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Sustainable factor investing: Where doing well meets doing good☆

John Hua Fan [a,*], Lachlan Michalski [b]

[a] Department of Accounting, Finance and Economics, Griffith Business School, Griffith University, Australia
[b] UQ Business School, Faculty of Business, Economics and Law, University of Queensland, Australia

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ABSTRACT

This paper investigates the impact of ESG integration on systematic factors in Australia. While excluding non-rated stocks leads to inferior performance, simultaneously exploiting ESG scores with past returns significantly improves the Sharpe ratio and the crash risk profile of the momentum strategy. Such outperformance is more pronounced during periods of slow growth, high inflation and high credit-spreads. The improved performance, which originates from the governance dimension, can be explained by sector tilts driven by ESG integration. Overall, our findings suggest that sustainable factor investing not only allows asset-owners to include their ethical preferences while offering strong potential for wealth generation, but also provides asset managers with the opportunity to mitigate risk.

1. Introduction

Investors are increasingly seeking companies with strong non-financial factors such as environmental (Env), social (Soc) and governance (Gov) scores (Bollen, 2007; Gutsche & Ziegler, 2019). Environmental, social and governance (ESG) integration is an approach, which allows investors to assess the risks associated with a particular firm and how the firm manages or intends to manage future risks. In September 2015, all 193-member states of the United Nations adopted the 17 sustainable development goals. These goals seek to stimulate action in areas of critical importance for humanity and the planet until 2030. Many of the sustainable development goals signatories believe their investments into companies can only be profitable in the long-run if the financial system and societies develop in an equitable and sustainable manner. In response, the PRI (2018) report that ESG integration into United States (U.S.) equities should not only be examined from a risk-return perspective on an investment, but rather the broader impact on society. At the institutional level, investors have a duty to act in the best interests of their stakeholders. In this fiduciary role, ESG scores provide an approach to identify and manage investment risks, whilst revealing opportunities for value creation over the long-term. Consequently, the adoption of ESG integration fosters effective corporate governance, integrity, accountability and assists with reducing the obstacles

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* Corresponding author. 170 Kessels Road, Nathan, Queensland, 4111, Australia. Telephone: +61 (0)7 373 54638
E-mail addresses: j.fan@griffith.edu.au (J. Hua Fan), l.michalski@uq.edu.au (L. Michalski).

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to achieving a sustainable financial system.

The responsible investing literature has developed rapidly following the global financial crisis (GFC). Studies have examined the impact of ESG disclosure scores on financial performance and risk characteristics globally (Brammer, Brooks, & Pavelin, 2006; Cremers & Nair, 2005; Humphrey, Lee, & Shen, 2012b; Statman & Glushkov, 2009). The general consensus is that ESG integration does not detract financial performance or differentiate risk characteristics relative to non-ESG integrated strategies. In Australia, Galbreath (2013) identified that S&P/ASX300 listed companies improved their ESG performance over the 2002–2009 period. Limkriangkrai, Koh, and Durand (2017) examined the independent effects of Env, Soc and Gov components of the aggregate ESG score on company performance and corporate financing decision, whilst Lee, Fan, and Wong (2020) report ESG integration does not harm returns, limit diversification or add additional risk to portfolios. In addition to ESG investing, factor investing has emerged from the extensive academic literature on asset pricing. Ang (2014) provides a systematic approach to factor investing, which highlights that asset owners can earn risk premia through exposure to factor risks. Periods of slowing economic growth, high inflation and volatile markets are often bad times for investors. However, tradable investment styles like value and momentum perform more favorably in these periods. To date, a large number of empirical studies conclude that systematic factors such as quality, low volatility, momentum, size, value and dividend yield deliver statistically significant risk-adjusted returns across global equity markets over long periods of time.

This paper seeks to contribute to the literature through investigating whether factor strategies can generate persistent economic profits in the new world of ESG investing. To date, only three studies attempted to address the integration of ESG scores into factors. Using MSCI and Sustainalytics, Bender, Sun, and Wang (2017) analyze the impact of incorporating ESG as a standalone factor and as a subcomponent of factor strategies in the US. They assign equal-weighting to ESG, low volatility, momentum, quality, size and value factors. The ESG integrated factors provide higher Sharpe ratios in comparison to the MSCI World Index. They conclude that the "right" approach depends on investor's investment rationale. Kaiser (2018) reports that both growth and value investors can integrate ESG criteria in their portfolios without hindering risk-adjusted performance. In a sample consisting U.S. and European stocks, the performance of value and growth increases when the sustainability rating of the portfolio rises. Specifically, the risk-adjusted performance of momentum does not increase with ESG integration, but integration reduces the risk that momentum investors bare. Melas, Nagy, and Kulkarni (2018, pp. 389–413) employ minimum-variance optimization by considering ESG criteria as an additional constraint in factor portfolios within the MSCI World Index. Their findings show that ESG integration modestly affect the target factor exposure. Since ESG is positively correlated to the low volatility, high quality and large-cap characteristics, integrating ESG scores into these factors does not detract the performance. However, integration leads to performance reductions in momentum and value strategies.

In this paper, we employ three integration methods to disentangle the relationship between systematic factors and ESG scores in Australia. By timing the non-ESG screen at various stages of the portfolio construction process, we find that simultaneously exploiting Bloomberg ESG ratings and factor signals deliver strong outperformance (consistent performance) over the standard momentum (quality) factor, particularly during adverse market conditions. We choose to study ESG integration in Australia for two main reasons.[1] First, with 2.1 trillion as of the beginning of 2017, Australia is the fourth largest market globally in terms of pension assets, following the U.S., the United Kingdom (UK) and Japan. Sovereign wealth funds and superannuation funds constitute a large proportion of assets integrating ESG information in the Australian market (RIAA, 2018). Second, despite the high proportion of ESG integration, Australian ESG reporting currently lags the U.S., UK, Canada and Japan (GSIA, 2016). As there is no mandatory ESG disclosure requirement of listed Australian companies, empirical studies involving ESG integration is of paucity.[2]

The findings presented in this study are important to both retail and institutional investors. For retail investors, many give broader thoughts to how their investment decisions impact society. As a greater proportion of funds redistributes to millennials and Gen Z, the generation who favors cleaner and healthier products and services, this poses a challenge for firms. Consequently, the integration of ESG aligns with the perspectives of the generational shifting investor. For institutional investors, the concept of ESG integration was once not considered a part of their fiduciary duty. However, as ESG analysis highlights potential risks, recognizing and understanding ESG concerns is vital for determining future allocations of funds. In addition to ESG issues, the rise of factor investing such as, value, size, momentum, quality and low volatility are increasingly converging with ESG integration. This is a phenomenon whose implications for the asset management industry are not yet well understood. Sustainable factor investing not only allows asset-owners to include their ethical preferences while offering strong potential for wealth generation, but also provides asset managers the opportunity to mitigate risk, whilst improving societal welfare.

This paper presents several key contributions to the ESG and factor investing literature. First, consistent with Bender et al. (2017) and Melas et al. (2018, pp. 389–413), we find that whilst non-ESG screening leads to inferior factor performance, simultaneously exploiting

[1] The uniqueness of the Australian market, including the effects of dividend imputation system (Cannavan, Finn, & Gray, 2004; Cummings & Frino, 2008), mandatory superannuation scheme (Huynh, Mallik, & Hettihewa, 2006), and high retail ownership (Henker & Henker, 2010; ASX, 2015, p. 49) are well-documented in the literature.

[2] In 2014, the ASX Corporate Governance Principles & Recommendations report suggested that a listed company should disclose whether it has any material exposure to economic, environmental and social sustainability risks and, if it does, how it manages or intends to manage those risks (ASX, 2019). According to RIAA (2018), as of December 2017, responsible investment constituted $866 billion of assets under management, which is an increase of 39% from $622 billion in 2016. The report indicates increasing institutional investor demand for ESG integration is the key driver of responsible investing growth of assets under management in Australia. Additionally, in 2017, $680 billion constituted ESG integration from asset managers, which demonstrates growth of 22% from 2016. Although there has been significant growth in recent years with respect to responsible investing, it is evident the market still possesses strong demand from both retail and institutional investors.

ESG scores with return on equity (ROE) and past returns fundamentals outperforms standard factor strategies.[3] For example, on average per annum net of transactions costs, our ESG integrated long-short strategies generate statistically significant profits of 16.79% for quality and 14.76% for momentum.[4] In particular, integration improves the Sharpe ratio of the momentum strategy by 3.3 times while reducing the crash risk from −0.53 to −0.36. We show that on average, stocks with the highest (lowest) ESG ratings that also exhibit moderate (the lowest) quality or momentum characteristics, tend to outperform stocks with the highest quality or momentum. This implies that ESG investing through a one-dimensional approach of non-ESG screen is unlikely to result in value-creation net of management fees, as it ignores the synergy between ESG scores and other crucial fundamentals. Furthermore, we demonstrate that ESG integration causes quality and momentum strategies to tilt more towards larger market-cap and lower book-to-market stocks.

Second, consistent with Nofsinger and Varma (2014), our ESG integrated factors significantly outperform the standard factor strategies during adverse market conditions such as periods of slow economic growth, high credit risk and high inflation. Boyd, Levine, and Smith (2001) show that during periods of high inflation, higher quality firms have better access to financing. They also demonstrate a robust positive relationship between inflation and stock return volatility. We find that ESG integrated momentum strategy outperforms the unintegrated factor during low growth, inflationary, low liquidity and high volatility periods. Meanwhile, ESG integrated quality only outperforms during low growth and low liquidity environments. The performance of the quality strategy is also consistent with Asness, Frazzini, and Pedersen (2019). As standard systematic factors perform differently across market conditions, incorporating ESG scores into factor portfolios can help reduce the downside risk faced by investors.

Third, we find that integrating Env, Soc or Gov ratings individually into factors, as opposed to the aggregate ESG ratings, also leads to improved performance in quality and momentum. Acknowledging the underlying ESG dimensions are not necessarily mutually exclusive events, we test the robustness of our findings by considering each aspect of the ratings separately. As a result, simultaneously exploiting Env scores with the ROE signal not only outperforms the ESG integrated quality strategy, but also the unintegrated quality strategy. This is generally in line with Dixon-Fowler, Slater, Johnson, Ellstrand, and Romi (2013) and Renneboog, Ter Horst, and Zhang (2008), who demonstrate that a long-short strategy constructed using Env scores generate significant economic profits. However, since the Env rating is superior to Soc, Gov or ESG ratings at improving the quality factor, aggregating Env, Soc and Gov scores present negative synergies for the performance of quality stocks. Meanwhile, combining Gov scores with past returns only improves the standard momentum not the ESG integrated momentum strategy. Thus, the performance improvement derives entirely from the Gov dimension. Since ESG integrated momentum still outperforms Gov integrated momentum, aggregating all dimensions of ESG contain positive synergies which are not captured otherwise.

Lastly, while the crash risk profile improves, diversifying across sectors negatively impacts the performance of quality, momentum and size strategies. As managers are often subject to constraints, we form factor portfolios in accordance to mandates that require adequate diversification whilst integrating ESG opportunities. Forcing portfolio diversification across sectors leads to inferior performance, because quality, momentum and size portfolios exhibit sector tilts towards consumer discretionary, materials and financials.[5] We show that in such a constrained framework, ESG integration no longer delivers performance improvements on a risk-adjusted basis. In contrast to the unconstrained factors, the underwhelming results of diversified factors suggest that the outperformance of ESG integrated factors are at least partially due to ESG driven sector tilts. Since ESG integration increases portfolio tilts to higher scoring industries, managers may wish to communicate the potential opportunity cost arising from mandated sector diversification. The remainder of the paper proceeds as follows. Section 2 details the data collection, whilst Section 3 outlines the portfolio construction procedures. Section 4 discusses the results with the paper concluding in Section 5.

2. Data

2.1. Sample selection

We obtain price-relatives, market-capitalization, Global Industry Classification Standard (GICS) sectors, dividends, trading volume and risk-free rate on Australian stocks from the Share Price & Price Relatives (SPPR) database through Securities Industry Research Centre of Asia-Pacific (SIRCA).[6] The SPPR data cover the period February 1958 through to December 2016. Mergers, acquisitions, name and ticker changes and historical GICS mapping are managed by SIRCA. To avoid survivorship bias, we include delisted stocks in our sample. Price-to-book and ROE ratios are retrieved from Datastream International and matched to each company in the SPPR database.

[3] Our approach differs from these studies in terms of portfolio construction and factor selection. Kaiser (2018) restricts the combination of ESG with value, growth and momentum to long-only portfolios. We investigate the construction of zero-investment (long/short) portfolios similar to Asness et al. (2013) but differs from an optimization-based portfolios in Bender et al. (2017).

[4] Standard factor strategies report profits of 14.45% for quality, 4.18% for momentum and 14.31% for size, while non-ESG screening generate 13.88% for quality, 2.96% for momentum and 12.18% for size.

[5] The significant holdings within materials is explained by the importance of commodity exports for the Australian economy. Consumer discretionary is pro-cyclical, as these firms offer non-essential goods and services. In this paper, we present a graphical illustration of portfolio holdings by sector from 2006 to 2016 for both standard and ESG integrated factors. Asset managers investing in the Australian equity market through factor strategies may find such visualization useful.

[6] SIRCA is a leading independent provider of financial data services for Australian and New Zealand universities. The SPPR Database contains monthly ASX share price movements, company names and name changes back to the 1950s. For further information, visit https://www.sirca.org.au/about-sirca/. In 2018, SIRCA merged with the Capital Markets Cooperative Research Centre (CMCRC), to form a combined entity named "Rozetta Institute".

To limit the exposure to micro-cap stocks and form investable portfolios consistent with the demand of institutional investors, we exclude stocks with market capitalization that are below 75th percentile (Doan, Lin, & Zurbruegg, 2010; Galbreath, 2013; Lim & Coggins, 2005; Limkriangkrai et al., 2017). Finally, we merge all ESG ratings available from Bloomberg to our filtered sample. Dictated by the availability of ESG data, our final sample covers January 2006–December 2016, from a start of 423–495 stocks in 2016. This will be referred to as "All" sample throughout the paper. To facilitate the comparison among strategies and integration results, we define a "Rated" sample as stocks with available Bloomberg ESG ratings. The "Rated" sample can be viewed as a subset of the "All" sample. The "Rated" sample begins with 5 stocks in 2006 and ends with 295 stocks in 2016. All GICS industries are included with the exception of the Real Estate due to insufficient stocks.

Table 1 details the firm count, median market-capitalization and mean returns of "All" and "Rated" sample sorted by industries. Within both samples, financials and consumer discretionary exhibit the highest firm count on average, whilst utilities and telecommunications report the lowest firm count. Utilities, consumer staple and financials report the highest average ESG score in 2016. Interestingly, high polluting industries, for instance, energy, industrials and materials, report the fifth, sixth and seventh highest aggregate ESG scores, respectively. As high polluting industries face greater pressure from government regulatory bodies and environmental groups, these industries should continually seek to improve their ESG performance and reporting. Furthermore, by 2016 the materials industry exhibits a 13.57% decrease in the average ESG score since 2007. Throughout the sample period, all other industries except telecommunications have increased their aggregate ESG scores.

Information technology exhibits the lowest ESG scores across all industries. Further, there has been only 5% growth with the industry average since 2007. The highest median market-capitalization industry within the "All" sample is utilities at $11.5 billion with 13 firms recorded at 2016, whilst information technology reports the lowest at $2.64 billion with 47 firm observations in 2016. Financials report a median market-capitalization of $6.02 billion with 137 firms at January 2016. In terms of ESG rated firms, the financials industry reports the highest median market-capitalization at $19.8 billion, with 70 firms, in comparison to information technology reporting the lowest. Industrials earns the highest average monthly return at 2.98% within the "All" sample, but healthcare performs the best within the "Rated" sample at 2.24%. It appears that financials perform the worst in the "All" sample at 1% per month, while energy reports a 0.60% monthly return on average within the "Rated" sample.

2.2. ESG scores

The Bloomberg ESG scores present several advantages over alternative data providers. ASSET4's ESG scores have been utilized extensively in the literature, see Stellner, Klein, and Zwergel (2015), Ferrell, Liang, and Renneboog (2016), Liang and Renneboog (2017) and Lee et al. (2020). However, one of the criticisms of the ASSET4 data is the inclusion of the "economic" dimension in its aggregate ESG scores. Alternatively, Regnan maintains a specific Australian database ('ValDA') of ESG ratings on the largest firms listed on the Australian Securities Exchange (ASX), through the independent analysis of companies' environment, social and governance exposures (see Limkriangkrai et al., 2017). However, Regnan employs a cardinal rating scale of 1–5, thus it becomes particularly problematic to implement portfolio sorts when the ratings distribution is skewed (e.g. Gov ratings). On the other hand, the Bloomberg ESG data do not have these issues. It offers a clear cost advantage over the other providers as most asset managers would already have access to Bloomberg terminals. Therefore, the integration of Bloomberg ESG scores should be more desirable for asset managers.

Bloomberg monitors the ESG performance of listed companies by compiling data from annual reports, corporate social responsibility and sustainability reports, published disclosures and news sources, and company direct contact (Bloomberg, 2018).[7] The Bloomberg ESG data covers stocks with mid ($2 billion) to large market capitalizations ($10 billion). Therefore, our sample of ESG rated stocks are not represented by only large-cap stocks. Aligned with ASSET4's ESG rating system, Bloomberg's ESG disclosure score ranges between 0 and 100 (with 0 being the lowest attainable score). The ESG ratings are normalized to adjust for skewness and the difference between the mean and median. Disclosure score rated firms update annually in September whilst non-disclosure rated firms can have their ratings introduced throughout the year. Furthermore, a fitted normal distribution curve allows for scores to range between 0 and 100, which produces a comparable score across each dimension for listed ESG rated companies. The scores do not measure performance, but assess the transparency, risks and opportunities a firm face.[8] For example, the percentage of women on executive boards, employee turnover percentage and the number of environmental spills are metrics utilized to determine ESG disclosure scores.

Consistent with Boutin-Dufresne and Savaria (2004), Lee et al. (2020), Humphrey, Lee, and Shen (2012a) and Lee and Faff (2009), we seek to examine companies' total ESG score, as investors are more willing to analyze and base their investment decisions off a firm's aggregated ESG. However, we also examine the interaction of the individual Env, Soc and Gov dimensions separately with factor strategies. It is postulated that a firm should seek to manage risks associated with all ESG dimensions that encompass their aggregate ESG score, rather than the total ESG score in isolation. The underlying ESG dimensions are not necessarily mutually exclusive events and, therefore, it is vital to analyze all aspects of disclosure score ratings. The interpretation of disclosure scores is consistent with other total firm ratings, for example, total credit rating scores provided by credit agencies. Consequently, a firm's total ESG score can be

[7] Bloomberg ESG data covers 120 environmental, social and governance indicators including: carbon emissions, climate change effect, pollution, waste disposal, renewable energy, resource depletion, supply chain, political contributions, discrimination, diversity, community relations, human rights, cumulative voting, executive compensation, shareholders' rights, takeover defence, staggered boards, and independent directors. Bloomberg ESG rating penalize companies for "missing data".

[8] Bloomberg's disclosure scores encompass 11,000 listed companies globally and assess 800 metrics to determine a firm-specific ESG score (Bloomberg, 2018).

Table 1
Stock counts and ESG scores. The table presents the stock counts, average ESG scores, median market capitalization (in AUD billions) and monthly returns for each sector and year from 2006 to 2016. "All" represents the number of stocks with top 25% market-capitalizations, whereas "Rated" refers to the number of stocks with Bloomberg ESG rating. "Score" represents the average ESG rating. Δ represents the percentage change in stock counts (x) and scores (%) from 2007 for all industries with the exception of Utilities, which represents the percentage change from 2009.

		2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	Δ Since 2007	Market Cap	Monthly Return
Consumer Discretionary	All	56	55	53	60	58	55	62	65	70	77	79	0.4x	6.89	1.46%
	Rated	0	7	15	22	28	29	33	37	42	40	52	6.4x	8.56	1.18%
	Score	–	9.15	11.56	12.42	12.59	13.90	15.12	16.18	17.28	18.40	18.78	105.20%		
Consumer Staple	All	19	20	20	24	16	18	17	15	17	22	30	0.5x	7.3	1.05%
	Rated	1	2	7	8	9	9	10	10	13	15	19	8.5x	8.91	1.16%
	Score	0.83	11.98	19.72	21.03	22.25	24.32	26.08	24.80	23.93	23.70	25.10	109.48%		
Energy	All	26	31	42	53	50	51	49	47	37	29	20	−0.4x	5.22	2.32%
	Rated	1	5	10	22	21	21	23	24	22	23	17	2.4x	10.5	0.60%
	Score	26.56	17.57	20.94	16.00	17.81	17.83	17.34	18.74	20.52	22.12	22.65	28.92%		
Financials	All	125	130	136	122	105	97	101	105	124	128	137	0.1x	6.02	1.00%
	Rated	0	12	23	27	28	35	34	38	47	57	70	4.8x	19.8	1.15%
	Score	–	19.12	18.45	20.34	22.41	23.40	25.87	25.21	22.92	23.45	23.52	22.97%		
Health Care	All	23	29	21	29	26	25	25	25	34	42	41	0.4x	5.06	2.24%
	Rated	0	7	7	11	13	14	15	16	20	19	21	2.0x	10.1	1.48%
	Score	–	11.10	13.90	12.19	13.90	14.42	16.60	15.54	15.41	17.34	18.37	65.55%		
Industrials	All	51	60	71	69	71	73	75	76	69	62	52	−0.1x	5.85	2.98%
	Rated	0	7	20	27	31	36	41	45	44	37	39	4.6x	6.48	0.81%
	Score	–	19.06	15.20	15.85	16.99	17.76	18.69	20.95	21.38	22.15	21.97	15.29%		
Information Technology	All	16	19	15	17	16	16	17	22	28	35	47	1.5x	2.64	2.39%
	Rated	0	1	3	6	7	7	7	9	12	16	21	20.0x	4.24	1.30%
	Score	–	14.05	11.85	12.45	12.39	12.39	12.51	13.30	13.63	14.85	14.75	5.00%		
Materials	All	89	90	116	97	123	141	128	113	82	70	63	−0.3x	4.69	2.10%
	Rated	2	13	29	39	49	55	56	63	53	42	43	2.3x	8.02	1.31%
	Score	36.99	25.33	19.01	18.26	19.11	17.95	18.21	18.72	19.97	20.24	21.90	−13.57%		
Telecommunications	All	6	7	6	9	9	9	12	13	14	13	13	0.9x	6.37	2.16%
	Rated	1	1	1	2	3	3	3	4	4	3	5	4.0x	13.9	0.67%
	Score	21.40	30.45	37.04	29.02	21.26	23.32	25.79	22.04	22.97	25.66	23.07	−24.24%		
Utilities	All	12	15	16	16	14	15	15	14	14	14	13	−0.1x	11.5	1.09%
	Rated	0	0	0	1	1	5	5	5	6	8	8	7.0x	18.9	1.23%
	Score	–	–	–	14.94	15.77	16.51	18.89	20.41	21.27	25.36	25.19	152.94%		
All Stocks	All	423	456	496	496	488	500	501	495	489	492	495	0.1x	6.15	1.88%
	Rated	5	55	115	165	190	214	227	251	263	260	295	4.4x	10.94	1.09%
	Score	21.44	17.53	17.76	17.25	17.45	18.18	19.51	19.59	19.93	21.33	21.53	22.78%		

interpreted as a signal for their overall ability to manage operational risks.

Fig. 1 illustrates the distribution of Bloomberg ESG scores by industry over the sample period. The maximum aggregate ESG and individual Env, Soc and Gov scores is 63.90, 59.82, 77.19 and 83.93, respectively. Across industries, Gov and Env report the highest and lowest average scores. The aggregate ESG score across the ten industries is heavily concentrated around 15 to 20, whilst the dispersion of observations significantly increases after the score of 20. The Gov score average across the industries is consistent amongst all industries and ranges from 45 to 50. The Soc score reports the second highest average across the ten industries when compared to the aggregate ESG and individual Env and Gov scores. Energy and consumer staple report the highest average score, whilst consumer discretionary exhibits the lowest average. The Env score distribution is vastly inconsistent with the other ratings. Energy, financials, materials and telecommunications are the highest industries for the Env score. Consumer discretionary, industrials, information technology and utilities all report averages below 10.

3. Portfolio construction

3.1. Factor portfolios

Deeply rooted in the academic literature, factor investing has gained tremendous popularity in the investment management industry over the past decade.[9] A vast amount of studies published in both the academic and practitioners' outlets find pervasive evidence on size, value momentum, quality and low volatility effects in equity markets around the globe. We construct these standard factor portfolios as a starting point for ESG integration.[10]

QUALITY: Intuitively, the idea associated to the quality investing style is that companies who are highly profitable, well-governed, stable and operationally efficient, will tend to outperform the market average over the long-run. Studies employ profitability measures, such as, ROE, return on assets or accruals as a proxy for quality (Asness et al., 2019; Novy-Marx, 2013; Sloan, 1996). Following the literature, we employ the most commonly used performance metric, the ROE ratio, as the sorting signal to capture the quality effect in Australia.

To form the quality portfolio, we first sort stocks into quartiles based on ROE, then take long positions in stocks within the highest-quality quartile, whilst shorting stocks in the lowest-quality quartile. Portfolios are value-weighted and rebalanced monthly throughout the paper.[11] The value weighting is consistent with professionally managed investment portfolios and ensures that the results can be easily replicated and practically implemented. No positions are held within quartile two and three portfolios.

LOW VOLATILITY: Traditional finance theory suggests that riskier securities, on average, deliver higher return as compensation for holding that risk. Black, Jensen and Scholes (1972) first identified the anomaly that being long low beta securities and short high beta securities generate significant positive returns. The notion of low volatility has since expanded in the literature as this factor provides an investor a more defensive approach on the downside while capturing most of the upside (Asness, Frazzini, & Pedersen, 2012, 2014; Clarke, De Silva, & Thorley, 2006; Jagannathan & Ma, 2003). Following the literature, we employ standard deviation (SD) as the sorting signal for the low volatility factor.

$$\sigma_{i,t} = \sqrt{\frac{\sum \left(r_{it(60)-} \bar{r}_{it(60)}\right)^2}{n_{it} - 1}} \tag{1}$$

Where $r_{i,t}$ is the return on asset i at time, whilst n represents the number of i assets over time t. We first sort stocks into quartiles based on $\sigma_{i,t}$ (i.e., SD over the past 5 years) in eq (1), then take long (short) positions in stocks within the lowest (highest)-volatility quartile.

MOMENTUM: Originating from the study on U.S. equity markets by Jegadeesh and Titman (1993), the momentum strategy have been empirically validated, such that stocks with strong past performance tend to outperform in the long-run (Asness, 1997; Asness, Moskowitz, & Pedersen, 2013; Carhart, 1997; Geczy & Samonov, 2013; Hong, Lim, & Stein, 2000). We follow the literature and define the sorting signal for the momentum portfolio as below:

$$MOM_{it} = \prod_{j=t-10}^{t} \left(1 + r_{i,j}\right) - 1 \tag{2}$$

Where MOM_{it}, is the holding period return of stock i at time t over the past 12 months (skipping the most recent month). We first sort stocks into quartiles based on MOM, then take long (short) positions in stocks within the highest (lowest) momentum quartile.

[9] BlackRock (2018) notes the factor industry is $1.9 trillion in Assets Under Management (AUM) and has grown organically at around 11% per year since 2011. In a survey of the world's 500 largest asset managers, 5.5% of the AUM of the firms surveyed was invested in factor-based strategies in 2016 (Willis Towers Watson, 2017). Similarly, Invesco (2017) estimated a 50% growth in proportion of AUM allocated to factor investing by 2022.

[10] Recently, dividend yield is increasingly appearing in the literature as a possible factor strategy. In addition, Australia is widely considered the world's third-highest yielding developed market. For this reason, it would be logical to include dividend yield as a factor strategy. However, from the entire universe obtained from the SPPR, only 5472 observations had an associated dividend yield value. Consequently, dividend yield is not used as a factor portfolio strategy in this paper.

[11] However, for slow moving signals such as the ROE, rebalancing takes place much less frequently. We examine portfolio turnovers across strategies later in the paper.

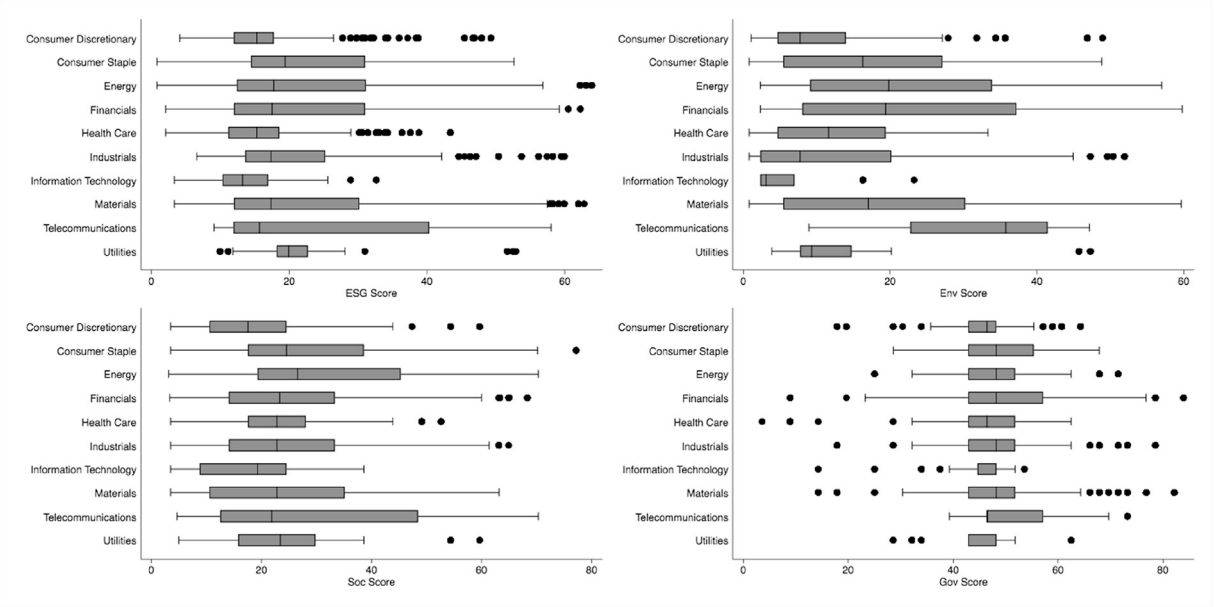

Fig. 1. Scores distribution by industry.
This figure illustrates the distribution of aggregate ESG, individual Env, Soc and Gov scores by industry from January 2006 to December 2016.

SIZE: Small capitalization stocks outperform large capitalization stocks (Banz, 1981; Keim, 1983; Lamoureux & Sanger, 1989; Malkiel, 2014; Reinganum, 1981; Fama & French, 1992, 1993). To construct the size portfolio, we sort stocks into quartiles based on their market capitalization. We then take long (short) positions in stocks within the lowest (highest) capitalization quartile.

VALUE: The concept of value investing has long been argued, such that there is a positive link between stocks whose price are considered undervalued relative to their fundamental value. Empirical evidence suggests the positive and significant relationship between book-to-price ratios and cash flows to average returns in the U.S. and international markets (De Bondt & Thaler, 1987; Fama & French, 1992; Hawawini & Keim, 2000). To construct the value portfolio, we sort stocks into quartiles based on the book-to-price ratio. We then take long (short) positions in stocks within the highest (lowest) value quartile.

3.2. Integration methods

The novelty of this paper is investigating the interaction between standard factor strategies and ESG scores. We propose three methods in order to integrate ESG information into factor portfolios and re-evaluate the performance of these ESG integrated portfolios against the standard, non-integrated factor portfolios.[12] Fig. 2 illustrates the integration process.

M1: Under method one, we first perform a non-ESG screen, where non-ESG rated firms within the "All" sample are excluded. Subsequently, the remaining stocks are sorted based on factor signals such as quality, low volatility, momentum, size and value. Finally, we form ESG integrated factor portfolios by taking long and short positions in the highest and lowest stock quartiles. Consequently, M1 would result in an equal amount of stocks under each quartile, i.e. the number of stocks within the long and short portfolios are identical (or balanced). For example, in M1 for the size strategy, all non-ESG rated firms are first excluded from the sample, a balanced long-short portfolio is then formed on the size signal.

M2: Under method two, we first perform the sort for each factor using the "All" sample. Subsequently, within the long and short quartiles of each factor, we eliminate non-ESG rated stocks. Unlike M1, this procedure can lead to "unbalanced" long and short portfolios, i.e. the integrated factor portfolio could be net long or short. For example, if quartile sorted portfolios are formed on the quality signal, stocks in the long or short portfolio might not report an ESG score. As firms with no ESG score are excluded, the number of stocks located in the long or short portfolio may reduce, causing the strategy to be no longer zero-cost or fully self-financed. Even if the dollar exposures are actively managed to be the same between long and short legs, long-short M2 portfolios would no longer be market-neutral, because the "unbalanced" positions would likely result in time-varying exposures to the market (Goyal & Jegadeesh, 2018).

M3: Under method three, we first perform a non-ESG screen by excluding non-ESG rated firms from the "All" sample. Subsequently, we generate a new sorting variable for each stock in the remaining sample, by combining the ESG score and the respective factor signal. The combined signal is formed by assigning a 50/50 wt between the factor signal and the ESG score. Unlike methods one and two, M3 is

[12] A fourth method of integration, ESG momentum (i.e. changes in ESG ratings), similar to the second method outlined in Melas et al. (2018, pp. 389–413) was also investigated. We fail to find significant returns after integrating ESG momentum into quality, low volatility, momentum, value and size strategies.

designed to capture both the factor signal and ESG rating simultaneously. This allows us to take into account any possible interaction effects, which are otherwise omitted. Since Bloomberg ESG score ranges from 0 to 100, we normalize each factor signal to a range of 0–100. Thus, the combined signal for each stock i at time t is computed as: $[0.5 \times \text{ESG\_score}_{it} + 0.5 \times \text{Signal\_score}_{it}]$. For example, for the momentum strategy under M3, non-ESG firms are initially screened out, a sorting signal is formed by allocating 50% weight to the momentum signal on the stock and another 50% weight to the ESG score of the same stock. Portfolios are then formed on the combined signal, which results in a balanced number of stocks in long and short portfolios.[13]

3.3. Benchmark portfolios

In order to rationalize the performance of ESG integrated factors, we first investigate their associations to known risk factors and industry wide benchmarks. In addition to the S&P/ASX200 and the All Ordinaries Index, we form standard market, size, value and momentum risk factors.

Australian ESG literature recognizes that high-rated and low-rated ESG companies differentiate on size, book-to-price value and risk factors (Humphrey et al., 2012a; Lee & Faff, 2009). Schneider and Gaunt (2012) established the significant momentum effect in the Australian equity market. Thus, we employ the Carhart (1997) four-factor model as follows:

$$R_{it} - R_{ft} = \alpha_i + \beta_{0i}\left(R_{mt} - R_{ft}\right) + \beta_{1i}SMB_t + \beta_{2i}HML_t + \beta_{3i}UMD_t + \varepsilon_{it} \quad (3)$$

Where R_{it} is the return on asset i, R_{ft} is the return on a risk-free asset, R_{mt} is the return on the market portfolio, SMB_t is the size factor, HML_t is the value factor, and UMD_t is the momentum factor, at time t. To construct the four-factor model, we employ the following steps.

The market risk factor (MKT) is constructed by subtracting the risk-free rate from returns of all stocks in the Australian market.[14] The SMB and HML are formed through size and book-to-market bivariate sorts. First, the universe of stocks are sorted into two size categories using market-cap medians (highest 50% (B), and smallest 50% (S)). Second, stocks are sorted into three groups based on book-to-market equity (highest 33% (H), middle 33% (M), and lowest 33% (L)). The intersection of stocks across the six categories are used to form the portfolios SH (small, high BE/ME), SM (small, middle BE/ME), SL (small, low BE/ME), BH (big, high BE/ME), BM (big, middle BE/ME), and BL (big, low BE/ME).

The SMB factor is formed through the average of the three small stock portfolios (1/3SH + 1/3SM + 1/3SL) minus the average of the three big stock portfolios (1/3BH + 1/3BM + 1/3BL). The HML factor is formed through the average of the two high book-to-market portfolios (1/2SH + 1/2BH) minus the average of the two low book-to-market portfolios (1/2SL + 1/2SH). The UMD factor is constructed similarly to the HML, in which two size groups (highest 50% (B), and lowest 50% (S)) and three momentum groups (highest 33% (U), middle 33% (M), and lowest 33% (D)) are used to form six portfolios. The UMD factor is then formed through the average of the small and big winners (1/2SU + 1/2BU) minus the average of the small and big losers (1/2SD + 1/2SD).

4. Results

4.1. Baseline performance

Table 2 reports the performance of long-short factor strategies before and after the integration of ESG scores. S represents standard factor portfolio before integration, M_N stands for method N of the ESG integrated factor portfolios, where $N = 1$, 2 and 3.

Table 2 presents several key findings. First, over the sample period 2006–2016, quality and size are the only strategies that report statistically significant returns prior to ESG integration. The significant size premium reported is consistent with Gaunt (2004), Gharghori, Chan, and Faff (2007), Gharghori, Hamzah, and Veeraraghavan (2010), Zhong, Limkriangkrai, and Gray (2014). The profitability of the quality strategy is consistent with Gallagher, Gardner, Schmidt, and Walter (2014), who report weak evidence of the quality premium at the fund level. Further, the insignificant returns of the low volatility strategy are contrary to Bay, Liu, Reeves, Rhee, and Wu (2017). The absence of significance on momentum can be explained by the "crashes" during the GFC from 2008 to 2009, as these profits become statistically significant when December 2008 and January 2009 returns are omitted. Meanwhile, since our value portfolio is constructed through a univariate sort, the absence of value may be due to the size effect. Halliwell, Heaney, and Sawicki (1999), Gaunt (2004) and Kassimatis (2008) find returns to high book-to-market portfolios in Australia are only higher than low book-to-market portfolios when considering large-cap stocks.

Second, for the statistically significant factors, when portfolios are formed on the factor signal after non-ESG firms are screened out (i.e. M1), it appears that the standard method often outperforms. In risk-adjusted terms, the standard factors produce the highest annualized Sharpe ratio of 1.09 for size. Further, the standard method produces the lowest maximum drawdown for all strategies except for momentum. For quality, momentum and size, M2, which results in unbalanced long-short portfolios, report similar performance with the

[13] Two robustness tests are considered here. First, in addition to quartiles, we find consistent results by forming portfolios using quintiles and terciles, across strategies and integration methods. Second, we assign alternative weightings (0.1–0.9) to ESG scores relative to factor signals under M3. The results remain qualitatively similar. The returns for quality and momentum range between 1 and 2% per month across weighting schemes, with t-statistics and returns increasing (decreasing) for momentum (quality) when higher convicted to ESG. For brevity reasons, these results are not presented in the paper but are available upon request.

[14] This is not to be confused with the "All" sample employed in study. The "All" sample excludes stocks which are below 75th Percentile of market capitalizations. To construct MKT, SMB, HML and UMD, we use all stocks available through the SPPR database.

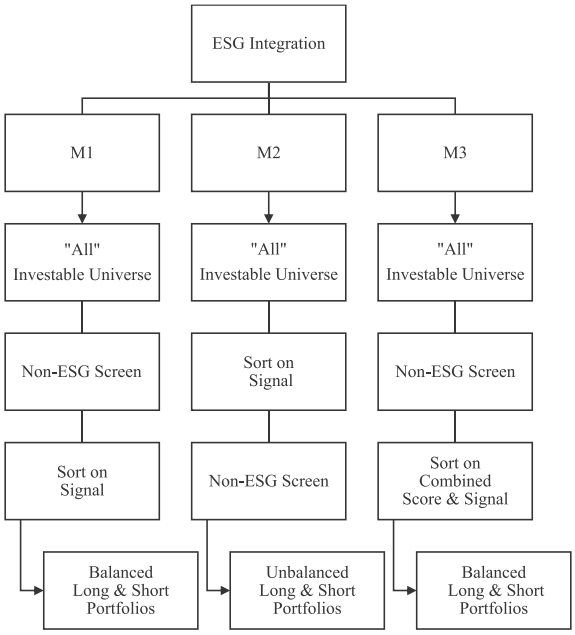

Fig. 2. Integration process.
This figure illustrates the ESG integration process. For M1, we first screen out non-ESG rated firms from the "All" sample, and then construct the factor portfolio as discussed above using the remaining stocks. For M2, we first form factor portfolios in the "All" sample, and then screen out non-ESG rated firms off the long and short portfolios. For M3, we first screen out non-ESG rated firms from the "All" sample, and then create a new sort signal by assigning a 50/50 weighting to the factor signal and ESG scores. Portfolios are then formed on this combined signal.

Table 2
ESG integrated factors. This table reports the performance of ESG integrated factors. The quality signal is represented by the ROE ratio. The low volatility signal is computed through a rolling 60-month standard deviation. The momentum signal is based on the past 12-month return, skipping the most recent month. The size is based on the market-capitalization and value is based on the book-to-price ratio. For standard factors (S), we sort stocks into quartiles based on the respective factor signal at the end of each month. For quality, momentum and value, we take long (short) positions in stocks within the highest (lowest) quartile. For low volatility and size, we take long (short) positions in stocks within the lowest (highest) quartile. Each long-short portfolio is market value-weighted and rebalanced monthly. The sample period covers January 2006 through December 2016. ESG scores are not integrated within the S portfolios. M1, M2 and M3 represent methods of ESG integration. For M1, we first screen out non-ESG rated firms from the "All" sample, and then construct the factor portfolio as discussed above using the remaining stocks. For M2, we first form factor portfolios in the "All" sample, and then screen out non-ESG rated firms off the long and short portfolios. For M3, we first screen out non-ESG rated firms from the "All" sample, and then create a new sort signal by assigning a 50/50 weighting to the factor signal and ESG scores. Portfolios are then formed on this combined signal. The market wide benchmarks consist of passive long positions in "All" stocks, "Rated" stocks, S&P/ASX200 Index and the All Ordinaries Index. "All" represents the sample of stocks with top 75% market-capitalization, "Rated" refers to the sample of Bloomberg ESG rated stocks. Average monthly returns, Newey-West adjusted *t*-statistics, volatility, skewness, kurtosis and maximum drawdown (MaxDD) are reported. Sharpe ratios are annualized.

	Quality				Low volatility				Momentum			
	S	M1	M2	M3	S	M1	M2	M3	S	M1	M2	M3
Returns	1.31%	1.28%	1.37%	1.52%	0.39%	0.44%	−0.41%	0.73%	0.69%	0.62%	0.72%	1.55%
t-statistics	3.11	2.32	2.81	2.58	0.76	0.48	−0.38	0.95	1.28	0.99	1.22	2.73
Volatility	4.54%	5.67%	4.94%	6.29%	5.47%	9.19%	9.89%	7.64%	5.43%	6.21%	6.53%	6.14%
Sharpe	0.80	0.64	0.74	0.71	0.05	0.04	−0.25	0.10	0.22	0.15	0.21	0.74
Skewness	0.10	−0.20	0.04	0.12	0.45	0.28	−0.22	0.40	−0.16	−0.19	−1.04	0.01
Kurtosis	4.63	4.49	4.16	5.18	4.36	6.12	5.62	4.21	5.04	3.78	6.58	3.63
MaxDD	−0.30	−0.49	−0.30	−0.44	−0.42	−0.64	−0.87	−0.54	−0.53	−0.60	−0.62	−0.36
	Size				Value				Market			
	S	M1	M2	M3	S	M1	M2	M3	All	Rated	ASX200	All Ords
Returns	1.35%	1.16%	1.48%	1.20%	0.17%	0.55%	−0.03%	0.02%	0.55%	0.28%	0.20%	0.20%
t-statistics	3.57	2.12	2.82	1.70	0.44	1.21	−0.08	0.05	1.39	0.73	0.58	0.57
Volatility	3.34%	4.82%	5.09%	5.83%	3.99%	4.97%	4.25%	4.69%	3.76%	3.74%	4.05%	4.12%
Sharpe	1.09	0.55	0.80	0.58	−0.12	0.16	−0.28	−0.20	0.25	−0.04	−0.10	−0.09
Skewness	0.19	0.54	0.18	0.79	0.07	0.71	0.10	0.58	−0.76	0.33	−0.66	−0.75
Kurtosis	3.44	4.20	3.80	5.34	3.62	5.06	3.08	4.68	3.53	3.59	3.14	3.52
MaxDD	−0.17	−0.28	−0.25	−0.36	−0.44	−0.40	−0.49	−0.44	−0.45	−0.31	−0.50	−0.51

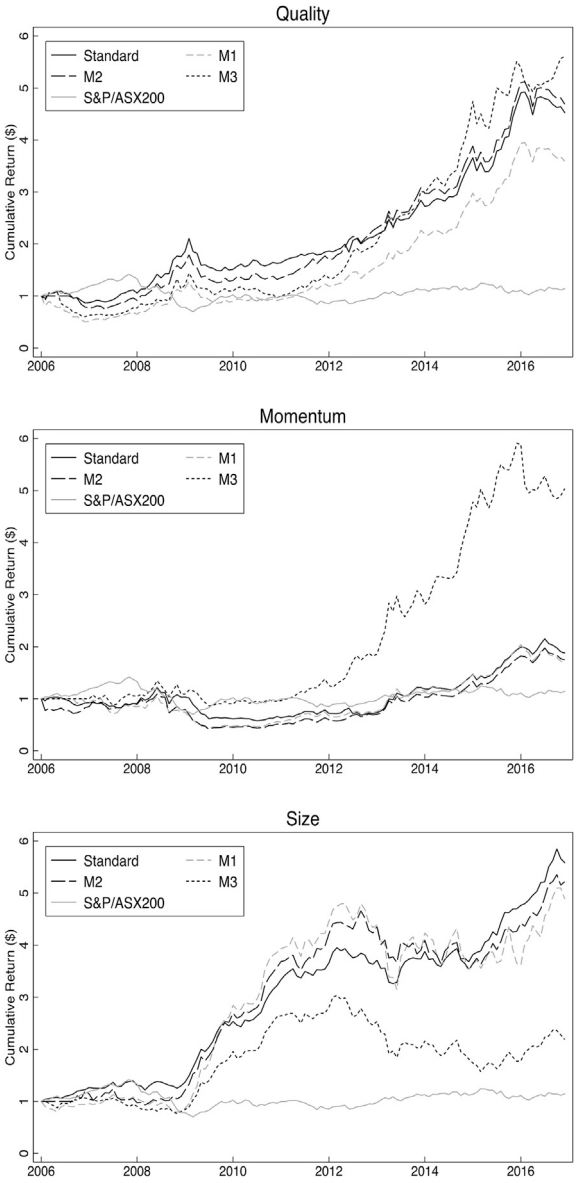

Fig. 3. Cumulative performance.
The figure illustrates the future value of 1AUD invested in ESG integrated quality, momentum and size strategies. Standard represents the non-ESG integrated strategies. M1, M2 and M3 represent various integration methods. The sample period covers January 2006–December 2016.

standard factors. In particular, size reports the highest average return under M2, however the increased volatility subdues the Sharpe ratio. As ESG rated firms are more prominent among larger market-capitalization firms and that the sample size is smaller in comparison to the "All" sample, it is not surprising that the standard factors generally outperforms M1. Consequently, this explains the weaker risk-adjusted performance of size after ESG integration under M1, M2 and M3 methods, as the size premia requires exposure to smaller cap stocks which receive nil or low ESG scores. All statistically significant strategies report higher risk-adjusted returns compared to the passive long-only benchmarks such as the value-weighed portfolios of "All" stocks, "Rated" stocks, the S&P/ASX200 and the All Ordinaries index.

Lastly, while quality and size remain profitable and significant after the integration of ESG scores across methods, momentum is only significant under M3. The M3, which captures the interaction between ESG scores and factor signals, reports higher returns over the standard quality and momentum strategies at 1.52% and 1.55% per month, respectively. For momentum, the M3 improves the Sharpe ratio significantly from 0.22 to 0.74 (3.3 times) and reduces the crash risk profile from −0.53 to −0.36 over the standard momentum strategy. However, the enhanced return of M3 quality is at the expense of increased volatility, as the Sharpe ratio and the maximum drawdown deteriorated over the standard quality strategy. Although the opportunity set is reduced for integrated strategies, ESG integrated quality strategies deliver Sharpe ratios which are of similar magnitude to those reported by the standard quality. These findings suggest that integrating Bloomberg ESG scores into quality and momentum strategies does not detract the performance but has the

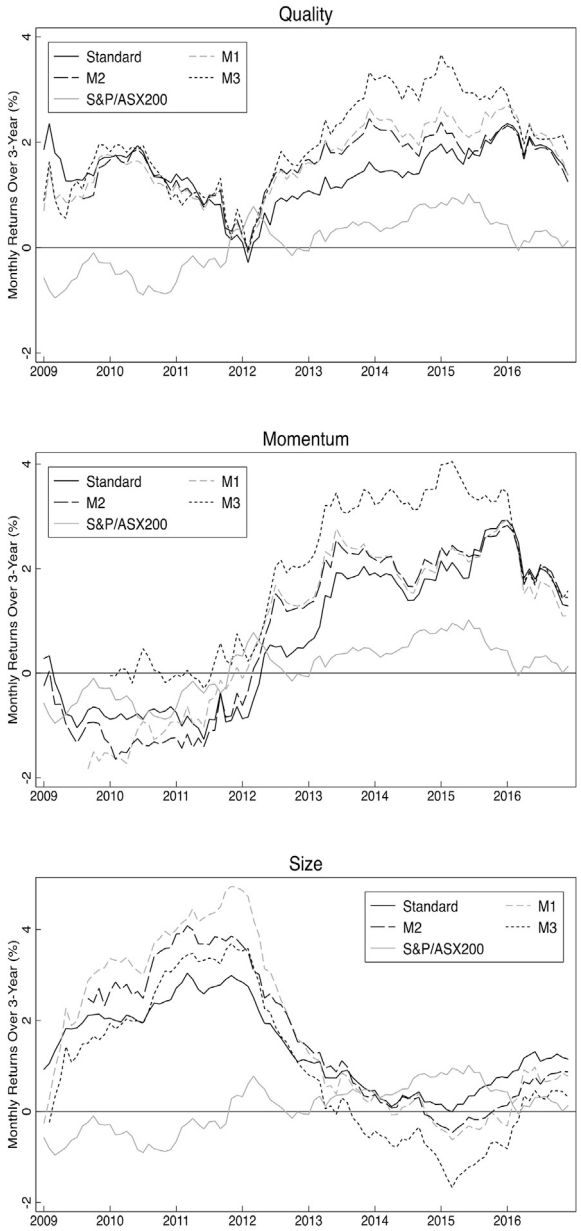

Fig. 4. Rolling performance.
The figure illustrates the average monthly returns of ESG integrated quality, momentum and size strategies in a 3-year rolling window. Standard represents the non-ESG integrated strategies. M1, M2 and M3 represent various integration methods. The period covers January 2009–December 2016.

potential to add value. These comparisons are better visualized in Figs. 3 and 4. Since low volatility and value strategies do not report statistically significant returns before or after integration, we focus on quality, momentum and size for the remainder of the paper.[15]

Fig. 3 illustrates the cumulative performance of the long-short quality, momentum and size portfolios. With 1AUD invested in January 2006, M3 returns the highest terminal wealth across quality and momentum strategies in 2016, at $5.61 and $5.04, respectively. Notably, the strong outperformance of M3 momentum suggests that combining ESG scores with past returns indeed helps reduce the crash risk profile of

[15] We also conducted tests by integrating ESG scores with multiple factors simultaneously. Regardless of factor combination, a higher weighting towards ESG in the integration process consistently reduces the volatility of the portfolio. However, this does not translate to a higher Sharpe ratio compared to non-integrated multi-factor strategies. Overall, the results suggest that in a multi-factor setting, ESG scores are best treated as a signal like other fundamental variables. Since multi-factor investing is beyond the scope of the paper, we proceed with single factor ESG integration; however, these results are available upon requests.

the momentum strategy illustrated post GFC. M2 reports the second highest cumulative return for the quality strategy, whilst standard provides the second highest for momentum. The higher Sharpe ratio of the standard size strategy over quality and momentum is consistent with the literature (Durand, Limkriangkrai, & Smith, 2006; Gaunt, 2004; Gharghori, Lee, & Veeraraghavan, 2009; Halliwell et al., 1999; Kassimatis, 2008). Meanwhile, all methods and factors outperform the S&P/ASX200, at a mere $1.14 by the end of the sample period. Overall, Fig. 3 highlights the fact that by combining ESG scores with factor signals, investors have the potential to achieve an improved terminal wealth outcome in the long-run. Meanwhile, given that M1 and M2 often underperform the standard factors along with the fact that "Rated" stocks underperform "All" stocks, our findings imply that ESG investing through non-ESG screening would likely lead to inferior investment outcomes, as it ignores the interactions between ESG scores and other crucial fundamentals such as past returns, size and quality. To further explore this, we examine the performance of ESG integrated strategies in rolling windows to capture the time-varying dynamics of returns.

Fig. 4 illustrates the performance of quality, momentum and size over 3-year rolling windows. It is evident that M3 consistently outperforms both the standard method and the market wide benchmark almost over the entire sample period. For quality and momentum, the average monthly return for M3 (at 1.97% and 1.93%, respectively) clearly outperforms the standard factors (at 1.41% and 0.68%, respectively). In fact, both M1 and M2 on average demonstrate higher monthly returns over a 3-year period, compared to standard, non-ESG integrated factors.[16] Fig. 4 is of particular importance for practitioners as it captures the return variations over varying market conditions. For example, over the period 2009 to 2012, all integration methods (M1 to M3) for the size strategy consistently report higher returns relative to the standard size strategy. As the returns depicted in 2009 reflect a 3-year rolling window beginning in 2006, our findings suggest that ESG rated small-cap stocks have the potential to outperform standard small-cap stocks during market downturns. Interestingly, when quality and momentum information are combined with ESG scores, M3 consistently delivers higher returns from 2010 to 2016 compared to the standard. Overall, Fig. 4 once again highlights the valuable investment insights by combining ESG and factor information simultaneously, particularly after taking into account the return variations through time. Furthermore, the outperformance of M3 in the second half of the sample period suggests that ESG has become increasingly relevant to the pricing of Australian stocks.[17] Thus, blending ESG with quality and momentum indicators have strong potential to add value in the long-run compared to non-integrated factors. This is most prominent for the momentum strategy, due partly to the muted performance of the momentum factor post-GFC.

One may be concerned about the size of the cross-section in the early part of our sample period. Meanwhile, since financial firms received substantial support from the government during the GFC (Lins, Servaes, & Tamayo, 2017), financial stocks may distort our findings. Therefore, we re-evaluate the performance of ESG integrated quality, momentum and size versus non-ESG integrated factors by excluding financial stocks. In addition, we repeat the same analysis eight times from 2007 to 2014, by varying the starting periods. Interestingly, during the crisis period, quality and size (momentum) without financials outperform (underperforms) the same strategies that include financials. When the size of the cross-section becomes larger, the results from 2010 to 2016 solidify the effectiveness of ESG integration in quality and momentum strategies. Overall, our results are robust to the exclusion of financial firms. These results are not reported due to brevity but are available upon requests.

4.2. Market conditions

Previous literature has examined the factor risk premia in different market conditions. We test whether ESG integration leads to improvement in factor performance during stress periods, to further analyze the time-varying performance of ESG integrated strategies. Table 3 demonstrates how quality, momentum and size strategies perform during variations of business cycles, inflation, credit, and volatility regimes. Panel A reports the performance in business cycles using information complied by the Organisation for Economic Co-operation and Development (OECD).[18]

During high growth periods, standard quality and size generate greater returns and Sharpe ratios. Momentum demonstrates higher monthly returns from M3 and outperforms the standard on a risk-adjusted basis.[19] However, in low growth periods, M3 delivers higher returns than standard quality, momentum and size. For quality strategies, M3 reports a Sharpe ratio of 0.96 versus 0.72 for the standard quality, whilst M3 for momentum delivers a Sharpe ratio of 0.77 relative to 0.16 in standard momentum. Nofsinger and Varma (2014) report that socially responsible mutual funds outperform conventional mutual funds during periods of crises. Their results indicate that the downside risk is dampened, however, in periods of non-crises, the upside potential is greater for conventional funds. Our findings are consistent with Nofsinger and Varma (2014) as methods which integrate ESG scores outperform during low growth periods and underperform during high growth periods, even from the perspective of long-short factor investing. This finding is consistent for quality

[16] In addition to a 3-year window, we also tested 1-year and 5-year rolling windows. M3 consistently outperforms the standard method for quality and momentum across the varying window lengths.

[17] In a Fama and MacBeth (1973) two-stage framework, we found that an ESG and ROE interaction term exhibits cross-sectional pricing power beyond traditional risk factors after controlling for firm-level ESG and fundamental characteristics. As formal asset pricing tests are beyond the scope of the current paper, these results are available upon request from the authors.

[18] OECD based recession indicators for Australia are obtained from the St. Louis Fed (see https://fred.stlouisfed.org/series/AUSRECM). It measures business cycles using the OECD composite leading indicators. A value of 1 is a recessionary period. For this time series, the recession begins midpoint of the period of the peak and ends midpoint of the period of the trough. Since Australia has not experienced an "official" recession in the last 25 years, we interpret the data as low versus high periods of economic growth.

[19] We focus on M1 and M3 because the M2 strategy takes dynamic net long or net short positions as opposed to "zero-investment" long-short positions. While it is considerably riskier, the M2 does not appear to outperform M1 and M3 strategies as reported in Table 2.

Table 3
Business cycles and market conditions. This table reports the performance of standard and ESG integrated quality, momentum and size strategies during various market conditions. Panels A, B, C and D report business cycle, inflation, credit and volatility risks, respectively. We obtain recession counts for the Australian economy from the OECD. Credit risk is proxied through the default spread defined as the yield difference between 5-year non-financial BBB-rated and A-rated corporate bonds. High inflationary periods are periods when the percentage change of CPI is above the 10-year median, where high credit risk periods are periods when the default spread is above the 10-year median. CPI and corporate bond yields are retrieved from the RBA. Market volatility is proxied by the S&P/ASX 200 VIX index (from Bloomberg). The S&P/ASX 200 VIX index measures the 30-day implied volatility of the Australian stock market using the settlement prices of the put & call options. The sample period covers January 2006 through December 2016, the VIX index begins in 2008. Sharpe ratios are annualized. *P*-values of the difference-in-mean and standard deviation are reported for each high and low regime.

		Quality			Momentum			Size		
		S	M1	M3	S	M1	M3	S	M1	M3
Panel A: Business cycles										
High growth	Returns	1.23%	0.83%	0.73%	0.86%	1.05%	1.29%	1.21%	0.55%	0.38%
(N=48)	*t*-statistics	1.84	0.82	0.70	1.34	0.94	1.27	3.54	0.77	0.50
	Volatility	3.64%	5.97%	6.12%	3.92%	6.82%	5.67%	2.65%	5.17%	4.66%
	Sharpe	0.57	0.25	0.20	0.41	0.34	0.60	1.06	0.10	0.29
Low growth	Returns	1.32%	1.73%	1.96%	0.57%	0.45%	1.66%	1.47%	1.77%	1.76%
(N=84)	*t*-statistics	2.36	2.57	2.83	0.75	0.46	2.17	2.6	1.64	1.72
	Volatility	5.02%	5.76%	6.38%	6.17%	7.75%	6.36%	3.68%	6.94%	6.34%
	Sharpe	0.72	0.87	0.96	0.16	0.07	0.77	1.11	0.74	0.84
	Diff-in-Mean	0.91	0.39	0.24	0.77	0.68	0.96	0.67	0.29	0.19
	Diff-in-SD	0.02	0.77	0.49	0.00	0.39	0.06	0.02	0.03	0.02
Panel B: Inflation										
High Inflation	Returns	1.14%	1.03%	1.15%	0.58%	−0.23%	1.37%	1.50%	1.27%	1.22%
(N=75)	*t*-statistics	1.92	1.25	1.42	0.80	−0.22	1.88	2.73	1.24	1.20
	Volatility	4.92%	6.67%	7.38%	6.02%	8.14%	6.62%	3.61%	6.98%	6.45%
	Sharpe	0.54	0.34	0.35	0.11	−0.25	0.55	1.07	0.44	0.48
Low Inflation	Returns	1.50%	1.93%	2.03%	0.81%	1.71%	1.77%	1.20%	1.41%	1.33%
(N=57)	*t*-statistics	2.84	2.93	2.97	1.23	1.87	1.95	2.65	1.69	1.91
	Volatility	4.01%	4.42%	4.39%	4.57%	6.40%	5.59%	2.94%	5.44%	4.86%
	Sharpe	1.08	1.31	1.57	0.43	0.79	0.98	1.12	0.74	0.80
	Diff-in-Mean	0.66	0.39	0.43	0.81	0.15	0.73	0.62	0.90	0.91
	Diff-in-SD	0.11	0.00	0.00	0.03	0.07	0.20	0.12	0.05	0.03
Panel C: Credit risk										
High Spread	Returns	1.31%	2.11%	2.10%	0.51%	0.40%	1.57%	1.39%	1.82%	1.85%
(N=73)	*t*-statistics	2.20	3.03	2.71	0.61	0.38	1.73	2.25	1.52	1.70
	Volatility	4.99%	5.76%	6.52%	6.32%	8.31%	6.71%	3.75%	7.29%	6.61%
	Sharpe	0.73	1.11	1.03	0.14	0.05	0.66	1.04	0.74	0.86
Low Spread	Returns	1.26%	0.53%	0.79%	0.88%	0.99%	1.52%	1.35%	0.72%	0.53%
(N=59)	*t*-statistics	2.32	0.61	0.89	1.42	1.2	2.17	3.71	0.98	0.73
	Volatility	4.00%	5.86%	5.97%	4.17%	6.03%	5.18%	2.78%	4.96%	4.57%
	Sharpe	0.75	0.07	0.26	0.40	0.35	0.89	1.18	0.23	0.20
	Diff-in-Mean	0.95	0.12	0.24	0.70	0.67	0.96	0.94	0.33	0.20
	Diff-in-SD	0.08	0.88	0.49	0.00	0.02	0.06	0.02	0.00	0.00
Panel D: Volatility risk										
High Volatility	Returns	1.03%	1.63%	0.71%	0.19%	−0.60%	0.66%	2.19%	3.37%	2.15%
(N=54)	*t*-statistics	1.36	2.06	0.85	0.21	−0.51	0.91	3.01	2.50	2.02
	Volatility	5.34%	6.08%	7.13%	6.34%	7.94%	6.20%	3.93%	6.97%	6.06%
	Sharpe	0.45	0.73	0.14	−0.07	−0.40	0.16	1.64	1.50	1.14
Low Volatility	Returns	1.79%	2.24%	2.47%	1.49%	2.21%	2.63%	0.51%	−0.15%	0.01%
(N=54)	*t*-statistics	3.8	3.43	7.73	1.93	2.47	3.1	1.21	−0.18	0.01
	Volatility	3.90%	4.75%	3.42%	5.10%	6.55%	5.95%	2.83%	5.72%	5.25%
	Sharpe	1.39	1.47	2.60	0.86	1.05	1.52	0.35	−0.22	−0.17
	Diff-in-Mean	0.40	0.56	0.08	0.24	0.05	0.08	0.01	0.01	0.04
	Diff-in-SD	0.02	0.07	0.00	0.11	0.17	0.76	0.02	0.15	0.27

and size, however, momentum outperforms the standard across both growth periods.

Panel B reports the long-short performance over differing inflationary regimes. During periods of high inflation (defined as periods with above median inflation), M3 outperforms the standard on a risk-adjusted basis only for momentum. Standard provides greater returns for size in comparison to ESG integrated methods. During low inflation periods, M3 outperforms standard for quality, momentum and size. Boyd et al. (2001) report that in low-to-moderate rates of inflation, stock market liquidity and trading volume have a pronounced inverse relationship with inflation. When inflation is low, long-run financial activity increases, intermediaries engage in borrowing, which allows firms to obtain credit. As ESG integrated strategies outperform the standard during low inflation periods, higher scoring ESG firms may be able to obtain funding at a lower cost relative to lower scoring ESG firms. Higher scoring ESG firms often resemble stronger governance and, therefore, better utilization of firm resources. Consequently, intermediaries are more inclined to lend to better managed firms. When inflation is lower, profits can increase from the reduction in real interest rates, which higher ESG rated firms can capitalize on. During high inflationary periods, the increased volatility of the strategies is consistent with the findings of Boyd et al. (2001).

Panel C reports the long-short factor performance during varying periods of credit risk measured by the default spread–the yield difference between BBB- and A-rated corporate bonds. In high spread periods, M3 quality and momentum strategies outperform standard. In comparison, during low spread periods, standard outperforms ESG integrated methods for quality and size. Default spread reacts to changes in inflation expectations. As inflation increases, default spread widens from the anticipation of a bear market which results in a reduction in stock market liquidity and trading volume. During these periods, higher scoring ESG firms, particularly those of high quality or small market-cap, have better access to credit relative to lower scoring firms. This helps explain the finding that standard factors perform better when credit risk is lower. Further, this is reinforced with the performance in Panel A, where standard is preferred for quality and size during an economic expansion.

Panel D reports the performance during periods of varying market volatility. A high volatility period is defined as periods when the S&P/ASX 200 VIX index is above the sample median. For momentum, M3 outperforms the standard regardless of the level of volatility. The performance of the quality strategy is consistent with the results reported in Asness, Frazzini, and Pedersen (2014). M3, where ESG interacts with the factor signal, delivers highly significant returns of 2.47% during periods of low volatility for quality. Furthermore, ESG integrated size strategy underperforms standard size in both volatility regimes. This implies that higher market cap ESG scoring firms resemble higher quality firms in both low and high volatility periods. When the market volatility is below the median, ESG integrated momentum strategies (M1 and M3) significantly outperform the standard momentum. This indicates the recent winners during low volatile markets are higher ESG scored firms. As M1 returns 2.21% per month, the results reveal that interaction between ESG and momentum is the preferred method of integration. We proceed with our analysis by benchmarking the performance of ESG integrated strategies with common risk factors constructed using the entire cross-section of Australian stocks.

4.3. Factor loadings

Table 4 reports the factor loadings of long-short quality, momentum and size strategies on the Carhart (1997) four-factor model. We regress realized returns generated from factor strategies on risk factors constructed using stock characteristics. To mitigate concerns over multi-collinearity, we also omit UMD and SMB for momentum and size strategies, respectively. In line with expectations, while our market proxies load positively on SMB, the "Rated" stocks load negatively on SMB, confirming the bias of ESG rating towards larger-cap stocks. Since our factor strategies constitute long-short positions, MKT loadings are generally low.

First, standard quality and M3 both report statistically significant alphas after controlling for SMB, HML and UMD. The MKT loadings are negative across the broad, indicating the performance of quality strategies are negatively associated with the overall market movements. The loadings on SMB and HML imply that the integration of ESG causes the strategy to tilt towards larger-cap and lower book-to-market firms compared to the standard quality stocks. This finding is consistent with a number of Australian and U.S. studies on the quality factor. For example, Humphrey et al. (2012a) and Lee and Faff (2009) report larger-cap firms tend to record higher ESG scores. Churet and Eccles (2014) posit that ESG management is a proxy for overall quality of management. Firms who manage ESG issues more effectively are more likely to remain competitive over the long-run. Novy-Marx (2013) and Asness et al. (2019) document significant alphas for the profitability sorted strategies. Without ESG integration, Gallagher et al. (2014) report evidence of a quality factor. As a result, our findings suggest that ESG integration does not significantly reduce the alpha of the quality factor, nor does it alter the loadings on MKT, SMB and HML factors.

Second, size strategies consistently load positively on MKT, with M1 reporting the highest loading of 0.47. The loading on SMB suggests that integrating ESG causes the size strategy to tilt towards smaller-cap stocks. This finding implies that it may be advantageous for smaller-cap firms to disclose information in relation to their Env, Soc and Gov risks. If SMB is excluded from the regression for the size factor, the alpha is significant across the four varying methods. This verifies that the size strategy is indeed largely explained by the SMB factor even after the integration of ESG ratings. Lastly, momentum strategies do no report significant alpha across the four different methods once UMD is controlled for, with the exception of M3. Low volatility and value report no statistically significant alphas. This implies that the four-factor model is able to fully capture the returns and are excluded from reporting. This finding again highlights the benefit of ESG integration for momentum strategies, as it adds alpha even after accounting for market, size, value and momentum factors. The loadings on SMB and HML imply that ESG integration causes the momentum strategy to tilt towards larger-cap and lower book-to-market stocks, in line with the loadings of quality strategies.

Overall, the regression results reveal that it is important for investors to consider ESG integration as it provides an additional dimension to assess risks and to achieve more sustainable returns. Institutional investors such as pension funds, superannuation funds and managed funds, who, in particular, are investing for the long-term, should understand the benefit of ESG integration. Our findings are of particular relevance to mangers who employ quality, size and momentum style strategies in Australia. Jointly exploiting ESG scores with factor signals does not significantly detract performance of factor strategies, integration could add value for investors in the long-run.

4.4. Disentangling ESG and factor characteristics

In this section, we further investigate the impact of ESG integration on portfolio characteristics. Table 5 reports the characteristics of breakpoint portfolios sorted by each factor. We first sort stocks into quartiles (Q1-Q4) based on their ESG scores, and report their average returns, ESG scores, ROEs, past 12-month returns and market capitalizations. We repeat the same process using quality, momentum and size signals, and report the results before (S) and after ESG integration (M1 & M3).

This breakdown makes several comparisons possible. First, it allows us to disentangle the performance of "ESG tilt" strategies against "factor" strategies prior to ESG integration. Sorting directly on ESG scores, we find the highest ESG rated stocks tend to exhibit lower

Table 4

Factor loadings. This table reports the factor loadings of ESG integrated quality, momentum and size strategies using the Carhart (1997) factors. The MKT is constructed by subtracting the risk-free rate from returns of all stocks in the Australian market. The SMB and HML are formed through size and book-to-market bivariate sorts. First, the universe of stocks are sorted into two size categories using market-cap medians (highest 50% (B), and smallest 50% (S)). Second, stocks are sorted into three groups based on book-to-market equity (highest 33% (H), middle 33% (M), and lowest 33% (L)). The intersection of stocks across the six categories are used to form the portfolios SH (small, high BE/ME), SM (small, middle BE/ME), SL (small, low BE/ME), BH (big, high BE/ME), BM (big, middle BE/ME), and BL (big, low BE/ME). The SMB is the average of the three small stock portfolios (1/3SH + 1/3SM+1/3SL) minus the average of the three big stock portfolios (1/3BH+1/3BM+1/3BL). The HML is the average of the two high book-to-market portfolios (1/2SH+1/2BH) minus the average of the two low book-to-market portfolios (1/2SL+ 1/2SH). The UMD is the average of the small and big winners (1/2SU + 1/2BU) minus the average of the small and big losers (1/2SD + 1/2SD). The *t*-statistics reported in parentheses are estimated following the Newey-West procedure. The sample period covers January 2006 through December 2016.

	Quality				Momentum				Momentum			
	S	M1	M2	M3	S	M1	M2	M3	S	M1	M2	M3
Alpha	0.022***	0.018***	0.020***	0.021***	0.003	0.001	0.004	0.014***	0.013**	0.015**	0.015**	0.022***
	(5.66)	(3.97)	(4.84)	(4.42)	(0.58)	(0.28)	(0.78)	(2.78)	(2.46)	(2.17)	(2.58)	(3.67)
MKT	−0.255*	−0.385**	−0.432***	−0.306**	−0.225**	−0.021	−0.100	−0.128	−0.275**	−0.058	−0.147	−0.167
	(-1.97)	(-2.51)	(-3.17)	(-2.53)	(-2.14)	(-0.17)	(-0.73)	(-1.20)	(-2.27)	(-0.30)	(-1.01)	(-1.52)
SMB	−0.489***	−0.546***	−0.461***	−0.480***	−0.243	−0.522**	−0.390*	−0.604***	−0.298	−0.722**	−0.447*	−0.648***
	(-4.56)	(-4.34)	(-4.20)	(-2.94)	(-1.40)	(-2.20)	(-1.76)	(-2.96)	(-1.48)	(-2.50)	(-1.79)	(-3.29)
HML	−0.834***	−0.735***	−0.648***	−0.619***	−0.463**	−0.356**	−0.444**	−0.242*	−0.728***	−0.848***	−0.737***	−0.473***
	(-7.11)	(-4.74)	(-4.80)	(-3.23)	(-2.38)	(-2.14)	(-2.33)	(-1.81)	(-3.66)	(-3.20)	(-3.19)	(-3.38)
UMD	−0.027	0.076*	0.054	0.053	0.309***	0.355***	0.330***	0.261***				
	(-0.64)	(1.69)	(1.12)	(1.08)	(3.47)	(5.27)	(3.67)	(4.21)				
Adj. R^2	0.448	0.347	0.380	0.174	0.378	0.345	0.314	0.234	0.227	0.204	0.176	0.145
	Size				Size				Market			
	S	M1	M2	M3	S	M1	M2	M3	All	Rated	ASX200	All Ords
Alpha	0.004**	0.001	0.002	0.001	0.014***	0.015**	0.015**	0.012*	−0.002	0.007*	−0.005	−0.005
	(2.29)	(0.15)	(0.70)	(0.32)	(3.11)	(2.03)	(2.54)	(1.91)	(-0.37)	(1.93)	(-1.17)	(-1.01)
MKT	0.206***	0.474***	0.217**	0.344***	0.100	0.317**	0.077	0.220	0.194*	−0.149*	0.173*	0.178
	(3.41)	(4.42)	(2.51)	(2.96)	(1.04)	(2.30)	(0.63)	(1.59)	(1.93)	(-1.87)	(1.70)	(1.64)
SMB	0.876***	1.305***	1.220***	1.068***					0.263**	−0.467***	0.348***	0.349***
	(11.81)	(6.12)	(11.05)	(5.28)					(2.23)	(-4.27)	(3.68)	(3.60)
HML	−0.049	0.282**	0.065	0.297	−0.070	0.251	0.023	0.267	0.157	−0.211*	0.089	0.093
	(-0.62)	(2.02)	(0.61)	(1.64)	(-0.70)	(1.35)	(0.16)	(1.13)	(1.29)	(-1.76)	(0.76)	(0.79)
UMD	0.028	−0.071	0.018	−0.017	−0.001	−0.113	−0.021	−0.049	0.020	0.026	−0.016	−0.023
	(0.67)	(-1.64)	(0.42)	(-0.41)	(-0.01)	(-1.52)	(-0.33)	(-0.82)	(0.26)	(0.48)	(-0.32)	(-0.45)
Adj. R^2	0.598	0.432	0.494	0.325	0.001	0.069	−0.019	0.0350	0.047	0.165	0.060	0.063

momentum but higher market-caps, while reporting similar returns and ROEs compared to the lowest rated stocks. On the other hand, although stocks with the highest ROEs and momentum report higher returns, their ESG scores and market-caps are similar to stocks with the lowest ROEs and momentum, respectively. However, we find that the smallest stocks, while reporting higher returns, exhibit significantly smaller ESG scores on average. These results suggest that quality and momentum factors do not significantly alter the ESG profile and the market-caps of long and short portfolios. The findings also reveal that the informational content of ESG versus the factor characteristics are indeed different.

Second, this approach enables us to directly assess the impact of ESG integration on both the long and short legs of the factor portfolios, which in turn helps explain the improved performance of the combined score (M3) approach of integration. For the quality factor, while the long portfolio (Q4) of the integrated strategies (M1 and M3) report similar returns to the unintegrated (S) portfolio, the returns have become considerably lower for the short portfolios (Q1). Besides, while the M1 strategy generally does not exhibit significant impact on the ESG profile and market-caps of quality portfolios, the M3 strategy considerably increases the spreads of ESG scores and market-cap between the long and short portfolios. This is achieved by picking stocks that exhibit relatively lower ROE but

Table 5

Impact of integration on portfolio characteristics. This table reports the impact of ESG integration on factor characteristics. The quality signal is represented by the ROE ratio. The momentum signal is based on the past 12-month return, skipping the most recent month. The size is based on the market-capitalization. For standard factors (S), we sort stocks into quartiles (Q1-4) based on the respective factor signal at the end of each month. Scores represent ESG scores. The table reports the average returns, ESG scores, ROE, past 12-month returns and market cap for each breakpoint portfolio. The sample period covers January 2006 through December 2016. ESG scores are not integrated within the S portfolios. M1 and M3 represent methods of ESG integration. For M1, we first screen out non-ESG rated firms from the "All" sample, and then construct the breakpoint portfolio using the remaining stocks. For M3, we first screen out non-ESG rated firms from the "All" sample, and then create a new sort signal by assigning a 50/50 weighting to the factor signal and ESG scores. Portfolios are then formed on this combined signal.

		Breakpoint Portfolios			
		Q1	Q2	Q3	Q4
	Sorted on Scores				
Returns		0.70%	0.47%	0.45%	0.89%
ESG		10.2	14.4	19.4	39.0
ROE		12.84	13.09	13.15	13.41
Past 12M return		22.4%	17.0%	13.2%	10.5%
log(Market-cap)		24.86	25.20	25.77	27.37
	Sorted on Quality				
Returns	S	−0.36%	0.59%	0.82%	1.00%
	M1	−0.48%	0.56%	1.04%	1.01%
	M3	−0.52%	0.13%	0.69%	0.98%
ESG	S	20.3	22.3	22.8	20.2
	M1	20.3	21.6	24.6	19.8
	M3	15.5	21.0	22.7	26.9
log(Market-cap)	S	25.15	25.69	25.68	25.53
	M1	25.56	26.13	26.37	26.08
	M3	24.41	25.57	25.74	26.45
ROE	S	−14.3	8.9	17.0	46.3
	M1	−12.9	9.9	18.3	37.8
	M3	−25.6	6.4	15.7	32.8
	Sorted on Momentum				
Returns	S	0.40%	0.35%	0.65%	1.01%
	M1	0.57%	0.23%	0.96%	0.92%
	M3	−0.51%	0.14%	0.75%	0.96%
ESG	S	20.1	21.6	21.8	19.7
	M1	21.5	23.7	24.3	19.8
	M3	15.1	19.4	21.9	25.7
log(Market-cap)	S	24.83	25.35	25.51	25.31
	M1	25.53	26.10	26.32	25.98
	M3	23.72	25.01	25.57	25.80
Past 12M return	S	−29.5%	−1.0%	17.8%	69.7%
	M1	−26.3%	−1.5%	17.8%	64.7%
	M3	−39.6%	−5.2%	20.5%	90.5%
	Sorted on Size				
Returns	S	1.81%	0.60%	0.58%	0.59%
	M1	1.60%	0.85%	0.56%	0.84%
	M3	0.66%	1.20%	1.26%	1.02%
ESG	S	13.5	14.0	16.5	28.5
	M1	13.9	14.6	19.2	35.0
	M3	11.9	14.0	17.0	35.5
log(Market-cap)	S	23.63	24.31	25.30	27.08
	M1	24.17	25.08	26.11	27.84
	M3	22.82	24.34	25.55	27.15

higher ESG scores and market-caps in the long portfolio, and stocks that exhibit much lower ROEs while simultaneously report lower ESG scores and lower market capitalizations. In other words, the M3 strategy selects stocks with lower ROEs on average relative to the standard quality strategy. Therefore, combined with the fact that M3 outperforms the standard unintegrated quality, this finding suggests that the superior predictability of the combined sorting variable is due to the synergies between the ROE and ESG signals.

We observe similar results on the momentum factor. While the M1 strategy generally does not exhibit significant impact on the ESG profile and market-cap of momentum portfolios, the M3 strategy considerably increases the ESG and the market-cap spreads between the long- and short portfolios. This is achieved by picking stocks that exhibit significantly higher past returns which simultaneously report higher ESG scores, and stocks which are more extreme losers while simultaneously report lower ESG scores and lower market capitalizations. In other words, the M3 strategy selects more extreme past winners and losers compared to the standard momentum strategy. This confirms the superior informational content of ESG for the identification of winners and losers stocks in the near future. As for the size factor, it is not surprising that integrated size strategies do not outperform the standard. Since ESG scores are generally lower when the market-cap becomes smaller, integrating ESG scores tilts the portfolio away from smaller stocks that are essential for the profitability of size strategies. This also explains the absence of synergies between ESG scores and the market capitalization.

Theoretically, good ESG practices can shelter firms from shocks to their underlying cash flows and provide improved investment and production opportunities, thereby creating value for shareholders (Cornell & Shapiro, 1987, pp. 5–14; Flammer, 2015). However, costs of firms' investments in ESG could outweigh the benefits, thereby resulting in the destruction of shareholder value (Revelli & Viviani, 2015; Statman & Glushkov, 2009). Following this vein, the outperformance of ESG integrated factors suggests that viewing ESG and financial performances of a firm jointly better captures the value-add than viewing ESG or financial performance in isolation, because

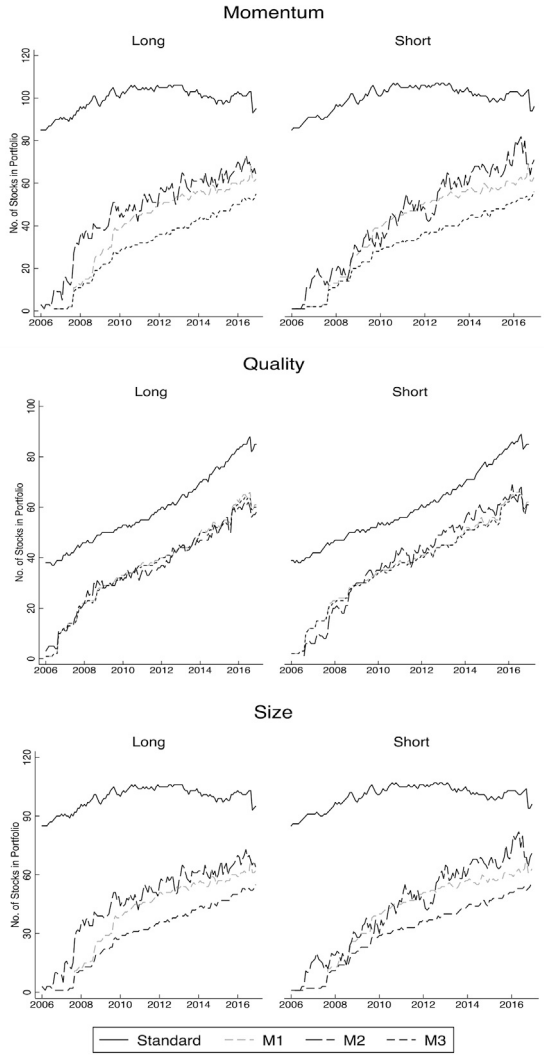

Fig. 5. Number of stocks traded.
The figure illustrates the number of stocks traded by quality, momentum and size strategies. Standard represents the non-ESG integrated strategies. M1, M2 and M3 represent various integration methods. The period covers January 2006–December 2016.

financial performance helps prevent (or minimize) the allocation to potentially value-destroying, but high ESG-rated stocks.

4.5. Portfolio holdings

Having established the potential benefits of integrating ESG into quality and momentum strategies, we now move on to examine the compositions of long and short portfolios. We first compare the number of stocks traded across integration methods against the standard factors, and then proceed to examine the portfolio holdings by sectors.

Fig. 5 illustrates the number of stocks traded across the standard and integration methods for quality, momentum and size. For standard quality, in 2006, 38 stocks are included in each long and short portfolios, this expands to 85 by 2016. As reflected in Table 1, the total count of Bloomberg ESG scores ranges from 5 to 295 from 2006 to 2016. Consequently, in 2006, M1, M2 and M3 trade between one and two stocks in each long and short portfolios, respectively. By 2016, M1, M2 and M3 trade 61, 58 and 60 stocks in each portfolio, respectively.

The standard momentum strategy trades 85 stocks in each long and short portfolios at the beginning of the sample period. The standard method trades up to 107 stocks in each portfolio, and ends with 96 stocks in 2016.[20] Similar to quality, the integrated strategies (M1 to M3) begin with only a few stocks in each portfolio in early 2006. By 2016, M1 and M3 trade 63 and 56 stocks in each portfolio, respectively. As depicted in Fig. 2, M2 screens out non-rated stocks in the portfolios after sorting on the factor signal and can result in unbalanced long and short portfolios, causing the strategy to be net long or short. In the case of momentum, the long portfolio for M2 trades 64 stocks in the long portfolio and 71 stocks in the short portfolio by December 2016. This slight discrepancy also indicates that some firms within the winners' portfolio do not disclose ESG information and, therefore, are excluded from the portfolio.

For the size strategy, 106 stocks are traded in each long and short portfolios in 2006, which increases to 117 by 2016. Once again, M1 and M3 integrated strategies only contain one to two stocks in each portfolio at 2006. In the same month however, M2 shorts 5 stocks whilst takes no positions in the long portfolio, thus creating a net short exposure. This also indicates that no small-cap firms disclosed an ESG score. It is not until September 2006 that a firm in the short portfolio has a Bloomberg disclosure score. The short portfolio trades two stocks, whilst the long portfolio trades 32 stocks, thus resulting in a net long exposure. At December 2016, 71 (62) stocks are traded in each long and short portfolios for M1 (M3). In addition, M2 trades 63 stocks in the long portfolio, whilst shorting 99 stocks at December 2016.

In summary, while M3 requires the least number of stocks to implement, it also maintains a self-financing long-short portfolio throughout the sample. On the other hand, a more costly and dynamically positioned, M2 integration method, does not necessarily provide a better investment outcome after considering the return variations through time. Overall, the findings presented in Fig. 5 imply that integrating ESG into factors through a one-dimensional approach of non-ESG screening (e.g. M1 and M2) is unlikely to result in value-creation net of management fees. We now proceed to examine the allocations by sectors across strategies in order to assess whether the performance of our integrated factors can be explained by industry concentrations.

Fig. 6 illustrates the portfolio holdings by sector from January 2006 to December 2016. As M3 delivers the best investment outcome, we focus on the comparison of sector holdings between standard and combined factors. Fig. 6A exhibits industry holdings for the quality strategy. For the standard quality, around 18% of the portfolio is allocated within each of the materials, industrials and financials industry in the long portfolio in 2006. In sharp contrast, M3 allocates 100% weight to materials. Consumer staple, telecommunications and utilities are allocated with less than 5% holdings over the sample period, whilst healthcare is held by less than 10% on average in the long portfolio. However, when ESG interacts with the quality information, energy, healthcare and telecommunications receive consistent weightings over the sample period in the long portfolio. Furthermore, M3 appears to tilt the long leg of the quality portfolio towards financials, materials and consumer staples. The short portfolio reports consistent holdings, with M3 betting more bearishly on materials and energy stocks, whereas the standard quality exhibits slightly larger holdings in financials and industrials.

Interestingly, the long portfolio holdings within the materials industry significantly declines for both the standard and M3. This corresponds to the subdued demand for Australian commodities, in particular, from China, following the collapse of Lehman Brothers. The holdings in materials in the long portfolio falls to 4% between January 2009 and June 2009 for the standard long portfolio. However, materials holdings within the M3 long portfolio increased from mid-2008 to early 2012. This indicates that high scoring quality firms, who also exhibit a high ESG score were perceived as a sound investment during this period. This further implies that these firms manage their associated downside risk greater than lower ESG and lower quality firms. The interaction between ESG and the quality factor therefore provides a signal which allows an investor to more accurately analyze a specific firm. The allocation in the short portfolio rose to 42% for standard and 41.67% for M3 in August 2008 for financials, whilst the allocation to industrials increased from 6.38% in June 2008 to 21.57% in July 2009 for the standard quality.

During the stock market rebound in 2010, holdings within materials grew to 25.45% for standard and 21.62% for M3 in the long portfolio. Industrials and information technology maintained consistent allocations, whilst by June 2012, financials fell to 6.56% of holdings in the long portfolio for standard. Financials sector tilt for M3 remained consistent during this period, which indicates high ESG and high quality firms within this industry were identified as a more viable investment relative to pure high quality firms. As the standard quality holdings appear to be more volatile than M3 over the sample period, this reveals that ESG scores provide vital information that can be utilized when rebalancing portfolios. During 2012 to December 2016, materials saw holdings in the short portfolio increase to a high of 41.94% in July 2012 and decreasing to 23.53% at the end of the sample period for the standard quality. Over the

[20] The SPPR database includes a larger proportion of Australian listed stocks than available ROE data on Thomas Reuters Datastream. Consequently, this explains the differential in number of stocks traded in the quality strategy relative to momentum and size.

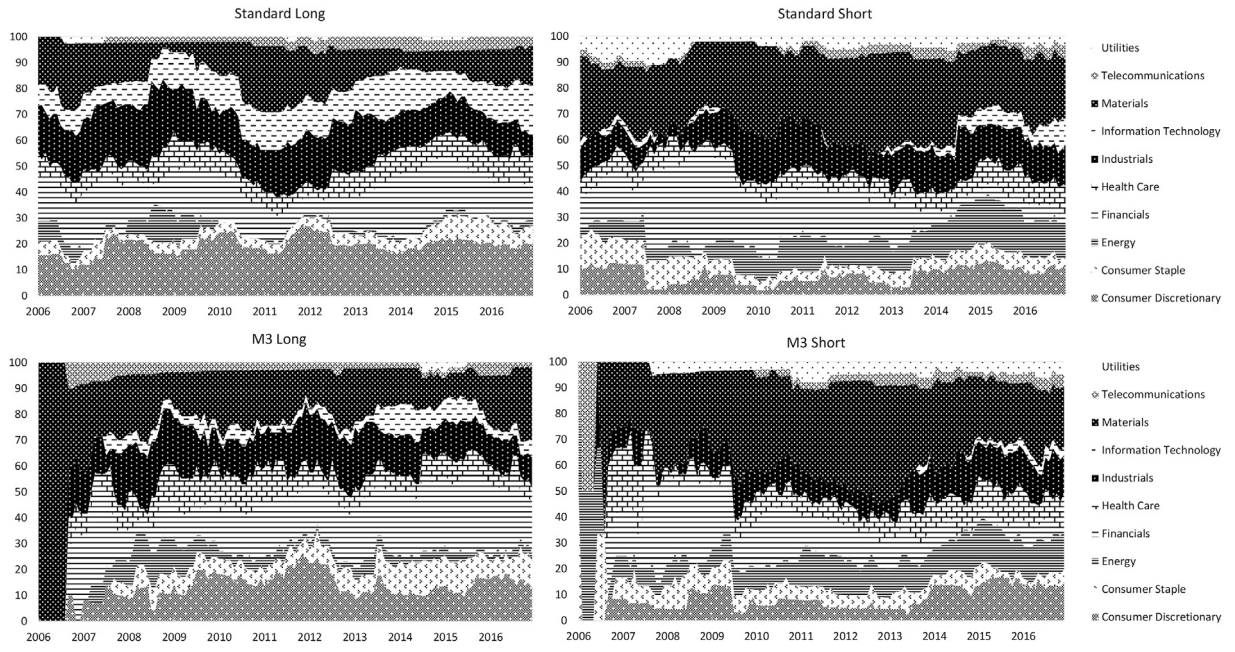

Fig. 6A. Holdings by sector: Quality.
The figure illustrates the stock holdings by sector for the quality strategy. Long and short portfolio holdings are separated reported. Standard represents the non-ESG integrated factor portfolio, whereas M3 represents the integration method that combines the ESG score and the quality signal. The period covers January 2006–December 2016.

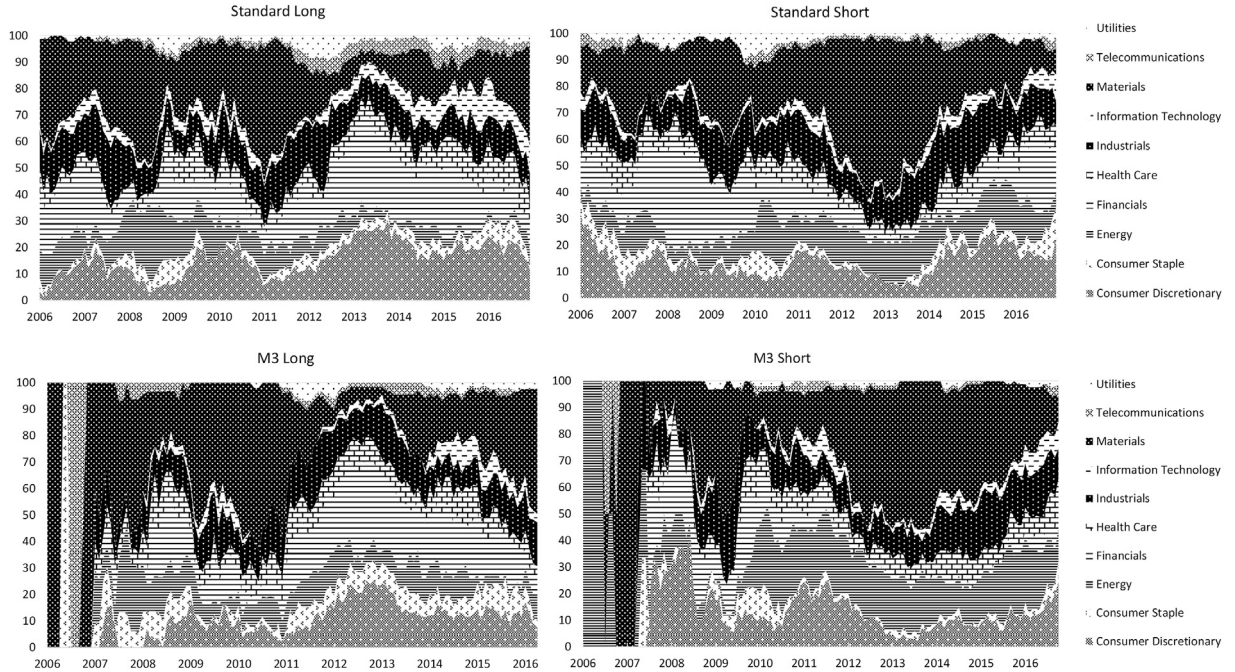

Fig. 6B. Holdings by sector: Momentum.
The figure illustrates the stock holdings by sector for the momentum strategy. Long and short portfolio holdings are separated reported. Standard represents the non-ESG integrated factor portfolio, whereas M3 represents the integration method that combines the ESG score and the momentum signal. The period covers January 2006–December 2016.

same period, the exposure to materials increased to 45.45% of the short portfolio, subduing to 22.95% by December 2016. This significant increase in mid-2012 until 2015 in the short portfolio is due to the weak global demand for the oversupply of Australian iron ore.

Fig. 6B illustrates the holdings by sector for the momentum strategy. Between 2006 and 2009, materials holdings average 31.63% for the non-ESG integrated standard factor and 47.02% for M3 in the long portfolio. Since inception of the first ESG score in 2005, materials report a high average ESG score and higher "Rated" firm count over the 2006 to 2009 period. With this in mind, it is not surprising that a large portion of the long portfolio encompass materials stocks. As momentum suggests past winners will continue to win over the short to medium term, the commodity boom in the early 2000's validates the portfolio holdings in both standard long and M3 long. Until the credit crunch in early 2009, long portfolio holdings averaged less than 10% within each industry for M3, with utilities receiving zero allocations. Standard winners demonstrate higher tilt towards consumer discretionary, energy and industrials. Over the period January 2008 to December 2010, short positions in financials account for 23.46% of weights for standard and 23.50% for M3.

Holdings in materials reached a high of 65.62% in February 2011 for M3, relative to 46.08% for the standard. The high concentration within the materials sector appear in both long and short portfolios across standard and integrated portfolios, indicates that momentum effect in Australia is largely driven by materials stocks. It is evident that consumer discretionary, materials and industrials exhibit cyclical behaviour, in both standard and M3 portfolios. Health care experiences increased sector tilts in the long portfolio when the Australian economy contracts. Holdings in the consumer discretionary and financial sectors appear to increase when materials holdings decrease. For example, throughout 2012 to 2014, materials holdings in the long portfolio contract in both standard and M3. However, financial tilts increased to a high of 36.89% for standard and 46.15% for M3. During this period, the Australian banking sector was one of the world's best performers. Consequently, the interaction between ESG scores and the momentum signal captured information which the momentum signal alone could not. As reported in Table 2, M3 for momentum returned 1.55% per month, whilst standard returned 0.69%. This additional performance is therefore attributed to information provided by combining momentum with ESG scores.

Lastly, Fig. 6C illustrates the holdings by sector for the size strategy. While the standard long and short portfolios demonstrate consistent allocations across sectors. M3 exhibits more dynamic weightings to sectors, particularly in the long portfolio. As the size strategy buys small-cap stocks and short-sells large-cap stocks, the weighting allocated to financials and materials in the short portfolio is expected. However, it is evident that sector tilts towards financials and materials is considerably greater in M3. This indicates that large-cap financials and materials stocks report ESG scores on average lower than other sectors, such as, consumer discretionary. The long portfolio exhibits weighting in materials in both standard and M3 with around 23% and 35% of the portfolio, respectively. However, the short portfolio bets heavily against materials (30.78%) in M3, in comparison to 18.56% by standard size. This implies that large-cap materials stocks disclose less ESG information relative to the other sectors. This also suggests that it may be advantageous for large-cap material firms to increase the disclosure on environmental, social and governance issues that affect their operations. Energy holdings are increased in the long portfolio of M3 relative to standard, suggesting that small-cap firms within these industries on average

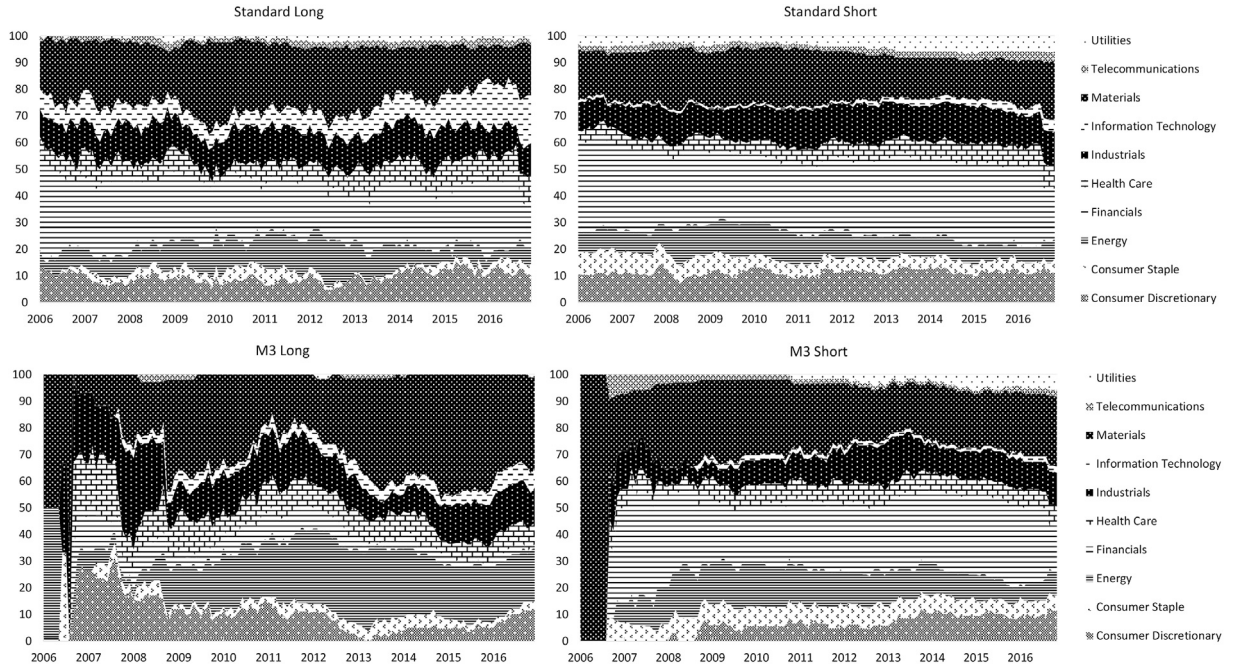

Fig. 6C. Holdings by sector: Size.
The figure illustrates the stock holdings by sector for the size strategy. Long and short portfolio holdings are separated reported. Standard represents the non-ESG integrated factor portfolio, whereas M3 represents the integration method that combines the ESG score and the size signal. The period covers January 2006–December 2016.

Table 6

Individual Environment, Social and Governance integrated factors. This table reports the performance of Env, Soc and Gov integrated factor portfolios. For the quality, stocks are sorted based on ROE. For momentum and size, stocks are sorted based on past 12-month returns and the market-capitalization, respectively. For quality and momentum, we take long (short) positions in stocks within the highest (lowest) quartile. For size, we take long (short) positions in stocks within the lowest (highest) quartile. S represents the standard factor. Individual Env, Soc or Gov scores are not integrated within the standard factor portfolios. M1, M2 and M3 factor portfolios integrate Env, Soc or Gov scores separately. For M1, we first screen out non-Env, Soc or Gov rated firms from the "All" sample, and then construct the factor portfolio as previously discussed using the remaining stocks. For M2, we first form factor portfolios in the "All" sample, and then screen out non-Env, Soc or Gov rated firms off the long and short portfolios. For M3, we first screen out non-Env, Soc or Gov rated firms from the "All" sample, and then create a new sort signal by assigning a 50/50 weighting to the factor signal and Env, Soc or Gov scores, respectively. Portfolios are then formed on this combined signal. The sample period covers 2006–2016. Average monthly returns, Newey-West adjusted *t*-statistics, volatility, skewness, kurtosis and maximum drawdown (MaxDD) are reported. Sharpe ratios are annualized.

	Unintegrated	ESG			Env			Soc			Gov		
	S	M1	M2	M3	M1	M2	M3	M1	M2	M3	M1	M2	M3
Quality													
Returns	1.31%	1.28%	1.37%	1.52%	1.13%	1.47%	1.69%	1.03%	1.38%	1.16%	1.21%	1.37%	1.44%
t-statistics	3.11	2.32	2.81	2.58	1.86	2.91	3.06	1.65	2.71	2.18	2.24	2.81	2.78
Volatility	4.54%	5.67%	4.94%	6.29%	5.93%	5.29%	5.88%	5.87%	5.15%	5.53%	5.52%	4.94%	5.57%
Sharpe	0.80	0.64	0.74	0.71	0.47	0.76	0.89	0.42	0.72	0.56	0.56	0.74	0.74
Skewness	0.10	−0.20	0.04	0.12	−0.22	−0.04	−0.46	−0.33	−0.12	−0.06	−0.20	0.05	0.02
Kurtosis	4.63	4.49	4.16	5.18	5.25	4.12	6.93	4.73	4.00	5.74	4.46	4.16	4.57
MaxDD	−0.30	−0.49	−0.30	−0.44	−0.51	−0.30	−0.41	−0.59	−0.32	−0.46	−0.47	−0.30	−0.37
Momentum													
Returns	0.69%	0.62%	0.72%	1.55%	0.57%	0.62%	0.66%	0.76%	0.77%	0.90%	0.42%	0.80%	1.03%
t-statistics	1.28	0.99	1.22	2.73	0.79	1.07	0.99	1.14	1.28	1.37	0.62	1.37	1.82
Volatility	5.43%	6.21%	6.53%	6.14%	7.01%	6.88%	6.14%	6.78%	6.71%	6.30%	6.19%	6.67%	5.68%
Sharpe	0.22	0.15	0.21	0.74	0.13	0.15	0.22	0.23	0.23	0.34	0.06	0.25	0.46
Skewness	−0.16	−0.19	−1.04	0.01	−0.12	−0.87	−0.70	−0.25	−1.04	−0.58	−0.16	−0.92	−0.19
Kurtosis	5.04	3.78	6.58	3.63	4.17	6.47	5.33	3.74	6.65	6.49	4.24	6.39	3.27
MaxDD	−0.53	−0.60	−0.62	−0.36	−0.65	−0.64	−0.60	−0.58	−0.62	−0.55	−0.69	−0.63	−0.43
Size													
Returns	1.35%	1.16%	1.48%	1.20%	0.41%	1.51%	0.32%	0.65%	1.19%	0.67%	1.14%	1.47%	1.07%
t-statistics	3.57	2.12	2.82	1.7	0.58	1.97	0.49	1.14	2.31	1.31	2.02	2.81	1.93
Volatility	3.34%	4.82%	5.09%	5.83%	6.26%	7.70%	6.08%	5.15%	4.96%	4.87%	4.93%	5.09%	4.81%
Sharpe	1.09	0.55	0.80	0.58	0.10	0.54	−0.03	0.22	0.62	0.26	0.66	0.79	0.66
Skewness	0.19	0.54	0.18	0.79	0.75	2.03	0.69	0.48	0.49	0.32	0.32	0.18	0.21
Kurtosis	3.44	4.20	3.80	5.34	5.62	12.45	5.50	4.60	3.67	4.12	4.53	3.80	4.12
MaxDD	−0.17	−0.28	−0.25	−0.36	−0.62	−0.48	−0.66	−0.41	−0.31	−0.31	−0.24	−0.25	−0.24

Table 7

Best-of-sector portfolios. This table reports the performance of aggregated and individual Environment, Social and Governance integrated factors using a best-of-sector approach. For the standard BOS factor portfolios (S), stocks in each sector are sorted into terciles based on quality, momentum and size. For quality and momentum, we take long (short) positions in stocks within the highest (lowest) tercile in each sector. For size, we take long (short) positions in stocks within the lowest (highest) tercile in each sector. The BOS ensures all industries are represented. Standard (S) represent factor portfolios before ESG integration. For M1, we first screen out non-ESG, Env, Soc or Gov rated firms from the "All" sample, and then construct the BOS factor portfolio using the remaining stocks. For M2, we first form BOS factor portfolios in the "All" sample, and then screen out non-ESG, Env, Soc or Gov rated firms off the long and short portfolios. For M3, we first screen out non-ESG, Env, Soc or Gov rated firms from the "All" sample, and then create a new sort signal by assigning a 50/50 weighting to the factor signal and ESG, Env, Soc or Gov scores, respectively. BOS portfolios are then formed on this combined signal. The sample period covers January 2006 through December 2016.

	Unintegrated		ESG			Env			Soc			Gov	
	S	M1	M2	M3	M1	M2	M3	M1	M2	M3	M1	M2	M3
Quality													
Returns	0.90%	0.74%	0.56%	0.90%	0.56%	0.44%	0.75%	0.70%	0.49%	0.61%	0.75%	0.55%	0.73%
t-statistics	3.29	2.18	1.37	2.84	1.89	0.99	2.34	2.05	1.16	2.03	2.2	1.34	2.24
Volatility	3.20%	3.53%	3.99%	3.62%	3.27%	4.36%	3.63%	3.31%	4.13%	3.40%	3.56%	3.99%	3.62%
Sharpe	0.71	0.44	0.23	0.58	0.26	0.12	0.43	0.43	0.16	0.31	0.44	0.22	0.41
Skewness	0.33	−0.34	−1.40	−0.34	0.20	−1.45	−1.24	−0.09	−1.33	−0.27	−0.37	−1.54	−0.30
Kurtosis	4.51	3.87	8.14	5.74	3.53	7.29	9.35	3.63	7.28	5.16	4.06	9.02	5.06
MaxDD	−0.17	−0.37	−0.41	−0.26	−0.26	−0.42	−0.27	−0.35	−0.43	−0.26	−0.37	−0.41	−0.34
Momentum													
Returns	0.49%	0.22%	0.51%	0.63%	−0.48%	0.34%	0.41%	−0.20%	0.53%	0.47%	0.19%	0.51%	0.51%
t-statistics	1.75	0.84	1.68	2.06	−1.25	1.11	1.25	−0.48	1.70	1.59	0.69	1.69	1.53
Volatility	2.91%	3.42%	3.50%	3.59%	4.06%	3.85%	3.86%	4.04%	3.72%	3.61%	3.47%	3.50%	3.91%
Sharpe	0.40	−0.08	0.24	0.33	−0.65	0.06	0.10	−0.42	0.24	0.18	−0.10	0.24	0.20
Skewness	0.18	−0.60	0.09	−0.31	−1.73	0.12	−0.51	−1.96	0.19	−0.87	−0.72	0.09	−0.90
Kurtosis	2.70	4.91	3.97	4.26	10.60	4.35	5.13	10.99	3.97	6.68	5.23	3.99	5.04
MaxDD	−0.27	−0.27	−0.41	−0.25	−0.57	−0.27	−0.36	−0.54	−0.24	−0.28	−0.28	−0.24	−0.31
Size													
Returns	1.09%	1.11%	1.41%	1.12%	0.43%	1.16%	0.29%	0.78%	1.00%	0.91%	1.09%	1.40%	1.13%
t-statistics	3.49	2.86	3.51	2.79	1.03	2.03	0.80	2.01	2.59	2.47	2.81	3.46	2.94
Volatility	2.89%	3.67%	4.08%	3.81%	4.12%	6.93%	3.79%	3.69%	4.10%	3.80%	3.64%	4.11%	3.64%
Sharpe	1.01	0.78	0.99	0.78	0.11	0.45	−0.01	0.45	0.60	0.56	0.77	0.96	0.82
Skewness	0.32	0.12	0.57	0.06	1.87	1.04	1.05	0.42	0.62	0.16	0.09	0.54	−0.08
Kurtosis	3.72	4.11	4.82	3.96	14.49	4.80	8.86	3.96	5.44	4.22	4.07	4.79	3.95
MaxDD	−0.12	−0.17	−0.17	−0.20	−0.42	−0.47	−0.41	−0.30	−0.19	−0.21	−0.17	−0.17	−0.18

disclose more ESG information. Therefore, it would also be beneficial for other industries to improve their ESG disclosure. Overall, the findings in Fig. 6 reveal that integrating ESG ratings into standard factor portfolios have significant impact on strategies' sector weights.

4.6. Env, Soc and Gov integrated portfolios

It is postulated that a firm should seek to manage risks associated with all ESG dimensions that encompass their aggregate ESG score, rather than the ESG scores in isolation. The underlying ESG dimensions are not necessarily mutually exclusive events. Therefore, we test the robustness of our findings in each aspect of disclosure score ratings separately.

Table 6 demonstrates the performance of quality, momentum and size strategies by separately integrating Env, Soc and Gov scores. For ease of comparison, we reiterate the ESG integrated results reported in Table 2. On a risk-adjusted basis, when the Env and Gov scores are combined with the quality characteristic, M3 continues to deliver higher returns over standard factors, at 1.69% and 1.44%, respectively. However, only the Env score leads to improved performance on a risk-adjusted basis. Nevertheless, Env (Gov) scores integrated M3 for quality reports an annualized Sharpe ratio of 0.89 (0.74), which are higher compared to the aggregate ESG integrated quality. This indicates that for the quality stocks, incorporating environmental and governance performance are more important than the social scores. This finding also implies that social scores may present conflicting information for the future financial performance of quality stocks. This finding is consistent with the empirical evidence in Kaiser (2018). This result also suggests that it is valuable for firms to increase reporting in regard to environmental risk management and environment policies implemented. Thus, for medium Env and Gov rated firms, it is extremely advantageous to improve reporting.

For the momentum strategy, combining the individual scores with momentum characteristics only leads to outperformance over the standard momentum when the Gov scores are integrated. However, individually integrated M3 momentum still underperforms the aggregately integrated momentum, suggesting that the performance enhancement of ESG integration primarily comes from firms' Gov scores rather than Env and Soc scores. Therefore, assessing the aggregate score, not the individual scores in isolation, should be preferred when implementing integrated momentum strategies. On the other hand, integrated size strategies demonstrate consistent underperformance relative to the standard size, suggesting that individual Env, Soc or Gov scores do not improve the performance of ESG integrated size strategy either. However, the Gov integrated size portfolios suggest that smaller cap stocks with better governance perform much better compared to those with higher environment and social scores.

Lastly, for all integration methods, the maximum drawdowns are larger relative to the standard strategy with the only exception in the Gov integrated momentum strategy. Overall, Table 6 reveals that integrating individual Env, Soc or Gov ratings into factors can lead to improved outcomes for unintegrated quality and momentum, and for ESG integrated quality and size strategies. Furthermore, performance enhancement by ESG integration over standard factors are attributable to environment and governance factors.

4.7. Diversification across sectors

Fund managers are often subject to constraints by the investment mandate. In this section, we form factor portfolios in accordance to mandates that require adequate diversification whilst integrating ESG opportunities. We refer to this strategy as the best-of-sector (BOS) strategy.

Table 7 reports the performance of ESG, Env, Soc and Gov integrated factor strategies by employing the BOS type portfolio formation. Since the number of stocks vary largely across industries, we employ tercile sorts instead of quartiles to ensure enough stocks are included in each industry. For the BOS factor portfolios, stocks in each sector are sorted into terciles based on quality, momentum and size. For quality and momentum, we take long (short) positions in stocks within the highest (lowest) tercile in each sector. For size, we take long (short) positions in stocks within the lowest (highest) tercile in each sector. The BOS ensures all industries are represented. First, while still significant, the BOS constrained factors report considerable declines in risk-adjusted performance compared to the unconstrained factors. However, we observe a consistent improvement in the volatility and crash risk profile across factors, suggesting that these better diversified factors could add value over the longer run. Second, as for the ESG integrated BOS factors, we find that ESG integration no longer improves the performance of quality, as the M3 reports a similar return profile compared to the standard BOS quality. Integrating individual scores reveals that all three dimensions are important when integrating ESG scores into quality factors in a BOS framework. We also find that M1 appears to underperform in comparison to standard strategies. Third, we continue to observe improvement when ESG scores are integrated into BOS momentum, although on a risk-adjust basis, the improvement disappears.

Lastly, while integration does not lead to risk-adjusted enhancement of BOS size, the returns are generally higher compared to integrated quality and momentum strategies. Sectors which often represent a small proportion of holdings, such as, consumer staple, information technology, telecommunications and utilities are now forced to be included by the BOS strategy. As a result, the BOS approach reduces the tilt towards larger cap stocks imposed by ESG integration. Thus, a larger amount of smaller stocks are included in each portfolio which in turn delivers relatively higher returns. Overall, findings presented in Table 7 suggest that diversifying across sectors negatively impact the performance of quality, momentum and size strategies. However, in such a constrained framework, ESG integration no longer delivers improved risk-adjusted performance. Furthermore, the impact of environment and governance considerations on quality and momentum, are no longer significant. This suggests that the outperformance of unconstrained ESG integrated factors are at least partly due to sector tilts.

4.8. Transaction costs

Since all strategies and portfolios are rebalanced no more than once in a given month, the impact of transaction costs should not be a

Table 8
Transaction costs. This table demonstrates the performance of the quality, momentum and size strategies after accounting for transaction costs. Q represents portfolio breakpoints. For quality and momentum, the long-short portfolio is defined as Q4-Q1 (Q1-Q4 for size). S represents the standard factors, without ESG integration. M1 and M3 represent methods of ESG integration. For M1, we first screen out non-ESG rated firms from the "All" sample, and then construct the factor portfolio as discussed above using the remaining stocks. For M3, we first screen out non-ESG rated firms from the "All" sample, and then create a new sort signal by assigning a 50/50 weighting to the factor signal and ESG scores. Portfolios are then formed on this combined signal. We follow Grundy and Martin (2001) and employ a transaction cost of 150 bps. Net return is the gross return minus the transaction costs. Break-even turnover represents the maximum portfolio turnover before the net return becomes zero. Break-even transaction costs represent the transaction costs where net return becomes zero.

		S					M1					M3				
		Q1	Q2	Q3	Q4	L-S	Q1	Q2	Q3	Q4	L-S	Q1	Q2	Q3	Q4	L-S
Quality																
Gross Return	Per month	−0.37%	0.58%	0.87%	0.93%	1.31%	−0.39%	0.52%	1.08%	0.89%	1.28%	−0.52%	0.17%	0.60%	1.00%	1.52%
	Annualized	−4.44%	6.96%	10.44%	11.16%	15.72%	−4.68%	6.24%	12.96%	10.68%	15.36%	−6.24%	2.04%	7.20%	12.00%	18.24%
Portfolio Turnover	Per month	7.99%	8.83%	8.10%	6.09%	7.04%	9.37%	11.91%	9.86%	7.05%	8.21%	9.31%	12.02%	10.32%	6.77%	8.04%
	Annualized	0.96x	1.06x	0.97x	0.73x	0.85x	1.12x	1.43x	1.18x	0.85x	0.99x	1.12x	1.44x	1.24x	0.81x	0.96x
Net Return (150bps)	Per month					1.20%					1.16%					1.40%
	Annualized					14.45%					13.88%					16.79%
Break-even Turnover (150bps)	Per month					87.33%					85.33%					101.33%
	Annualized					10.48x					10.24x					12.16x
Break-even Transaction Cost						18.60%					15.59%					14.78%
Momentum																
Gross Return	Per month	0.24%	0.27%	0.95%	0.92%	0.69%	0.52%	0.38%	0.61%	0.96%	0.62%	−0.58%	0.29%	0.67%	0.97%	1.55%
	Annualized	2.88%	3.24%	11.40%	11.04%	8.28%	6.24%	4.56%	7.32%	11.52%	7.44%	−6.96%	3.48%	8.04%	11.64%	18.60%
Portfolio Turnover	Per month	21.96%	40.90%	41.23%	23.55%	22.76%	24.42%	43.97%	42.05%	25.35%	24.88%	20.97%	39.07%	38.96%	21.73%	21.35%
	Annualized	2.64x	4.91x	4.95x	2.83x	2.73x	2.93x	5.28x	5.05x	3.04x	2.99x	2.52x	4.69x	4.67x	2.61x	2.56x
Net Return (150bps)	Per month					0.35%					0.25%					1.23%
	Annualized					4.18%					2.96%					14.76%
Break-even Turnover (150bps)	Per month					46.00%					41.33%					103.33%
	Annualized					5.52x					4.96x					12.40x
Break-even Transaction Cost						3.03%					2.49%					4.46%
Size																
Gross Return	Per month	1.97%	0.41%	0.53%	0.62%	1.35%	1.92%	0.60%	0.54%	0.76%	1.16%	2.05%	0.84%	0.37%	0.85%	1.20%
	Annualized	23.64%	4.92%	6.36%	7.44%	16.20%	23.04%	7.20%	6.48%	9.12%	13.92%	24.60%	10.08%	4.44%	10.20%	14.40%
Portfolio Turnover	Per month	17.49%	12.55%	7.78%	3.54%	10.51%	13.84%	15.10%	10.43%	5.46%	9.65%	10.30%	14.63%	9.95%	4.63%	7.46%
	Annualized	2.10x	1.51x	0.93x	0.42x	1.26x	1.66x	1.81x	1.25x	0.66x	1.16x	1.24x	1.76x	1.19x	0.56x	0.90x
Net Return (150bps)	Per month					1.19%					1.02%					1.09%
	Annualized					14.31%					12.18%					13.06%
Break-even Turnover (150bps)	Per month					90.00%					77.33%					80.00%
	Annualized					10.80x					9.28x					9.60x
Break-even Transaction Cost						12.84%					12.02%					18.36%

major concern given the magnitude of profits reported. Nevertheless, for robustness reasons, we estimate the returns to standard and integrated strategies net of transaction costs.

Table 8 demonstrates the portfolio turnover, net returns, break-even turnover and transaction costs for quality, momentum and size strategies. Following Grundy and Martin (2001), we employ a transaction cost of 1.5% per annum. Portfolio turnover resembles the frequency with which holdings change over a specific period. For quality strategies, the portfolio turnover is typically quite low, given the nature of the quality signal. The standard long-short quality portfolio turns over 7.04% on average per month. After ESG integration, the turnovers increase slightly, 8.21% and 8.04%, respectively. Portfolio turnovers are higher for momentum strategies compared to quality since the momentum signal does vary on a monthly basis. However, the mid portfolios (Q2 and Q3) turn over considerably more compared to the long (Q4) and short (Q1) portfolios. This implies that winner and loser stocks do have a higher tendency to continue, whereas such tendency is weaker for stocks in the middle portfolios. M1 reports the highest turnover percentage, followed by standard and M3. As for size strategies, the highest turnover is reported by the standard size at 10.51% per month, while M3 and M1 exhibit 7.46% and 9.65%, respectively. Overall, M3 delivers higher returns for quality and momentum relative to standard even after accounting for transaction costs. Consequently, long-short strategies examined in this paper can be profitably implemented in a real-world setting.

Break-even turnover reports the maximum portfolio turnover until strategy profits no longer exist. For long-short portfolios, standard quality can survive a turnover of up to 87.33% on average per month, versus 85.33% and 101.33% for M1 and M3, respectively. Size reports similar results to quality, whilst momentum reports break-even turnover of 46%, 41.33% and 103.33% for standard, M1 and M3, respectively. Lastly, break-even transaction cost resembles the transaction cost necessary to negate all strategy profits. Clearly, these costs suggest that the profits are simply too large to be subsumed by the transaction costs. Notably however, it appears that momentum profits are most sensitive to the transaction costs, as it reports the highest turnovers. The reported break-even transaction costs suggest there is ample room for factor strategies to generate real profits, not just significant paper returns.

Overall, the transaction costs analysis confirms findings discussed throughout the paper. Evident in all breakpoint portfolios (Q1-Q4), returns for the long legs of the portfolio under M3 exceeds the standard long portfolios across factors. This implies that high ESG firms who are either high quality, high momentum or small market-cap outperform stocks which are purely high quality, high momentum or small market-cap. Meanwhile, low scoring ESG firms who are low quality and low momentum do not outperform their standard counterparts. This implies that valuable information for low quality or low momentum firms is already captured by ESG scores. To sum up, simply screening out non-rated stocks from factor portfolios does not lead to net returns in excess of standard factors in Australia. However, simultaneously exploiting ESG with fundamentals can deliver statistically significant and economically meaningful profits for investors who are conscious of the Env, Soc and Gov issues.

5. Conclusion

This paper investigated the performance of ESG integrated factor strategies in the Australian equity market. We found that ESG integration through naïve non-rated screening leads to inferior performance compared to unintegrated factors. However, combining ESG scores with quality or momentum in a joint framework, generate persistent economic profits superior to their unintegrated counterparts. Such outperformance is more pronounced during adverse market conditions such as periods of low growth, high inflation and high credit risk. Furthermore, we found that integration of the individual Env, Soc and Gov scores with factors only leads to improved performance when the quality signal is combined with the Env and Gov scores, and when the momentum signal is combined with the Gov scores. Lastly, under a strict mandate of sector diversification, ESG integration no longer delivers significant performance enhancements. Since the outperformance of ESG integrated factors has become stronger in more recent times, our findings suggest that the market has indeed taken ESG into account when pricing stocks.

In the context of Australia, institutional investor demand is the driving factor for the growth of ESG integration. This paper identified the success of an alternative ESG integration method which interacts with various factor strategies, consistent with those reported in other advanced economies. In order for asset managers to maintain a long-term philosophy, sustainable factor investing provides this opportunity to mitigate risk, whilst improving societal welfare. Jointly exploiting ESG scores with factor signals does not significantly detract performance of factor strategies, integration could add value for investors in the long-run. Our findings are of particular relevance to mangers who employ quality, size and momentum style strategies in Australia. However, a major barrier inhibiting ESG integration is the lack of ESG data and the necessary tools to handle the fragmented information. To accelerate ESG integration by institutional investors, we recommend the relevant industry bodies and authorities to gradually move towards a mandatory ESG reporting system. Finally, due to the annual nature of ESG reporting, investment decisions are currently made based on lagged ESG information. As a firm's impact on Environment, Social and Governance criteria can vary significantly over the short-term, a more dynamic approach of ESG reporting can facilitate the acceleration of ESG integration in Australia.

CRediT authorship contribution statement

John Hua Fan: Conceptualization, Methodology, Investigation, Software, Writing - original draft, Writing - review & editing. **Lachlan Michalski:** Conceptualization, Methodology, Investigation, Software, Writing - original draft, Writing - review & editing.

References

Ang, A. (2014). *Asset management: A systematic approach to factor investing*. Oxford University Press.

Asness, C. S. (1997). The interaction of value and momentum strategies. *Financial Analysts Journal, 53*(2), 29–36.
Asness, C. S., Frazzini, A., & Pedersen, L. H. (2012). Leverage aversion and risk parity. *Financial Analysts Journal, 68*(1), 47–59.
Asness, C. S., Frazzini, A., & Pedersen, L. H. (2014). Low-risk investing without industry bets. *Financial Analysts Journal, 70*(4), 24–41.
Asness, C. S., Frazzini, A., & Pedersen, L. H. (2019). Quality minus junk. *Review of Accounting Studies, 24*, 34–112.
Asness, C. S., Moskowitz, T. J., & Pedersen, L. H. (2013). Value and momentum everywhere. *The Journal of Finance, 68*(3), 929–985.
ASX. (2015). *The Australian share ownership study*. Retrieved from https://www.asx.com.au/documents/resources/australian-share-ownership-study-2014.pdf.
ASX. (2019). *Corporate governance principles and recommendations*. Retrieved from https://www.asx.com.au/documents/regulation/cgc-principles-and-recommendations-fourth-edn.pdf.
Banz, R. W. (1981). The relationship between return and market value of common stocks. *Journal of Financial Economics, 9*(1), 3–18.
Bay, J., Liu, Q., Reeves, J. J., Rhee, S. G., & Wu, H. (2017). *The low volatility anomaly in Australian stock returns. Working Paper*. UNSW Business School.
Bender, J., Sun, X., & Wang, T. (2017). *Thematic indexing, meet smart beta! merging ESG into factor portfolios. Working Paper*. State Street Global Advisors.
BlackRock. (2018). *Factor investing: 2018 landscape*. New York, NY: BlackRock.
Bloomberg. (2018). *Sustainable finance*. Retrieved from https://www.bloomberg.com/professional/solution/sustainable-finance/.
Bollen, N. P. B. (2007). Mutual fund attributes and investor behavior. *Journal of Financial and Quantitative Analysis, 42*(3), 683–708.
Boutin-Dufresne, F., & Savaria, P. (2004). Corporate social responsibility and financial risk. *Journal of Investing, 13*(1), 57–66.
Boyd, J. H., Levine, R., & Smith, B. D. (2001). The impact of inflation on financial sector performance. *Journal of Monetary Economics, 47*(2), 221–248.
Brammer, S., Brooks, C., & Pavelin, S. (2006). Corporate social performance and stock returns: UK evidence from disaggregate measures. *Financial Management, 35*(3), 97–116.
Cannavan, D., Finn, F., & Gray, S. (2004). The value of dividend imputation tax credits in Australia. *Journal of Financial Economics, 73*(1), 167–197.
Carhart, M. M. (1997). On persistence in mutual fund performance. *The Journal of Finance, 52*(1), 57–82.
Churet, C., & Eccles, R. G. (2014). Integrated reporting, quality of management, and financial performance. *The Journal of Applied Corporate Finance, 26*(1), 56–64.
Clarke, R., De Silva, H., & Thorley, S. (2006). Minimum-variance portfolios in the US equity market. *Journal of Portfolio Management, 33*(1), 10–24.
Cornell, B., & Shapiro, A. C. (1987). *Corporate stakeholders and corporate finance*. Financial Management.
Cremers, K., & Nair, V. B. (2005). Governance mechanisms and equity prices. *The Journal of Finance, 60*(6), 2859–2894.
Cummings, J. R., & Frino, A. (2008). Tax effects on the pricing of Australian stock index futures. *Australian Journal of Management, 33*(2), 391–406.
De Bondt, W., & Thaler, R. (1987). Further evidence on investor overreaction and stock market seasonality. *The Journal of Finance, 42*(3), 557–581.
Dixon-Fowler, H. R., Slater, D. J., Johnson, J. L., Ellstrand, A. E., & Romi, A. M. (2013). Beyond "does it pay to be green?" A meta-analysis of moderators of the CEP–CFP relationship. *Journal of Business Ethics, 112*(2), 353–366.
Doan, P., Lin, C. T., & Zurbruegg, R. (2010). Pricing assets with higher moments: Evidence from the Australian and US stock markets. *Journal of International Financial Markets, Institutions and Money, 20*(1), 51–67.
Durand, R. B., Limkriangkrai, M., & Smith, G. (2006). Momentum in Australia—a note. *Australian Journal of Management, 31*(2), 355–364.
Fama, E. F., & French, K. R. (1992). The cross–section of expected stock returns. *The Journal of Finance, 47*(2), 427–465.
Fama, E. F., & French, K. R. (1993). Common risk factors in the returns on stocks and bonds. *Journal of Financial Economics, 33*(1), 3–56.
Fama, E. F., & MacBeth, J. D. (1973). Risk, return, and equilibrium: Empirical tests. *Journal of Political Economy, 81*(3), 607–636.
Ferrell, A., Liang, H., & Renneboog, L. (2016). Socially responsible firms. *Journal of Financial Economics, 122*(3), 585–606.
Flammer, C. (2015). Does corporate social responsibility lead to superior financial performance? A regression discontinuity approach. *Management Science, 61*(11), 2549–2568.
Galbreath, J. (2013). ESG in focus: The Australian evidence. *Journal of Business Ethics, 118*(3), 529–541.
Gallagher, D. R., Gardner, P. A., Schmidt, C. H., & Walter, T. S. (2014). Quality investing in an Australian context. *Australian Journal of Management, 39*(4), 615–643.
Gaunt, C. (2004). Size and book to market effects and the Fama French three factor asset pricing model: Evidence from the Australian stockmarket. *Accounting and Finance, 44*(1), 27–44.
Geczy, C., & Samonov, M. (2013). *212 years of price momentum (the world's longest backtest: 1801–2012)*. University of Pennsylvania. Working paper.
Gharghori, P., Chan, H., & Faff, R. (2007). Are the Fama-French factors proxying default risk? *Australian Journal of Management, 32*(2), 223–249.
Gharghori, P., Hamzah, Y., & Veeraraghavan, M. (2010). Migration and its contribution to the size and value premiums: Australian evidence. *Journal of International Financial Markets, Institutions and Money, 20*(2), 177–196.
Gharghori, P., Lee, R., & Veeraraghavan, M. (2009). Anomalies and stock returns: Australian evidence. *Accounting and Finance, 49*(3), 555–576.
Goyal, A., & Jegadeesh, N. (2018). Cross-sectional and time-series tests of return predictability: What is the difference? *Review of Financial Studies, 31*(5), 1784–1824.
Grundy, B. D., & Martin, J. S. M. (2001). Understanding the nature of the risks and the source of the rewards to momentum investing. *Review of Financial Studies, 14*(1), 29–78.
GSIA. (2016). *Global sustainable investment review*. Retrieved from http://www.gsi-alliance.org/wp-content/uploads/2017/03/GSIR_Review2016.F.pdf.
Gutsche, G., & Ziegler, A. (2019). Which private investors are willing to pay for sustainable investments? Empirical evidence from stated choice experiments. *Journal of Banking & Finance, 102*, 1155–1182.
Halliwell, J., Heaney, J., & Sawicki, J. (1999). Size and book to market effects in Australian share markets: A time-series analysis. *Accounting Research Journal, 12*(2), 122–137.
Hawawini, G., & Keim, D. B. (2000). *The cross section of common stock returns: A review of the evidence and some new findings. Working paper*. University of Pennsylvania.
Henker, J., & Henker, T. (2010). Are retail investors the culprits? Evidence from Australian individual stock price bubbles. *The European Journal of Finance, 16*(4), 281–304.
Hong, H., Lim, T., & Stein, J. C. (2000). Bad news travels slowly: Size, analyst coverage, and the profitability of momentum strategies. *The Journal of Finance, 55*(1), 265–295.
Humphrey, J. E., Lee, D. D., & Shen, Y. (2012a). Does it cost to be sustainable. *Journal of Corporate Finance, 18*(3), 626–639.
Humphrey, J. E., Lee, D. D., & Shen, Y. (2012b). The independent effects of environmental, social and governance initiatives on the performance of UK firms. *Australian Journal of Management, 37*(2), 135–151.
Huynh, W., Mallik, G., & Hettihewa, S. (2006). The impact of macroeconomic variables, demographic structure and compulsory superannuation on share prices: The case of Australia. *Journal of International Business Studies, 37*(5), 687–698.
Invesco. (2017). *Invesco global factor investing study 2017*. Atlanta, GA: Invesco.
Jagannathan, R., & Ma, T. (2003). Risk reduction in large portfolios: Why imposing the wrong constraints helps. *The Journal of Finance, 58*(4), 1651–1683.
Jegadeesh, N., & Titman, S. (1993). Returns to buying winners and selling losers: Implications for stock market efficiency. *The Journal of Finance, 48*(1), 65–91.
Kaiser, L. (2018). *ESG integration: Value, growth and momentum*. Working Paper. University of Liechtenstein.
Kassimatis, K. (2008). Size, book to market and momentum effects in the Australian stock market. *Australian Journal of Management, 33*(1), 145–168.
Keim, D. B. (1983). Size-related anomalies and stock return seasonality: Further empirical evidence. *Journal of Financial Economics, 12*(1), 13–32.
Lamoureux, C. G., & Sanger, G. C. (1989). Firm size and turn–of–the–year effects in the OTC/NASDAQ market. *The Journal of Finance, 44*(5), 1219–1245.
Lee, D. D., & Faff, R. W. (2009). Corporate sustainability performance and idiosyncratic risk: A global perspective. *Financial Review, 44*(2), 213–237.
Lee, D. D., Fan, J. H., & Wong, V. (2020). *No more excuses! Performance of ESG-integrated portfolios in Australia. Accounting and Finance, Forthcoming*.
Liang, H., & Renneboog, L. (2017). On the foundations of corporate social responsibility. *The Journal of Finance, 72*(2), 853–910.
Lim, M., & Coggins, R. (2005). The immediate price impact of trades on the Australian Stock Exchange. *Quantitative Finance, 5*(4), 365–377.
Limkriangkrai, M., Koh, S., & Durand, R. B. (2017). Environmental, social, and governance (ESG) profiles, stock returns, and financial policy: Australian evidence. *International Review of Finance, 17*(3), 461–471.
Lins, K. V., Servaes, H., & Tamayo, A. (2017). Social capital, trust, and firm performance: The value of corporate social responsibility during the financial crisis. *The Journal of Finance, 72*(4), 1785–1824.

Malkiel, B. G. (2014). Is smart beta really smart? *Journal of Portfolio Management, 40*(5), 127–134.
Melas, D., Nagy, Z., & Kulkarni, P. (2018). *Factor investing and ESG integration. Factor Investing*. New York: Elsevier.
Nofsinger, J., & Varma, A. (2014). Socially responsible funds and market crises. *Journal of Banking & Finance, 48*(1), 180–193.
Novy-Marx, R. (2013). The other side of value: The gross profitability premium. *Journal of Financial Economics, 108*(1), 1–28.
Reinganum, M. R. (1981). Misspecification of capital asset pricing: Empirical anomalies based on earnings' yields and market values. *Journal of Financial Economics, 9*(1), 19–46.
Renneboog, L., Ter Horst, J., & Zhang, C. (2008). Socially responsible investments: Institutional aspects, performance, and investor behavior. *Journal of Banking & Finance, 32*(9), 1723–1742.
Revelli, C., & Viviani, J. L. (2015). Financial performance of socially responsible investing (SRI): What have we learned? *A meta-analysis. Business Ethics: European Review, 24*(2), 158–185.
RIAA. (2018). *Responsible investment benchmark report*. Retrieved from https://responsibleinvestment.org/wp-content/uploads/2018/08/RIAA_RI_Renchmark_Report_AUS_2018v6.pdf.
Schneider, P., & Gaunt, C. (2012). Price and earnings momentum in Australian stock returns. *Accounting and Finance, 52*(2), 495–517.
Sloan, A. (1996). Do stock prices fully reflect information in accruals and cash flows about future earnings? *The Accounting Review, 71*(3), 289–315.
Statman, M., & Glushkov, D. (2009). The wages of social responsibility. *Financial Analysts Journal, 65*(4), 33–46.
Stellner, C., Klein, C., & Zwergel, B. (2015). Corporate social responsibility and Eurozone corporate bonds: The moderating role of country sustainability. *Journal of Banking & Finance, 59*, 538–549.
Willis Towers Watson. (2017). *The world's 500 largest asset managers*. London: Willis Towers Watson.
Zhong, A., Limkriangkrai, M., & Gray, P. (2014). Anomalies, risk adjustment and seasonality: Australian evidence. *International Review of Financial Analysis, 35*, 207–218.