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The countdown to carbon neutrality: Implications for passive investors

Nicola Carta [a,b,*], Matteo Carta [c], Ugo Rigoni [b]

[a] *Department of Economics and Business Studies, Università del Piemonte Orientale, Via E. Perrone 18, 28100 Novara, Italy*
[b] *Venice School of Management - Department of Management, Università Ca' Foscari, Fondamenta San Giobbe, Cannaregio 873, 30121 Venezia, Italy*
[c] *Fondazione di Venezia, Cannaregio 252, 30121 Venezia, Italy*

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ABSTRACT

In 2019 the European Union (EU) Climate Benchmarks Regulation established a set of standardized emission reduction criteria for financial benchmarks. This study examines the risk-adjusted performance of equity exchange-traded funds (ETFs) tracking EU Climate Transition Benchmarks (CTBs) and EU Paris-Aligned Benchmarks (PABs). Our findings reveal that, after the implementation of the regulation, equity CTB ETFs have exhibited no significant risk-adjusted performance difference compared to their non-sustainable twin ETFs. Conversely, equity PAB ETFs, which adhere to more stringent environmental standards, have underperformed their non-sustainable counterparts. Our results suggest that stringent emission reduction objectives have a negative effect on investors' returns.

1. Introduction

The relationship between ESG (environmental, social, and governance) investing and investment returns remains a topic of ongoing debate among finance scholars (López Prol and Kim, 2022; Starks, 2023; Whelan et al., 2021). The genesis of the discussion arises from investors' expectations underlying their investment approaches that may differ depending on whether they are consistent with a "values" or "value" approach (Starks, 2023). "Values" investors focus on ensuring that their investments reflect their moral and social principles, often adopting negative screening to exclude companies or industries that do not meet their ethical standards. As a result, due to the constraints imposed by their sustainability considerations and the smaller investment opportunity set, their ESG portfolios should not be expected to outperform conventional portfolios (Geczy et al., 2021). Conversely, "value" investors integrate ESG factors into their investment process to enhance risk management and uncover superior investment opportunities. According to this view, investment portfolios should benefit from sustainability considerations, potentially leading to lower risk or higher return (Albuquerque et al., 2019; Hoepner et al., 2024). These two contrasting perspectives may explain, from a theoretical point of view, the absence of univocal findings in studies assessing ESG portfolio performance. Alongside this philosophical concern, important practical limitations contribute to the inconsistent results observed in the literature. Empirical research often compares returns across samples comprising an amalgamation of funds with different types of objectives and investment approaches, consequently leading to evident performance biases (Starks, 2023). In addition, the integrity of existing studies is jeopardized by discrepancies in ESG ratings across different rating agencies (Berg et al., 2022) and ESG rating manipulation by providers over time (Berg et al., 2021).

When considering environmental sustainability, it is unequivocal that the primary concern lies in climate change, which is predominantly driven by greenhouse gas (GHG) emissions resulting from human activities. In this sense, the Paris Agreement[1] stands as the most important global initiative to mitigate climate change. Building upon this milestone treaty, the European Union (EU) recently introduced the Climate Benchmarks Regulation, which established a set of standardized

* Corresponding author.
E-mail address: nicola.carta@unive.it (N. Carta).

[1] The Paris Agreement is a legally binding international treaty on climate change. It was negotiated by 196 Parties at the 2015 UN Climate Change Conference (COP21) in Paris, France and it entered into force on November 4th, 2016. Its overarching goal is to hold "the increase in the global average temperature to well below 2°C above pre-industrial levels" and pursue efforts "to limit the temperature increase to 1.5°C above pre-industrial levels" (UNFCCC, 2024).

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Table 1
Summary of minimum standard requirements of EU CTBs and EU PABs.

Minimum standards	EU CTB	EU PAB
Risk-oriented minimum standards		
Minimum Scope 1 + 2(+3)[a] *carbon intensity reduction compared to the investable universe*	30%	50%
Scope 3 phase-in	Up to 4 years	Up to 4 years
Baseline Exclusions	Yes Controversial Weapons Societal norms violators[b]	Yes Controversial Weapons Societal norms violators
Activity Exclusions	No	Coal (≥1% of revenues) Oil (≥10% of revenues) Natural Gas (≥50% of revenues) Electricity producers with carbon intensity of lifecycle GHG emissions higher than 100 gCO2e/kWh (≥50% of revenues)
Opportunity-oriented minimum standards		
Year-on-year self-decarbonization of the benchmark	At least 7% on average per annum: in line with or beyond the decarbonization trajectory from the IPCC's 1.5 °C scenario (with no or limited overshoot)	
Minimum green share / brown share ratio compared to investable universe (VOLUNTARY)	At least equivalent	Significantly larger (factor 4)
Exposure constraints	Minimum exposure to sectors highly exposed to climate change issues is at least equal to equity market benchmark value	
Corporate Target Setting	Weight increase shall be considered for companies which set evidence-based targets under strict conditions to avoid greenwashing	
Disqualification from label if 2 consecutive years of misalignments with trajectory	Immediate	Immediate
Relevance-oriented minimum standards		
Review Frequency	Minimum requirements shall be reviewed every three years to recognize market development as well as technological and methodological progress.	

Source: TEG (2019).
[a] Carbon emissions from a company's operations and economic activity are typically grouped into three different categories: direct emissions from production (scope 1), indirect emissions associated with the generation of purchased electricity, heat, or steam (scope 2), other indirect emissions from the production of purchased materials, product use, waste disposal, outsourced activities, etc. (scope 3).
[b] Societal norms include UNGC Principles, OECD Guidelines for Multinational Enterprises and the 6 Environmental Objectives: 1) climate change mitigation; 2) climate change adaptation; 3) sustainable use and protection of water and marine resources; 4) transition to a circular economy, waste prevention and recycling; 5) pollution prevention and control; 6) protection of healthy ecosystems.

emission reduction criteria for financial benchmarks. In the words of the technical expert group on sustainable finance (TEG),[2] these criteria are designed to embody a "value" logic, i.e., exploiting return opportunities from the transition to a net-zero world. More specifically, the EU Regulation 2019/2089 and its delegated acts introduced two new categories of low-carbon benchmarks: the EU Climate Transition Benchmarks (CTBs) and the EU Paris-Aligned Benchmarks (PABs). These designations respectively require adhering benchmark providers to build indices that follow a decarbonization trajectory consistent with the minimum standards in the delegated acts or align with the carbon emission goals outlined in the Paris Climate Agreement.

Within this framework, we study equity exchange-traded funds (ETFs) that track benchmarks labeled as CTB or PAB.[3] Our primary objective is to assess their risk-adjusted financial performance in comparison to their respective non-sustainable counterparts. Since ETFs are characterized by a passive investment strategy that replicates their benchmarks, we can disentangle the relationship between emission reduction objectives and financial returns, avoiding performance deviations arising from active fund management styles.

We implemented a rigorous one-to-one matching procedure to ensure the utmost alignment between sustainable and non-sustainable equity ETFs. The results show that after the implementation of the EU Climate Benchmarks regulation, equity CTB ETFs have exhibited no significant risk-adjusted performance difference compared to their non-sustainable twin ETFs. Conversely, equity PAB ETFs, which adhere to more stringent environmental standards, have underperformed their non-sustainable counterparts. Specifically, the annualized risk-adjusted performance of equity PAB ETFs has been about 1.1% lower from 2021 to the end of 2023.

In the last few years, investors' interest in the ETF market has proliferated (Blackrock, 2024; Morningstar, 2024; Pwc, 2024). Our study is the first to provide evidence on the consequences of the EU Climate Benchmarks Regulation for passive investors allocating capital towards climate-friendly ETFs. The IPCC (2023)[4] documents relevant adaptation and mitigation gaps towards global warming, with an increasingly concrete risk of intensifying multiple and concurrent hazards. In such a context, it is imperative to understand from the outset the financial consequences for investors interested in a timely transition to carbon neutrality. Our findings reveal that while the construction of EU Climate Benchmarks is driven by "value" intentions, rigorous investment criteria for containing global warming seem to resonate more closely with a "values" rationale, in which investors may be asked to accept lower returns to pursue higher-level objectives. Our study also makes an important contribution to the ongoing debate on the

[2] "While benchmarks incorporating constraints or objectives related to GHG emissions have primarily been built around a (tail) risk reduction objectives, [EU Climate Benchmarks] have broader ambitions. Investors using these new types of benchmarks not only intend to hedge against climate transition risks (Risk objective) but also have the ambition to direct their investments towards opportunities related to the energy transition (Opportunity objective)" (TEG, 2019).

[3] The paper focuses on CTB and PAB ETFs rather than the indices themselves because investors cannot invest directly in market indices.

[4] The Intergovernmental Panel on Climate Change (IPCC) is a body of the United Nations that regularly provides scientific reports and assessment on climate change, encompassing future projections and risk, as well as strategies for both mitigation and adaptation.

relationship between ESG investing and financial performance. By leveraging the standardized sustainability requirements defined for EU Climate Benchmarks and the inherent replicating nature of their relative ETFs, we isolated the "pure" effect of incorporating sustainability objectives on financial performance. Finally, this study contributes to the limited literature on the intersection between ETFs and sustainability (Omura et al., 2021; Pavlova and de Boyrie, 2022).

2. Hypotheses development

In its quest for sustainable growth, the EU Climate Benchmarks Regulation mandates adhering benchmarks to comply with minimum standards to qualify as CTB or PAB (refer to Table 1). Notably, CTBs and PABs are required to maintain a total GHG intensity below specific thresholds relative to the investable universe. Their GHG intensity will also have to decrease at least 7% on average per annum to align with the decarbonization trajectory depicted by the IPCC. Moreover, they must exclude from their portfolio companies involved in any activities related to controversial weapons or tobacco, as well as those that violate societal norms.

The literature on the impact of ESG on financial performance is extensive but yields mixed results (Dervi et al., 2022; Starks, 2023; Whelan et al., 2021). Starks (2023) suggests that these mixed results may stem not only from variations in study methodologies and time frames but also from differences in investment criteria, particularly whether the investment strategy prioritizes the risk-return profile (i.e., a value-oriented approach) or the sustainability impact (i.e., a values-oriented approach).

Although the construction criteria underlying EU Climate Benchmarks claim to embody a "value" logic, emphasizing a positive effect on financial return, we believe there are compelling grounds to suggest that the risk-adjusted return of equity ETFs mirroring climate benchmarks may be lower than that of equivalent non-sustainable ETFs.

Pedersen et al. (2021) present a theoretical framework that sheds light on the costs and benefits of sustainability investing. They demonstrate that sustainability investing does not necessarily lead to an inferior risk-return profile; however, this outcome is contingent upon the ability to short stocks with lower ESG performance. Conversely, when only long positions are permitted, returns are significantly impacted. This finding explains the growing popularity of integration strategies over negative screening approaches in ESG investing. Since CTBs and PABs are constructed using a negative screening approach and restrict investment to long-only positions, these constraints could lead to sub-optimal portfolios and potential underperformance.

Further supporting this perspective, previous literature has found that investors avoiding companies with high carbon emissions suffer a performance loss from their portfolio, as firms with elevated carbon footprints tend to generate higher returns (Bolton and Kacperczyk, 2021; Hsu et al., 2023; Rohleder et al., 2022). Investors, aware of the environmental risks associated with carbon emissions, may demand higher returns from such firms to offset their exposure to potential regulatory, reputational, and operational risks.

Furthermore, numerous studies have documented that shares in companies involved in the production of alcohol, tobacco, and gaming, referred to as "sin stocks", achieve positive risk premiums after taking usual risk factors into account (Durand et al., 2013; Fabozzi et al., 2008; Han et al., 2022; Hong and Kacperczyk, 2009; Statman and Glushkov, 2009). This effect is attributed to investors' aversion to such companies, which depress their prices relative to their fundamental values, therefore leading to higher expected returns compared to other stocks.

Drawing from these insights, we argue that the constraints imposed on EU Climate Benchmarks negatively affect the performance of their relative ETFs. Hence, we propose:

H1a. *Equity ETFs tracking CTBs underperform their non-sustainable counterparts.*

H1b. *Equity ETFs tracking PABs underperform their non-sustainable counterparts.*

Although both categories of climate benchmarks share the objective of mitigating GHG emissions and transitioning towards a low-carbon economy, their ambitions are different. CTBs aim to protect investors' assets against risks related to climate change, whereas PABs are designed for investors who want to be at the forefront of the immediate transition towards a + 1.5 °C scenario (TEG, 2019). To achieve their purpose, PABs have stricter requirements than CTBs in terms of carbon intensity reduction and activity exclusion. Thus, we posit:

H2. *The underperformance of equity ETFs tracking PABs is higher than that of equity ETFs tracking CTBs.*

3. Data and methodology

Our first step involved defining a comprehensive list of all sustainable equity ETFs labeled as CTB or PAB by consulting the official websites of prominent ETF providers.[5] Our exploration identified 28 CTB-labelled ETFs and 96 PAB-labelled ETFs. Most of these ETFs were created in response to the enactment of the EU Climate Benchmarks regulation, starting from January 2021.

Secondly, we performed a meticulous one-to-one manual matching to pair each CTB or PAB ETF with a non-sustainable ETF (from now on referred to as "conventional ETFs"), ensuring a perfect correspondence in terms of underlying benchmark, use of proceeds, type of replication, asset weighting constraints, currency hedging, and exchange.[6] This rigorous matching process accounts for all potential ETF characteristics that could influence returns, enabling us to isolate the impact of climate-related criteria on risk-adjusted financial performance. To avoid repetitions, each conventional ETF has only been picked once. If any of the EU CTB or EU PAB ETFs could not be perfectly paired with a corresponding conventional ETF, they were omitted from the analysis. In the end, we successfully matched 23 CTB ETFs and 55 PAB ETFs with their respective counterparts.[7] Table 2 reports the composition of the two datasets.

Next, on each dataset described in Table 2, we conducted a panel regression analysis using the main asset pricing models developed by scholars over the last 30 years. In particular: Eq. (1) is based on the CAPM; Eq. (2) is based on the Fama and French (1993) 3-factor model; Eq. (3) is based on the Carhart (1997) 4-factor model; Eq. (4) is based on the Fama and French (2015) 5-factor model; Eq. (5) is based on the Fama and French (2018) 6-factor model.

$$R_{it} - Rf_{it} = \alpha + \beta_1 EU\ label_i + \beta_2 (Rm_{it} - Rf_{it}) + \beta_3\ Time\ FE_t + \varepsilon_{it} \tag{1}$$

$$R_{it} - Rf_{it} = \alpha + \beta_1 EU\ label_i + \beta_2 (Rm_{it} - Rf_{it}) + \beta_3 SMB_{it} + \beta_4 HML_{it} + \beta_5\ Time\ FE_t + \varepsilon_{it} \tag{2}$$

$$R_{it} - Rf_{it} = \alpha + \beta_1 EU\ label_i + \beta_2 (Rm_{it} - Rf_{it}) + \beta_3 SMB_{it} + \beta_4 HML_{it} + \beta_5 Momentum_{it} + \beta_6 Time\ FE_t + \varepsilon_{it} \tag{3}$$

$$R_{it} - Rf_{it} = \alpha + \beta_1 EU\ label_i + \beta_2 (Rm_{it} - Rf_{it}) + \beta_3 SMB_{it} + \beta_4 HML_{it} + \beta_5 RMW_{it} + \beta_6 CMA_{it} + \beta_7 Time\ FE_t + \varepsilon_{it} \tag{4}$$

[5] These include Amundi, BNP Paribas, Franklin Templeton, HSBC, Invesco, iShares, J.P. Morgan, Lyxor, Ossiam, State Street Global Advisors, UBS and Xtrackers.

[6] We initiated the matching process prioritizing the exchange with the highest number of traded CTB and PAB ETFs. If a corresponding ETF was not found on this exchange for a given CTB or PAB ETF, we proceeded to conduct the matching process on the second-best exchange based on the number of traded CTB and PAB ETFs, and so forth until a match was found.

[7] The list of paired ETFs with their identifiers and characteristics can be found in the Appendix (Table A1 for the CTB dataset and Table A2 for the PAB dataset).

Table 2
Composition of datasets.

	CTB dataset		PAB dataset	
	No. of CTB ETFs	No. of matched conventional ETFs	No. of PAB ETFs	No. of matched conventional ETFs
OVERALL	**23**	**23**	**55**	**55**
ETF provider				
Amundi	10	3	16	10
Credit Suisse	–	–	–	1
Franklin Templeton	–	–	3	–
HSBC	–	–	6	4
Invesco	–	–	5	–
iShares	–	7	8	14
JP Morgan	2	–	2	–
Lyxor	5	2	1	4
State Street Global Advisors	–	2	3	5
UBS	1	4	6	7
Vanguard	–	–	–	2
Xtrackers	5	5	5	8
Use of proceeds				
Accumulating	17	17	47	47
Distributing	6	6	8	8
Currency hedging				
Hedged	2	2	6	6
Unhedged	21	21	49	49
Type of replication				
Physical	23	23	55	55
Synthetic	–	–	–	–
Geographical exposure				
Developed markets	5	5	10	10
Emerging markets	1	1	7	7
North America	1	1	–	–
USA	3	3	12	12
Europe	8	8	16	16
Asia Pacific ex. Japan	–	–	2	2
Japan	5	5	8	8

Note: This table presents the composition of CTB and PAB datasets by ETF providers, use of proceed, currency hedging, type of replication, and geographical exposure. The CTB dataset contains CTB ETFs and their matched conventional counterparts, while the PAB dataset encompasses PAB ETFs and their matched conventional counterparts.

$$R_{it} - Rf_{it} = \alpha + \beta_1 EU\ label_i + \beta_2 (Rm_{it} - Rf_{it}) + \beta_3 SMB_{it} + \beta_4 HML_{it} + \beta_5 Momentum_{it} + \beta_6 RMW_{it} + \beta_7 CMA_{it} + \beta_8 Time\ FE_t + \varepsilon_{it} \quad (5)$$

The dependent variable, R_{it}-Rf_{it}, is the monthly log excess return computed from Bloomberg prices; i is an index for ETFs; t refers to different time periods (months); $EU\ label_i$ is a dummy variable that equals 1 if the ETF is aligned to the climate benchmark regulation; Rm_{it}-Rf_{it}, SMB_{it}, HML_{it}, $Momentum_{it}$, RMW_{it}, and CMA_{it} are respectively the market, size, value, momentum, profitability and investment factors related to the particular geographical exposure of each ETF[8]; $Time\ FE_t$ stands for time fixed effect; ε_{it} is the error term. The time period under examination spans from January 2021 (the month immediately following the implementing acts of the EU Regulation 2019/2089 regulation) to December 2023.[9]

All variables have been checked for stationarity using the Fisher-type unit-root test (Fisher, 1932). The Durbin-Wu-Hausman (Durbin, 1954; Hausman, 1978; Wu, 1973) and the Breusch and Pagan Lagrangian

[8] All factors have been collected from Prof. Kenneth R. French online data library: https://mba.tuck.dartmouth.edu/pages/faculty/ken.french/data_library.html

[9] Only a small fraction of CTB and PAB ETFs existed as sustainable ETFs before the implementation of the EU regulatory framework. This insufficient sample size prevents the investigation of the effect of the EU Climate Benchmarks Regulation on the performance of pre-existing sustainable ETFs.

Table 3
Descriptive statistics and correlations.

Panel A: CTB dataset	N	Mean	Median	SD	Min	Max	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
(1) CTB label	1466	0.4352	0.0000	0.4960	0.000	1.0000	1.0000							
(2) R_i-Rf	1466	0.0040	0.0070	0.0401	−0.0991	0.1248	−0.0160	1.0000						
(3) Rm-Rf	1466	0.0029	0.0086	0.0489	−0.1076	0.1264	−0.0020	0.8720*	1.0000					
(4) SMB	1466	−0.0037	−0.0045	0.0185	−0.0694	0.0732	−0.0150	0.0170	0.0500	1.0000				
(5) HML	1466	0.0113	0.0111	0.0389	−0.0885	0.1458	−0.0110	−0.3220*	−0.2600*	0.1210*	1.0000			
(6) Mom	1466	0.0007	0.0060	0.0297	−0.1601	0.0703	0.0170	−0.3710*	−0.3910*	−0.1090*	−0.0570	1.0000		
(7) RMW	1466	0.0021	0.0020	0.0214	−0.0669	0.072	0.0100	0.2060*	0.1920*	−0.3270*	−0.5140*	0.0150	1.0000	
(8) CMA	1466	0.0056	0.0077	0.0256	−0.0722	0.0968	−0.0090	−0.4670*	−0.410*	−0.0220	0.7990*	0.1500*	−0.3020*	1.0000
Panel B: PAB dataset	N	Mean	Median	SD	Min	Max	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
(1) PAB label	2966	0.4370	0.0000	0.4961	0.0000	1.0000	1.0000							
(2) R_i-Rf	2966	0.0028	0.0043	0.0416	−0.1188	0.1387	−0.0330	1.0000						
(3) Rm-Rf	2966	0.0030	0.0052	0.0500	−0.1076	0.1418	−0.0040	0.8620*	1.0000					
(4) SMB	2966	−0.0030	−0.0034	0.0204	−0.0698	0.0732	−0.0240	0.0280	0.0260	1.0000				
(5) HML	2966	0.0107	0.0111	0.0379	−0.0885	0.1458	−0.0160	−0.3380*	−0.2570*	0.1650*	1.0000			
(6) Mom	2966	0.0009	0.0060	0.0315	−0.1601	0.0703	0.0040	−0.3800*	−0.4140*	−0.1130*	0.0360	1.0000		
(7) RMW	2966	0.0025	0.0019	0.0218	−0.0669	0.0720	−0.0030	0.1490*	0.1390*	−0.3590*	−0.3820*	0.0030	1.0000	
(8) CMA	2966	0.0051	0.0071	0.0257	−0.0722	0.0809	−0.0050	−0.4680*	−0.3940*	0.0020	0.7830*	0.2250*	−0.1910*	1.0000

Note: This table presents descriptive statistics and correlations for all variables for the CTB dataset (Panel A) and the PAB dataset (Panel B). Significance level: *$p < 0.01$.

Table 4
Monthly excess returns and risk factors.

Panel A: CTB dataset	(1)	(2)	(3)	(4)	(5)
	R_i-Rf	R_i-Rf	R_i-Rf	R_i-Rf	R_i-Rf
CTB label	−0.000729	−0.000737	−0.000727	−0.000687	−0.000681
	(0.000584)	(0.000571)	(0.000564)	(0.000604)	(0.000601)
Rm-Rf	0.928***	0.910***	0.908***	0.895***	0.894***
	(0.0369)	(0.0319)	(0.0317)	(0.0326)	(0.0327)
SMB		−0.102***	−0.105***	−0.140***	−0.141***
		(0.0242)	(0.0249)	(0.0255)	(0.0265)
HML		−0.0590***	−0.0548**	−0.0739***	−0.0731***
		(0.0208)	(0.0238)	(0.0256)	(0.0267)
Momentum			−0.0206		−0.0130
			(0.0315)		(0.0294)
RMW				−0.113***	−0.112***
				(0.0242)	(0.0239)
CMA				−0.0253	−0.0220
				(0.0334)	(0.0304)
Constant	0.00553***	0.00825***	0.00862***	0.00770***	0.00790***
	(0.00195)	(0.00206)	(0.00207)	(0.00215)	(0.00214)
Time FE	yes	yes	yes	yes	yes
Observations	1466	1466	1466	1466	1466
No. of ETFs	46	46	46	46	46
R-squared	0.905	0.907	0.907	0.909	0.909

Panel B: PAB dataset	(1)	(2)	(3)	(4)	(5)
	R_i-Rf	R_i-Rf	R_i-Rf	R_i-Rf	R_i-Rf
PAB label	−0.000942*	−0.000968*	−0.000965**	−0.000950*	−0.000950*
	(0.000518)	(0.000497)	(0.000487)	(0.000498)	(0.000489)
Rm-Rf	0.929***	0.900***	0.892***	0.893***	0.887***
	(0.0247)	(0.0200)	(0.0210)	(0.0207)	(0.0217)
SMB		−0.110***	−0.121***	−0.129***	−0.137***
		(0.0187)	(0.0200)	(0.0222)	(0.0230)
HML		−0.0895***	−0.0795***	−0.0994***	−0.0940***
		(0.0170)	(0.0181)	(0.0184)	(0.0190)
Momentum			−0.0404**		−0.0366**
			(0.0163)		(0.0154)
RMW				−0.0599***	−0.0569***
				(0.0191)	(0.0187)
CMA				−0.00394	0.00336
				(0.0297)	(0.0296)
Constant	0.00891***	0.0125***	0.0136***	0.0120***	0.0130***
	(0.00165)	(0.00173)	(0.00175)	(0.00186)	(0.00189)
Time FE	yes	yes	yes	yes	yes
Observations	2966	2966	2966	2966	2966
No. of ETFs	110	110	110	110	110
R-squared	0.906	0.910	0.911	0.911	0.911

Note: This table presents the monthly risk-adjusted returns of ETFs in the CTB dataset (Panel A) and the PAB dataset (Panel B). Columns 1, 2, 3, 4, and 5 show the results under Eqs. (1)–(5) respectively. The sample period runs from January 2021 to December 2023. Significance levels: *10%, **5%, ***1%. Robust standard errors are clustered at the ETF level.

multiplier (Breusch and Pagan, 1980, 1979) tests suggested the use of a pooled OLS model. Robust standard errors, clustered around ETF, have been used in all models to control for heteroskedasticity and serial correlation. Table 3 reports the summary statistics and correlations for all variables for the CTB dataset (Panel A) and the PAB dataset (Panel B).

4. Empirical results

Table 4 presents the regression of ETF monthly excess returns on risk factors in the CTB and PAB datasets. Columns 1, 2, 3, 4, and 5 show the results under Eqs. (1)–(5), respectively.

Focusing on Panel A of Table 4, the variable *CTB label* exhibits a consistent negative coefficient but is not statistically significant in any of the models presented. The result indicates that CTB ETFs have shown no significant risk-adjusted performance difference compared to their non-sustainable matched ETFs from January 2021 to December 2023. Hypothesis 1a, predicting an underperformance of CTB ETFs, is therefore not supported.

Shifting attention to Panel B of Table 4, the variable *PAB label* has a negative and significant effect in all models presented, indicating PAB ETFs have underperformed their non-sustainable counterparts from January 2021 to December 2023. Hypothesis 1b, which postulates the underperformance of PAB ETFs, is thus supported. Hypothesis 2, which posits a stronger underperformance for ETFs tracking PABs than for ETFs tracking CTBs, is also supported. Due to stricter emission reduction objectives and activity exclusions, the PAB label entails a meaningful negative effect on financial performance. Remarkably, the annualized risk-adjusted performance of PAB ETFs has been significantly lower, about 1.1%[10] from 2021 to the end of 2023.

As for control variables, the signs of the risk factors across both panels are consistent with the nature of the benchmarks followed by the ETFs in our dataset.[11]

5. Conclusions

The establishment of CTBs and PABs by the EU Climate Benchmarks Regulation has offered investors a harmonized and reliable tool to pursue low-carbon investment strategies. This study assesses the financial performance of equity ETFs tracking CTBs and PABs compared to their non-sustainable counterparts. We find that equity PAB ETFs have underperformed their non-sustainable counterparts due to the stringent decarbonization objectives of their benchmarks. Despite the “value” intentions underlying the construction of EU Climate Benchmarks, PABs’ rigorous criteria for containing global warming seem to align more closely with a "values" rationale. In this respect, investors may be asked to accept lower returns to pursue higher-level objectives.

This study makes an important contribution to the ongoing discussion on the relationship between ESG investing and financial performance by overcoming some of the limitations that fuel the current literature debate.

Our research lays the foundation for future investigations. As scholars advance in defining and quantifying climate transition risk, future research endeavors could assess whether the underperformance of PAB ETFs persists even after accounting for this risk factor. Additionally, extending the analysis over a longer time horizon that captures various macroeconomic scenarios could enrich our findings. The EU Regulation 2019/2089 has fostered the creation of a broader range of ETFs that track benchmarks labeled as CTB or PAB, making it easier for retail investors to follow well-defined and transparent sustainable investment strategies. Given the growing number of sustainable ETFs, future research might also compare the performance and characteristics of PAB and CTB ETFs with other categories of sustainable ETFs (e.g., MSCI ESG and climate indices), following Bolognesi et al. (2024) research on sustainable indices. Finally, there is also scope for research to assess whether analogous outcomes to those uncovered in the realm of equity ETFs hold true for bond ETFs as well.

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Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Supplementary materials

Supplementary material associated with this article can be found, in the online version, at doi:10.1016/j.econlet.2024.112024.

Data availability

Data will be made available on request.

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[10] The coefficient of the variable *PAB label* in Panel B of table 4 represents the monthly log return difference for PAB ETFs with respect to their counterparts. The annualized performance difference was computed by multiplying this coefficient by 12.

[11] The observed negative coefficients associated to the SMB and HML factors are consistent with the presence in our dataset of CTB and PAB ETFs, whose benchmarks are tilted towards large-cap and growth stocks. This concept becomes evident if one looks, for instance, at the carbon metrics of the S&P500 growth (https://www.spglobal.com/spdji/en/indices/equity/sp-500-growth/#data) versus the S&P500 value (https://www.spglobal.com/spdji/en/indices/equity/sp-500-value/#data). The same explanation holds for the negative coefficient associated to the RMW factor, which reflects a preference for growth potential over profitability. Finally, the negative coefficient associated to the Momentum factor suggest benchmarks in our dataset have diverged from following an investment strategy based upon short-term price trends.

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