, the footprint is 91Kt / 534Kt, as illustrated by Figure 8. Note the high differential (net -443Kt) between the footprint of the Blue and Grey portfolios. Effectively, a notional neutral[23] long-short portfolio with equal notionals (EUR1bn) invested in the Blue and Grey legs would have a negative carbon footprint of slightly short of half a million tonnes of CO_2. The notionals on the 83 Blue credits would be EUR12mn and on the (short) 12 Grey credits EUR83.3mn. In terms of the credit derivatives market, these sizes of positions would be considered large to very large if executed in one go. Having said that, that a EUR1bn long-short strategy would also be considered quite large.[24]

Perhaps even more relevant than the notional neutral long-short case, the investor with a long-only portfolio could add a long short overlay with EUR370mn exposure to each of the legs of the long-short strategy to make the total portfolio carbon neutral. The increase in gross leverage would be 2xEUR370mn / EUR1bn = 0.75x.[25] In this set-up, the investor would hold a notional of EUR4.5mn per long risk position in the Blue names, and EUR30.8mn notional per short position in the Grey names. However, given that the Grey portfolio trades at a higher spread (59bps) vs the Blue (47bps), the Blue-Grey overlay would cost the investor on an outright carry basis and could be argue to not be market-beta neutral. In order to make the overlay zero-cost, we thus increase the weight on the long positions by a factor of (59/47)=1.24x, which reduces the carbon-reduction effect of the overlay somewhat. Based on our own experiences of the CDS market, executing sizes of trades (EUR5 to 30mn) in these magnitudes would not be trivial but feasible.

In the analysis above, we have outlined the long-short overlay as 'cost-less'. By this, we mean cost-less in terms of expected carry and roll-down on the Blue and Grey indices. Naturally, there is a risk that the long-short overlay introduces additional volatility into the portfolio in which case it does not become cost-less it the investor applies some sort of volatility budgeting. To counter this, there is a possibility that the long-short combination would reduce the total portfolio volatility if the long-short overlay is negatively correlated to the full index or the broader investment portfolio.[26] For example, the Fidelity investment book oil sands component highlighted earlier is likely to be negatively correlated with a carbon negative long-short strategy. To optimize long-short, carbon-negative, negative correlation overlays remains a topic for future research, but we shall note already here that from a pure diversification benefit standpoint, adding zero-cost long-short carbon negative overlays could provide

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[23]A portfolio where the sum of the notionals on the long positions equals the sum of notionals on the short positions.

[24]For an example of analysis around outstanding notional sizes, see Levels et al. (2018).

[25]This would be well within the limits of leverage for some traditional investment vehicles such as European UCITS funds, Braunsteffer et al. (2019).

[26]Other investors may be able to invest in a long-short portfolio on a hold-to-maturity basis and avoid mark-to-market (unless there are defaults in either portfolio) to reduce volatility.

Figure 8: Carbon footprint of iTraxx non-financial portfolio in Grey and Blue settings.
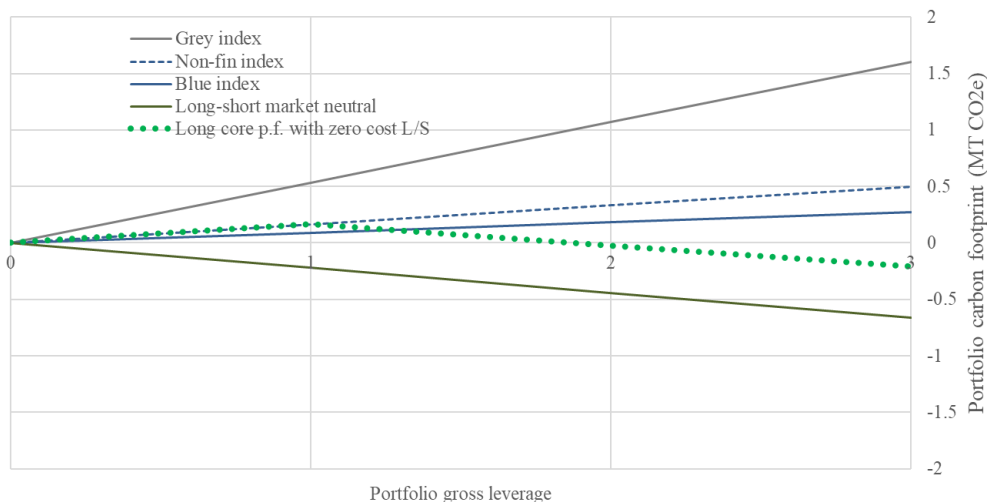
better portfolio benefits for investors with currently more carbon intensive portfolios.

It should also be noted that the long-short strategy could be combined with potential quantitative or fundamental alpha generating strategies to make the expected return on the carbon negative component positive. Indeed, for investors who have an investment hypothesis that high carbon exposed trades will underperform over the longer term, the long-short combination might be expected to generate alpha just by construction.

Finally, a possible critique of the above approach could be with regards to how this actually could affect cost of capital and real world impact. As an example, we refer back to the sub-prime mortgage market evolution in the 00s. Irrespective of how one would frame that as an analogy (on the upside or the downside), it is clear that leveraged bets through the derivatives markets had real financing cost implications and real economic decision impacts. Delineating and quantifying the elasticities (and convexity) of those relationships remains the topic for further research.

5   Conclusion, summary, further research

This paper has illustrated how the usage of long-short strategies can contribute to reducing or even reach carbon neutral or -negative footprint of an investment portfolio. The amount of leverage applied to such strategies will be crucial for the total impact. In the empirical section, we show how this could be feasibly applied in a credit derivative context, that should be suitable in particular for real-money investors that are able to use gross- if not net leverage on their core

portfolios.

We believe a broader point of the paper is how it demonstrates the principle that the investments investors make in terms of 'green' or less carbon-intensive assets on the long side are highly dependent on what they divested from or shorted on the other side to fund that investment. An investor buying a mediocre green bond can consider that investment as 'green-er' if it is paired with shorting a high-fossil asset on the other side, whereas the investor shifting from a low-carbon benchmark into that mediocre green bond provides very little additionality from an investment impact perspective.

6 References

Bauer, F., Tilsted, J., Nielsen, T., Ostrovnaya, A. and Erlandsson, U. (2021), *Petrochemicals, Major credits, carbon risks, green bonds*, Anthropocene Fixed Income Institute, available <u>here</u>

Bloomberg Intelligence; Diab, A. and Adams G. M. (2021), *ESG assets may hit $53 trillion by 2025, a third of global AUM*, available <u>here</u>

Braunsteffer, A., Guagliano, C., Kenny, O. and Mazzacurati, J. (2019), *Use of credit default swaps by UCITS funds; evidence from EU regulatory data*, ESRB Working Paper No 95, available <u>here</u>

Doyle, D.H. (2021), *What is the Impact of the EU Sustainable Finance Disclosure Regulation (SFDR)?*, S&P Global Market Intelligence, available <u>here</u>

Erlandsson, U. (2017), *Credit alpha and CO2 reduction: A portfolio manager approach*, Working paper, available at <u>SSRN</u>

Financial Times; Flood C. (2021), *Danish pension group crticised for fossil fuel exposure*, available <u>here</u>

Friedlingstein, P. and additional authors (2020),textitGlobal Carbon Budget 2020, Earth Syst. Sci. Data 12:3269-3340, DOI <u>here</u>

Levels, A., van Stralen, R., Petrescu, S. K. and van Leyveld, I. (2018), *CDS market structure and risk flows: the Dutch case*, DNB Working Paper 592, available <u>here</u>

Markit (2018), *Markit iTraxx Europe Index Rules*, Technical document

Responsible Investor; Milburn, E. (2020), *Japan's GPIF presses on with ESG efforts after exit of renowned CIO Mizuno*, available <u>here</u>

Sjöström, E. and Erlandsson, U. (2020), *The bond market: Its relevance and functionality for the climate transition*, Stockholm Sustainable Finance Insight,

available here

Wall Street Journal; Patrik M. (2021), *Credit Suisse Failed to Act on Archegos Risks, Report Says*, available here

World Bank (2021), *Global Economic Prospects June 2021*, available here