ORIGINAL ARTICLE

Ownership of ESG characteristics

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Abstract

A portfolio can be viewed as the collection of the businesses, policies and practices of constituent companies. We measure investors' Ownership of this collection. Ownership metrics aggregate an assortment of company specific Environmental, Social and Governance (ESG) characteristics to the portfolio level, and they can inform investment and engagement decisions. Relative to a benchmark, investor Ownership is active and satisfies a zero-sum property, which underscores the distinction between Ownership and impact. Ownership of ESG characteristics may be interpreted as ascribing ethical responsibility, but that conclusion and any decisions that result from it belong to the investor.

Keywords ESG · Ownership · Impact · Responsibility · Portfolio characteristics · Ethical investing

Ownership and responsibility

Socially responsible investing (SRI) has long evoked the image of well-intentioned investors willing to accept subpar returns for selecting securities that they deem "good" or at least "not bad" on ethical grounds. The word "responsible" in SRI implies that the investor is acting as an ethical decision maker. SRI investors may attempt to align their portfolios with their values, for example, avoiding companies that sell tobacco or pornography, or choosing companies with the best records on human rights. We leave for another day a discussion of the ongoing debate regarding the financial performance of SRI portfolios since our purpose is to define and analyze investor Ownership of ESG characteristics. In this note, we formalize *Ownership* as a family of portfolio-level metrics, with implications for reporting as well as investment and engagement decision making.

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Limited liability stock corporations cap the downside risk of investing to loss of principal. Shareholders enjoy the financial benefit of being owners in proportion to their stakes even as they are shielded from the direct consequences of legal or financial obligations incurred by the company. This fractional ownership of the financial benefits also comes with fractional ownership of all the activities of a company and responsibilities, including electing a board of directors that hires managers to run the company. It is through the board and management that the activities of the company are determined, so while arms-length, shareholders have responsibilities that influence the activities of companies they own. To understand the extent of their exposure to various issues, investors need accurate information about the range of businesses, policies, and practices for which they assume ownership when they purchase a security.

We measure investor Ownership of a diverse collection of Environmental, Social and Governance (ESG)[1] issues considered by investors. To put an ESG characteristic's Ownership in perspective, we calculate it for a same-size investment in a cap-weighted benchmark. The difference is *active Ownership*. We provide formulas that can be used to calculate Ownership as well as schematic examples that show how the formulas work. Many ESG characteristics, such as carbon emissions per dollar of revenue and fraction

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1 While the acronyms SRI and ESG are sometimes used interchangeably, we distinguish them. ESG is most appropriately considered as a set of issues within environmental, social and governance domains, different subsets of which may be of interest to different investors. ESG issues contain no judgment about values or bias while SRI does.

of board seats occupied by individuals belonging to an ethnic minority, are ratios. Since combining ratios can lead to unintuitive outcomes, we give special consideration to these characteristics. We treat binary characteristics, such as whether or not a firm has a particular policy, as ratios. Subsequently, we talk about how to interpret Ownership and give a realistic example showing that Ownership of multiple ESG characteristics can be measured in a single portfolio. Our final point is that active Ownership satisfies a *zero-sum property*, which underscores the distinction between Ownership and impact.
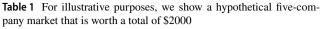
Measuring Ownership

A company's businesses, policies and practices have consequences. Companies hire workers and buy goods from suppliers, creating economic activity. Some companies build solar panels or install and maintain chargers, helping to tackle the issue of fossil fuel consumption and climate change. At the same time, companies may pollute rivers, sell products that directly harm humans or exploit their workers. Ownership of a company's impact can be allocated to investors based on the fraction of the company they own. Company-level Ownership for a given issue can be aggregated to the portfolio level.

Our setup is a market with N companies, and we let m_n be the dollar value of company n, in other words, its market cap. As a benchmark, we take the market portfolio. The weight of company n in the benchmark is m_n/m, where $m = \sum_n m_n$ is the value of the market. We compute Ownership for an investor whose dollar allocation to company n is p_n, so $p = \sum_n p_n$ is the value of the investor's portfolio.

We accompany our mathematical formulation of Ownership with schematic examples that show how the formulas work. These examples are based on a hypothetical five-company market worth \$2000 and a hypothetical investor with a stake of \$100. The details of the market and the investment are in Table 1.

Physical characteristics

We begin with a formula that can be used to calculate an investor's Ownership of Scope 1 carbon emitted[2] or the number of jobs offered in a particular region or any other physical characteristic that can be measured numerically. The investor's Ownership of characteristic J at company n

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[2] The carbon emissions for which a company is directly responsible are *Scope 1*. Carbon emissions for which a company is indirectly responsible are *Scope 2* or *Scope 3*.

Table 1 For illustrative purposes, we show a hypothetical five-company market that is worth a total of \$2000

Company (n)	Market cap (\$) (m)	Investment (\$) (p)
1	300	25
2	300	30
3	500	20
4	600	15
5	300	10
Total	2000	100

In this example, a single investor has a stake of \$100

$O_P^n(J)$ is the company's contribution J_n scaled by p_n/m_n, the fraction of the company owned by the investor,

$$O_P^n(J) = \frac{p_n}{m_n} J_n. \tag{1}$$

Portfolio Ownership is obtained by aggregating over companies:

$$O_P(J) = \sum_n O_P^n(J) \tag{2}$$

For a cap-weighted benchmark portfolio equal in value to the investment, the fraction of portfolio value invested in company n is pm_n/m. Applying formula (1) to calculate company level Ownership $O_B^n(J)$ for this benchmark investment and formula (2) to aggregate to the portfolio level, benchmark Ownership for a portfolio with value p is

$$O_B(J) = \sum_n O_B^n(J_n) = \sum_n \frac{p}{m} J_n = \frac{p}{m} \sum_n J_n. \tag{3}$$

Active Ownership O_A is the difference between portfolio and benchmark Ownership:

$$O_A(J) = O_P(J) - O_B(J) = \sum_n \left(\frac{p_n}{m_n} - \frac{p}{m} \right) J_n. \tag{4}$$

Portfolio, benchmark and active Ownership depend on the value p of the investment.

Table 2 shows how to use our formulas to calculate Ownership for a physical characteristic in our hypothetical market. The characteristic J in our example is the number of jobs offered in the city of Denver, and the total is 98. Using weights obtained from Table 1, we calculate portfolio Ownership O_P to be 7.31 jobs offered and benchmark Ownership O_B to be 4.90 jobs offered. Active Ownership O_A is 2.41 jobs offered, the difference between portfolio Ownership $O_P = 7.31$ and benchmark Ownership $O_B = 4.90$. The portfolio's percentage increases in Ownership for jobs offered in Denver relative to the benchmark is $2.41/4.90 = 47\%$.

Table 2 For illustrative purposes, we calculate Ownership for jobs offered in Denver in a hypothetical five-company market

Company	Ownership			
	Jobs in Denver	Portfolio	Benchmark	Active
(n)	(J_n)	$((P_n/m_n) * J_n)$	$((p/m) * J_n)$	$(((P_n/m_n) - (P/m)) * J_n)$
1	46	3.83	2.3	1.53
2	27	2.70	1.35	1.35
3	6	0.24	0.3	-0.06
4	12	0.30	0.6	-0.30
5	7	0.23	0.35	-0.12
Total	98	7.31	4.9	2.41

Calculation of Ownership relies on the hypothetical investment data in Table 1. Active portfolio Ownership is 2.41 jobs offered, which is an increase of 47% over the same investment in the benchmark

Ratios of characteristics

Suppose we want to measure Ownership of carbon emissions per revenue or the fraction of women on a board. These are ratios of physical characteristics. Applying formulas (1) and (2) directly to ratios can lead to unintuitive outcomes, especially when the denominators vary substantially.[3] When the required data are available, we compute Ownership for numerators and denominators of ESG characteristics separately. This leads to useful aggregates of firm level concepts, such as the board of an investor's portfolio, from which we can determine the fraction that has a specific attribute.

Let J be the characteristic in the numerator, say the number of women on a company's board. Let K be the characteristic in the denominator, say the total number of board members. We are interested in Ownership of J/K, the fraction of the board that is composed of women. In this example, portfolio Ownership of the board $O_P(K)$ is calculated by applying (2) to characteristic K. The same calculation applied to characteristic J gives us portfolio Ownership of the number of women on boards of firms in the investor's portfolio. Ownership of gender diversity in the portfolio is given by

$$O_P(J/K) = \frac{O_P(J)}{O_P(K)}. \tag{5}$$

Applying formula (3), which computes Ownership for a cap-weighted benchmark scaled to the level of investment, benchmark Ownership for gender diversity is given by

$$O_B(J/K) = \frac{O_B(J)}{O_B(K)} = \frac{\frac{p}{m}\sum_n J_n}{\frac{p}{m}\sum_n K_n} = \frac{\sum_n J_n}{\sum_n K_n}. \tag{6}$$

Both the numerator and the denominator in formula (6) scale with the ratio p/m, which cancels out. Benchmark Ownership for a ratio does not rely on the level of investment.[4]

Here's the active Ownership formula for ratios:

$$\begin{aligned}O_A(J/K) &= O_P(J/K) - O_B(J/K) \\ &= \frac{O_P(J)}{O_P(K)} - \frac{O_B(J)}{O_B(K)}\end{aligned} \tag{7}$$

Table 3 shows how to use our formulas to calculate Ownership of a ratio of characteristics in our hypothetical market. Using weights obtained from Table 1, applications of formula (2) tell us that the portfolio's board has $O_P(K) = 2.91$ members, $O_P(J) = 0.67$ of which are women. Applying formula (5), portfolio Ownership for gender diversity is $O_P(J/K) = 0.67/2.91 = 0.23$, or 23.0%. Applications of formula (3) tell us that the benchmark's board has $O_B(K) = 2.45$ members, $O_B(J) = 0.65$ of which are women. Applying formula (6), benchmark Ownership $O_B(J/K) = 0.65/2.45 = 0.265$ or 26.5%. Based on a calculation with formula (7), the investor's portfolio is less gender diverse than the benchmark: active Ownership is -0.035, or -3.5%.

Policies and other binary characteristics

ESG investors may consider policies on child labor or paternity leave or human rights as they evaluate companies. Portfolio Ownership for a policy can be viewed as a ratio. The denominator characteristic K indicates the potential for a company to have the policy in question, and it is always set to 1. The numerator characteristic J is set to 1 if a company has the policy and 0 otherwise. This allows us to measure portfolio and active Ownership of policies and other binary

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[3] See, for example, https://en.wikipedia.org/wiki/Simpson%27s_paradox

[4] The dependence of portfolio and active Ownership on portfolio value p is generally greater for physical characteristics than for ratios.

Table 3 For illustrative purposes, we calculate Ownership of board gender diversity in a hypothetical five-company market

Company	Board Size	Women	Ownership				
			Board		Women on Board	
			Portfolio	Benchmark	Portfolio	Benchmark
(n)	(K_n)	(J_n)	$((P_n/m_n) * K_n)$	$((p/m) * K_n)$	$((P_n/m_n) * J_n)$	$((p/m) * J_n)$
1	10	3	0.83	0.5	0.25	0.15
2	12	1	1.20	0.6	0.10	0.05
3	8	5	0.32	0.4	0.20	0.25
4	9	2	0.23	0.45	0.05	0.1
5	10	2	0.33	0.5	0.07	0.1
Total	49	13	2.91	2.45	0.67	0.65

Calculation of portfolio and benchmark Ownership relies on the hypothetical investment data in Table 1. The fraction of women on the board of the portfolio is $0.67/2.91 = 0.23$ or 23.0%. The fraction of women on the board of the benchmark is $0.65/2.45 = 0.265$ or 26.5%. The portfolio's board is less diverse than the benchmark's, and the active Ownership is -0.035 or -3.5%

Table 4 For illustrative purposes, we calculate Ownership for a human rights policy in a hypothetical five-company market

Company	Potential to have a Human Rights Policy	Human rights policy	Ownership			
			Potential		Actual	
			Portfolio	Benchmark	Portfolio	Benchmark
(n)	(K_n)	(J_n)	$((p_n/m_n) * K_n)$	$((p/m) * K_n)$	$((p_n/m_n) * J_n)$	$((p/m) * J_n)$
1	1	0	0.08	0.05	0.00	0.00
2	1	0	0.10	0.05	0.00	0.00
3	1	1	0.04	0.05	0.04	0.05
4	1	0	0.03	0.05	0.00	0.00
5	1	1	0.03	0.05	0.03	0.05
Total			0.28	0.25	0.07	0.10

Calculation of portfolio and benchmark Ownership relies on the hypothetical investment data in Table 1. The fraction of the portfolio that has a human rights policy is $0.07/0.28 = 0.26$ or 26.0%. The fraction of the benchmark that has a human rights policy is $0.10/0.25 = 0.40$ or 40.0%. Portfolio Ownership of human rights policies is lower than benchmark Ownership, and active Ownership is -14.0%

characteristics using the ratio formulas in Section "Ratios of characteristics".

Table 4 shows how to use our formulas to calculate Ownership of a human rights policy in our hypothetical market. Using weights obtained from Table 1, applications of formula (2) tell us that the portfolio has the potential to have Ownership of $O_P(K) = 0.28$ polices, while the Ownership of actual policies is $O_P(J) = 0.07$. Applying formula (5), portfolio Ownership of a human rights policy is $O_P(J/K) = 0.07/0.28 = 0.26$, or 26%. At the same level of investment, applications of formula (3) tell us that the benchmark has the potential to have Ownership of $O_B(K) = 0.25$ human rights policies, while the actual Ownership is $O_B(J) = 0.10$. Applying formula (6), benchmark Ownership of a human rights policy is $O_B(J/K) = 0.10/0.25 = 0.40$, or 40%. Based on a calculation with formula (7), the investor's portfolio has a lower percentage of human rights policies than the benchmark: active Ownership is -0.14, or -14%.

Interpreting ownership

For a physical characteristic such as carbon emissions, Ownership is straightforward: an investor's share of the carbon emitted by a company's activities increases with the size of the share. Investors who want to offset their portfolio carbon emissions can use Ownership to indicate the amount of carbon that needs to be addressed. A more nuanced example is the level of gender diversity of a board of directors, which doesn't break down into fractional shares as easily as a metric ton of carbon. Every investor in a company has the same board of directors.[5] An additional complication arises for boards when we aggregate Ownership of companies, which involves partial board members across companies. It

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[5] While influence on the election of directors increases, in theory at least, with investment size, all investors have the same board once it is elected.

is helpful to think of the board of directors for the portfolio as an aggregate of the board members for the constituent companies, with adjustments made for their weights. This makes it possible to consider portfolio level board characteristics, such as racial or ethnic diversity. Similar considerations apply to policies and other characteristics that do not naturally divide across investors.

Calculating ownership for several issues in a realistic portfolio

Since ESG covers a diverse set of issues, it is possible for a portfolio to be stronger in some areas and weaker in others. We illustrate this in the context of a realistic, hypothetical portfolio.

Portfolios constructed by excluding unwanted companies from a diversified index are widely used by ESG investors.[6] We consider a hypothetical $10,000,000 investment in the S&P 500® Fossil Fuel Free Index benchmarked against the S&P 500 Index. We compute Ownership for carbon emissions per year, women on boards and human rights policies[7] as of 20 May 2022 (Table 5).

Ownership of carbon emissions, a physical quantity, relies on formulas (1) through (4) in Section "Physical characteristics". As expected, Ownership of carbon emissions was lower in the fossil-free portfolio than in a comparable investment in the benchmark, yielding a negative active Ownership. The fraction of women on boards is a ratio, so Ownership calculations rely on formulas (5) through (7) in Section "Ratios of characteristics". We find the portfolio and benchmark Ownership to be almost identical, at around 0.32. Following the logic in Section "Policies and other binary characteristics", we use formulas (5) through (7) from Section "Ratios of characteristics" to calculate Ownership for a human rights policy. Fossil fuel companies were more likely than average to have human rights policies, leading to negative active Ownership for the fossil-free portfolio on this issue. This example illustrates that conscious decision making based on a specific issue is required to ensure better active Ownership for that issue.

Table 5 For illustrative purposes, we calculate Ownership for three issues in a hypothetical $10,000,000 fossil-free portfolio benchmarked against the S&P 500 Index on 20 May 2022

	Ownership		
	Portfolio	Benchmark	Active
Carbon emissions/year (tons)	4775.5	5472.5	− 697
Board gender diversity (% women)	30.0	29.9	+ 0.1
Human right policy (%)	4.9	6.3	− 1.4

Ownership of carbon emissions was lower in the hypothetical fossil-free portfolio than in a comparable investment in the benchmark. Portfolio and benchmark Ownership for gender diversity on boards were almost identical. Excluding fossil fuel companies from the benchmark lowered responsibility for human rights policies. Sources: MSCI and ISS

Investor impact and the Ownership zero-sum formula

Investors have impact when they change a company's businesses, policies or practices. Impact requires a causal mechanism, which might be direct engagement through which investors lobby to change a policy or procedure, exiting or selling short in sufficient quantity to put financial pressure on a company to change behavior, altering public policies to force the company to change behavior to stay within the law, or other mechanisms that pressure management to alter company characteristics. Ownership, in contrast to impact, is an investor's proportional Ownership of everything a company does, and it can be aggregated to the portfolio level.

Using our formulas, investors might discover their Ownership for diversity, equity and inclusion (DEI) is lower than they would like it to be. There are several actions these investors can take. For example, they could exclude companies that lack racial or ethnic minority board members or overweight companies with lots of minority board members. These options would alter Ownership but in isolation, would likely not have impact on the company or the world. Alternatively, investors can maintain a status quo portfolio and engage with the companies they own to increase minority representation on boards. While this engagement strategy does not guarantee impact, it offers the possibility. Before any change, Ownership remains fixed for all investors. If the engagement has impact, then, the Ownership of all investors adjusts accordingly.

Anecdotes indicate the potential for engagement to have impact. For example, investors in Monster Beverage partnered with As You Sow (AYS) in 2020 on a shareholder resolution to promote racial justice. Upon receiving the resolution and engaging with AYS, the company made several commitments, including the promise to elect a board member from an underrepresented community. Based on this commitment, AYS withdrew the shareholder resolution. This engagement had impact on Monster Beverage.

Engagement, however, is constrained in the kind of impact it can have. Consider that an investor with positions in tobacco companies has Ownership of tobacco revenue.[8] They may wish for the company to change its business to something other than tobacco, but the SEC will allow companies to omit resolutions that micromanage. In other words, shareholder resolutions are not a feasible mechanism for fundamentally altering a company's line of business. These investors may choose to sell their tobacco stock, eliminating their exposure to and Ownership of tobacco revenue. Ownership is shifted to another investor and that typically does not result in immediate impact.

There is disagreement about whether divestment, from the perspective of impact is a hollow gesture. In a 1996 research article, Teoh et al. (1999) argue that divestment activities related to South African apartheid did not force a change in that country, but Nelson Mandela and Archbishop Desmond Tutu credit divestment and selective purchasing laws for putting pressure on companies to leave South Africa which in turn pressured the government of South Africa to dismantle apartheid. A similar debate is now taking place regarding fossil fuels. Berk and von Binsberger et al. (2021) argue that divestment and other so-called impact investing strategies cannot change a company's cost of capital and, hence, cannot have impact. In contrast, Bill McKibben and 350.org have argued that divesting from fossil fuels could exert pressure on policy makers even if these campaigns do not directly force a company to change its business model.[9]

It is for investors to determine their own reactions to their Ownership of the businesses, policies and practices of the companies in their portfolios. Different responses may be appropriate for different issue areas. The essential takeaway is that Ownership and impact should not be conflated. The zero-sum property of active Ownership shows that buying or selling a security has no impact unless it causes companies to change. Rather, Ownership is simply transferred to another investor. In case an investor, through engagement or buying and selling, does cause a company to change, the zero-sum property applies to the new situation, with Ownership for company businesses, practices and policies reallocated proportionally to all shareholders.

Summary

In this paper, we explored the concept of investor Ownership and provided tools that can be used to calculate it. We argued that investors own the businesses and business practices of companies in their portfolios, good and bad, in the same proportion that they own financial rewards. For socially inclined investors who may have previously identified as socially responsible, our definition of Ownership represents a shift in thinking. Rather than seeking to make "responsible" investments, investors acknowledge their ownership for the activities of the companies in which they are shareholders. With this mindset, investors can calculate their aggregate Ownership of physical characteristics of the companies in their portfolios, as they do for financial performance. In addition, investors can evaluate their active Ownership—the amount above or below benchmark Ownership. Investors can use our formulas to assess their Ownership of ESG issues, which they incur when they own securities. We acknowledge that each investor's reaction to Ownership will be unique, ranging from decisions to avoid the Ownership by exiting a security to seeking to change a company's behavior, with the potential to change all investors' Ownership in that area, to ignoring the notion altogether.

A Proofs of zero-sum properties

We mathematically verify the zero-sum properties of our Ownership formulas.

For a physical characteristic J, active responsibility with respect to a cap-weighted benchmark sums to zero. This can be seen by summing over investors, indexed by ℓ, and reversing the order of summation.

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\begin{aligned}
\sum_{\ell} O_A^{\ell}(J) &= \sum_{\ell} O_P^{\ell}(J) - O_B^{\ell}(J) \\
&= \sum_{\ell} \sum_n \left(\frac{p_n^{\ell}}{m_n} - \frac{p^{\ell}}{m} \right) J_n \\
&= \sum_n \sum_{\ell} \left(\frac{p_n^{\ell}}{m_n} - \frac{p^{\ell}}{m} \right) J_n \\
&= \sum_n \left(\frac{m_n}{m_n} - \frac{m}{m} \right) J_n \\
&= 0.
\end{aligned}
$$

A consequence of the zero-sum property is that the sum over all investors of portfolio Ownership and benchmark Ownership agree, and we denote the common sum by O_M. For any characteristic J,

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$$O_M(J) = \sum_\ell O_B^\ell(J) = \sum_\ell O_P^\ell(J). \tag{8}$$

For a ratio of characteristics *J/K*, the simple zero-sum property does not hold. Instead, active responsibility weighted by portfolio responsibility of the denominator characteristic is zero sum. To see this, note first that formula (3) implies that for characteristics *J* and *K* and investor ℓ,

$$\frac{O_B^\ell(J)}{O_B^\ell(K)} = \frac{O_M(J)}{O_M(K)} \tag{9}$$

Applying formula (9), which tells us that the ratio $R_B^\ell(J)/R_B^\ell(K)$ is the same for all investors ℓ,

$$\begin{aligned}
\sum_\ell O_P^\ell(K)O_A^\ell(J/K) &= \sum_\ell O_P^\ell(K)\left(\frac{O_P^\ell(J)}{O_P^\ell(K)} - \frac{O_B^\ell(J)}{O_B^\ell(K)} \right) \\
&= \sum_\ell O_P^\ell(J) - \sum_\ell \frac{O_B^\ell(J)}{O_B^\ell(K)} O_P^\ell(K) \\
&= \sum_\ell O_P^\ell(J) - \frac{O_M(J)}{O_M(K)} \sum_\ell O_P^\ell(K) \\
&= O_M(J) - O_M(J) \\
&= 0.
\end{aligned}$$

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