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CLIMATE CHANGE EXPOSURE AND FINANCIAL PERFORMANCE: EVIDENCE FROM THE MEDITERRANEAN REGION

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FEMISE CONFERENCE **PAPER**

ENERGY POLICIES AND LABOUR MARKET GENDER GAPS: THE CASE OF EUROMED REGION

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CLIMATE CHANGE EXPOSURE AND FINANCIAL PERFORMANCE: EVIDENCE FROM THE MEDITERRANEAN REGION

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ABSTRACT

This study examines the effects of Climate Change Exposure (CCE) on financial performance using a panel of 556 firms operating in 24 Mediterranean countries, observed over the period from 2001 to 2022. Using linear regression analysis, we find that CCE significantly impacts three measures of financial performance: Return on Assets (ROA), Return on Equity (ROE), and Tobin's Q. Furthermore, Environmental Performance moderates this relationship.

By splitting our sample according to pollution levels (less polluting versus more polluting firms), the results indicate that industries with higher pollution levels face more severe consequences on financial performance due to their exposure to climate risks. Additionally, the study highlights a more pronounced impact of CCE during the post-Paris Agreement period. This suggests an increase in companies' sensitivity to climate risks after 2015, potentially attributed to the implementation of stricter environmental regulations and increased compliance pressures.

These findings carry significant implications for firms, policymakers, and investors in the Mediterranean region. This research contributes novel insights to the field of climate change.

Keywords: Climate Change Exposure, financial performance, adaptation, resilience. legitimacy theory.

EXPOSITION AU CHANGEMENT CLIMATIQUE ET PERFORMANCE FINANCIÈRE : PREUVES ISSUES DE LA RÉGION MÉDITERRANÉENNE

RÉSUMÉ

Cette étude examine les effets de l'exposition au changement climatique (ECC) sur la performance financière à partir d'un panel de 556 entreprises opérant dans 24 pays méditerranéens, observées sur la période allant de 2001 à 2022. En utilisant une analyse de régression linéaire, nous constatons que l'ECC a un impact significatif sur trois indicateurs de performance financière : le retour sur actifs (ROA), le retour sur capitaux propres (ROE) et le Q de Tobin. De plus, la performance environnementale modère cette relation.

En scindant notre échantillon selon les niveaux de pollution (entreprises moins polluantes versus plus polluantes), les résultats indiquent que les industries à plus forte intensité de pollution subissent des conséquences financières plus sévères en raison de leur exposition aux risques climatiques. L'étude met également en évidence un impact plus marqué de l'ECC durant la période post-Accord de Paris. Cela suggère une sensibilité accrue des entreprises aux risques climatiques après 2015, potentiellement attribuée à la mise en œuvre de réglementations environnementales plus strictes et à des pressions accrues en matière de conformité.

Ces résultats ont des implications importantes pour les entreprises, les décideurs politiques et les investisseurs de la région méditerranéenne. Cette recherche apporte des perspectives nouvelles et originales au champ d'étude du changement climatique.

التعرض لتغير المناخ والأداء المالي: أدلة من منطقة البحر الأبيض المتوسط

الملخص

على الأداء المالي باستخدام بيانات لوحة مكونة من 556 (CCE) تدرس هذه الدراسة تأثير التعرض لتغير المناخ شركة تعمل في 24 دولة متوسطية خلال الفترة من 2001 إلى 2022. ومن خلال تحليل الانحدار الخطي، نجد أن ، العائد على (ROA) التعرض لتغير المناخ يؤثر بشكل كبير على ثلاثة مؤشرات للأداء المالي: العائد على الأصول علاوة على ذلك، تؤدي الأداء البيئي دورًا تعديليًا في هذه .(Tobin's Q) ، ونسبة توبين(ROE) حقوق الملكية العلاقة.

عند تقسيم العينة وفقًا لمستويات التلوث (شركات أقل تلوثًا مقابل شركات أكثر تلوثًا)، تشير النتائج إلى أن الصناعات ذات المستويات الأعلى من التلوث تواجه عواقب أكثر حدة على أدائها المالي نتيجة تعرضها للمخاطر المناخية. كما تبرز الدراسة تأثيرًا أقوى للتعرض لتغير المناخ خلال فترة ما بعد اتفاق باريس، مما يشير إلى زيادة حساسية الشركات للمخاطر المناخية بعد عام 2015، وهو ما قد يُعزى إلى تطبيق لوائح بيئية أكثر صرامة وزيادة الضغوط التنظيمية.

تحمل هذه النتائج دلالات مهمة للشركات وصناع السياسات والمستثمرين في منطقة البحر الأبيض المتوسط، كما تقدم هذه الدراسة رؤى جديدة ومبتكرة في مجال تغير المناخ.

INTRODUCTION

Climate change presents unprecedented challenges to the global financial system, manifesting through both direct physical impacts and indirect economic effects. These challenges include extreme weather events, rising sea levels, regulatory changes, and market transitions, all of which significantly affect corporate operations and financial performance. The urgency of addressing these challenges is evidenced by the United Nations' establishment of 17 Sustainable Development Goals in 2015, which prioritize climate change mitigation. These goals have particular relevance for the industrial sector, as firms must increasingly align their operations with sustainability targets while maintaining financial viability. Recent research underscores this urgency: a joint survey by the United Nations Development Program (UNDP) and Oxford University shows that 64% of the global population expresses serious concern about climate change (Flynn et al., 2021). The Intergovernmental Panel on Climate Change (IPCC) reinforces these concerns, supporting climate change's current impacts across all regions and warning of rising problems with each gradual temperature rise.

In this context, organizations face a specific measurable challenge: climate change exposure (CCE). CCE covers both the direct physical impacts experienced by firms due to climate events in their operating regions (such as extreme weather, rising temperatures, and sea-level changes) and their exposure to the broader climate change agenda, including regulatory changes, market transitions, and international climate agreements. This dual definition allows us to capture both immediate physical risks and longer-term transition risks facing organizations. The level of CCE varies based on a company's sector, location, and implemented climate adaptation measures. Recent empirical studies have shown that CCE significantly influences corporate adaptation and resilience (Hong et al., 2020; Ji et al., 2021; Hossain and Masum, 2022; Hossain et al., 2023). These findings highlight the growing importance of understanding how organizations can effectively respond to and manage their climate exposure while maintaining financial performance.

Two key organizational capabilities have emerged as critical in addressing climate-related challenges: adaptability and resilience. Adaptability refers to a firm's capacity to identify and capitalize on emerging market opportunities (Chakravarthy, 1982) while effectively reallocating resources in response to environmental changes (Smit and Wandel, 2006). In the climate context, this manifests as the ability to modify business processes, technologies, and strategies to address both physical and transition risks (Linnenluecke et al., 2012). Corporate resilience, conversely, represents an organization's ability to absorb stress, maintain critical functionality, and succeed under varying conditions (Williams et al., 2017). Together, these capabilities form the foundation of an organization's response to climate challenges, directly influencing financial outcomes.

The financial implications of these capabilities are significant and clearly demonstrated. Organizations demonstrating stronger climate resilience and adaptation achieve superior financial outcomes (Ortiz-

de-Mandojana and Bansal, 2016; DesJardine et al., 2019), including lower capital costs (Chava, 2014), higher market valuations (Bolton and Kacperczyk, 2021), and enhanced operational performance (Busch and Hoffmann, 2011).

Given these considerations, our study addresses the following research question: *How does climate change exposure impact firms' financial performance?*

We examine this question through an analysis of 566 firms in the Mediterranean region from 2001 to 2022. Our methodology uses Sautner et al.'s (2023) CCE measure and assesses financial performance through multiple financial metrics, including Return on Assets, Return on Equity, and Tobin's Q. The study incorporates several additional dimensions: examining Environmental Performance's moderating effect on the CCE- financial performance relationship, analyzing differences between high- and low-pollution companies, and evaluating the Paris Agreement's impact.

The Mediterranean region provides an ideal research setting due to its unique characteristics. The region faces heightened vulnerability to climate impacts, experiencing temperature increases 20% faster than the global average. Additionally, the region's diverse economic landscape, covering both developed and developing economies, offers rich insights into how different institutional contexts influence corporate climate responses.

Our research contributes to the existing literature in three key ways. *First,* it provides novel insights into corporate climate response strategies in a region particularly susceptible to climate change impacts. *Second,* it offers empirical evidence on the effectiveness of adaptation and resilience strategies in maintaining financial performance. *Third,* it explores the environmental performance's role in moderating the relationship between CCE and firm vulnerability.

The significance of this research is highlighted by four key factors: (1) the increasing frequency and severity of climate risks in sensitive regions like the Mediterranean region, (2) growing regulatory pressure for sustainable practices, (3) direct financial implications of climate change for companies, including operational costs and supply chain disruptions, and (4) practical implications for developing effective climate adaptation and resilience strategies.

The paper is structured as follows: the next section develops our theoretical framework and hypotheses, followed by our methodology, including data description, variable definitions, and econometric approach. We then present and discuss our results, concluding with final observations and implications.

THEORETICAL FRAMEWORK, LITERATURE REVIEW, AND HYPOTHESIS DEVELOPMENT

Legitimacy theory provides a persuasive framework for understanding how CCE affects organizational performance through its impact on firms' social contracts and "licenses to operate." This theory shows how CCE initiates a cascade of effects: from challenging organizational legitimacy, to reducing adaptability, increasing vulnerability, and finally reducing financial performance.

The relationship between CCE and organizational legitimacy operates through three institutional pressure mechanisms, as identified by DiMaggio and Powell (1983). *First,* normative pressures emerge from industry standards that necessitate costly adaptation measures. *Second,* regulative pressures arise from climate regulations that impose compliance costs and operational constraints. *Third,* cognitive pressures arise from stakeholder expectations that create reputational risks.

These institutional pressures create legitimacy gaps, misaligning existing organizational capabilities with evolving environmental expectations (Deegan, 2019). The consequences of these pressures manifest in several ways. Normative pressures strain resources and reduce operational flexibility, while regulative pressures limit strategic options and increase vulnerability (Suchman, 1995). Simultaneously, cognitive pressures can reduce market confidence and restrict capital access (O'Donovan, 2002).

Recent empirical research has shown complex relationships between environmental challenges and organizational performance. Studies by Kumari and Patel (2020), Naranjo Tuesta et al. (2021), and Kalash (2021) have demonstrated positive correlations between proactive carbon management and financial metrics. Conversely, research by Busch et al. (2022) has shown negative effects of higher carbon emissions on both short and long-term performance.

The impact of CCE is moderated by several key factors. Research by Almaghrabi (2023) has shown that managerial ability can significantly mitigate adverse financial effects, while Ozkan et al. (2023) has put in evidence how corporate social responsibility helps alleviate climate risks. Furthermore, studies by Gomes et al. (2023) and Ghose et al. (2023) have shown significant variations in climate strategy effectiveness across different industry sectors.

The Mediterranean region presents unique characteristics that make it particularly relevant for studying CCE impacts. The region includes a spectrum from advanced Nordic economies with robust sustainability frameworks to emerging Southern Mediterranean markets with acute climate vulnerabilities. This economic diversity is complemented by a complex regulatory environment, characterized by stringent EU regulations, including the Green Deal, alongside varied sustainability frameworks across the region. Additionally, the region faces significant physical risk exposure, including high vulnerability to water scarcity, increased exposure to agricultural disruptions, and greater frequency of extreme weather events.

Based on this theoretical framework and contextual analysis, we propose our hypothesis:

H.1: Climate change exposure negatively impacts firms' financial performance in the Mediterranean region.

METHODOLOGY

SAMPLE

The sample covers firms from the Mediterranean region, observed over the 2001 to 2022 period. This longitudinal approach enables us to capture both temporal changes and cross-sectional variations in climate change impacts across the region. We applied some filtering rules to ensure data availability and sample homogeneity. Some countries are excluded from the sample. Specifically, as data for the CCE and Environmental Performance Index variables were not available for some countries (Algeria, Lebanon, Israel, Jordan, Palestine, Tunisia, Bulgaria, Croatia, Latvia, Slovakia), these countries were excluded from the analysis.

After the sample filtering process, our final dataset includes 566 firms operating across 24 countries within the Mediterranean region: Austria, Belgium, Cyprus, the Czech Republic, Denmark, Egypt (Arab Republic), Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Luxembourg, Malta, the Netherlands, Poland, Portugal, Romania, Slovenia, Spain, and Sweden.

Table 1 presents our sample by country.

Table 1. Sample distribution

Country	Percent	Country	Percent
Austria	2.59	Iceland	0.15
Belgium	3.08	Ireland	5.91
Cyprus	0.43	Italy	7.62
Czech Republic	0.60	Luxembourg	2.99
Denmark	4.25	Malta	0.18
Egypt, Arab Rep.	0.57	Netherlands	8.69
Estonia	0.04	Poland	2.06
Finland	6.08	Portugal	1.44
France	14.66	Romania	0.15
Germany	16.34	Slovenia	0.03
Greece	2.71	Spain	5.92
Hungary	0.58	Sweden	12.93
Total		**100.00**	

VARIABLES AND MEASURES

Dependent variable; Financial performance (FP)

We consider three indicators to measure financial performance. The first is Return on Assets (ROA),

which indicates a company's profitability in relation to its assets and is calculated as operating income before depreciation divided by total assets. The second indicator is Return on Equity (ROE), which reflects financial profitability for shareholders, calculated as net income divided by shareholders' equity. The third variable is Tobin's Q, which is the ratio of a company's market value to its total assets. These variables are commonly used to assess a company's financial performance.

Independent variable: Climate change exposure (CCE)

We employ the firm-level metric for CCE introduced by Sautner et al. (2023). This metric is developed through the application of a machine-learning approach that makes use of transcripts from quarterly corporate conference calls. Sautner et al. (2023) employ a methodology similar to that proposed by Hassan et al. (2019) in constructing this measure, in which they provide a reliable proxy for firm-level political risk. This measure is based on a "bigrams analysis" of conference call transcripts, in order to identify the level of attention given by a company to the CCE in terms of its regulatory and physical shocks, and climate change opportunities. Sautner et al. (2023) employ a method that adapts a keyword discovery algorithm. This process begins by identifying a small set of initial bigrams associated with climate change. Then, they look for new bigrams that might represent discussions related to climate change opportunities.

in the transcript. This iterative process results in a compilation of climate change opportunity bigrams, which includes both the initial and the new bigrams. This process can be represented by the following equation:

$$\mathrm{CCE}_{i;q} = \frac{1}{\mathrm{B}_{i,q}} \sum_{b}^{\mathrm{Bi,q}} (1[b \in C]) \qquad (1)$$

Where:

CCEi,q represents the total CCE for company i in quarter q. Bi,q refers to the total number of bigrams in a transcript across companies and corresponding quarters. The indicator function 1 [.] is used, with [b ∈ C˘] taking values like 1, 2, 3, etc., thus capturing the explicitly total number of bigrams that are exclusively related to CCE. We calculate the arithmetic mean of the quarterly measures to obtain the annual values (t), following the methodology introduced by Sautner et al (2023). They conducted a number of proof-of-concept tests for their firm-level measure, finding that it correlates significantly with the relevant macro- and micro-level risk indicators. The authors also measured CCE on the basis of three thematic standards that reflect exposure to climate-related physical impacts, opportunities and regulatory shocks.

This multi-country dataset is one of the most complete datasets that provides information on CCE at a firm level. Previous studies have used this dataset to investigate the tangible effects of climate change on companies' asset valuations and financial policies. To simplify the interpretation of our regression coefficients, we have multiplied this measure by 1000.

Control variables

We included several variables that account for both firm characteristics and macroeconomic factors at the country level. Our review of the firm performance literature identifies seven key factors that are likely to influence bank performance, which we incorporate into our study. The first factor is capital expenditures (CAPEX), measured as the ratio of capital expenditure to total assets. The second factor relates to firm liquidity (CASH), which is assessed by the ratio of cash and cash equivalents to total assets. The third variable involves capital structure, where we include leverage (LEV), approximated by the ratio of long-term debt to total assets. The fourth variable is the market-to-book ratio (MTB), calculated as the market value of equity divided by the book value of equity. The fifth factor is board gender diversity (Bdiv), which is measured by the percentage of women on the board of directors.

The sixth factor is green innovation (innov), derived from the Refinitiv database. Finally, the seventh variable indicates firm growth (Growth), which we measure as the percentage increase in sales. Furthermore, we also control for various country-level variables. We include GDP growth (GDP), measured as the natural logarithm of GDP per capita for each country. Additionally, we introduce foreign direct investment (FDI_GHT), which is measured by the sum of equity capital, reinvestment of earnings, other long-term capital, and short-term capital as captured in the balance of payments. This measure reflects net inflows, showing the difference between new investment inflows and disinvestment within the reporting economy, divided by GDP. Lastly, we consider the country governance index (gov_score), based on the governance index provided by Refinitiv database.

Appendix A presents all variables.

ECONOMETRIC MODELS

To assess the impact of CCE on the financial performance of companies in the Mediterranean region, we conducted a linear regression analysis. The model utilized in this study is as follows:

$$FP_{,t} = \beta 0 + \beta 1\ CCEi_{,t} + Firm\ Controls + Country\ Controls + Firm\ FE + Year\ FE + \varepsilon \qquad (2)$$

We use Ordinary Least Square (OLS) method.

The OLS regression method is particularly well-suited for our research design due to its ability to estimate the linear relationship between CCE and financial performance while minimizing the sum of squared residuals. OLS provides unbiased and efficient estimates of coefficients under the Gauss-Markov assumptions, which are particularly robust when examining complex relationships with multiple control variables across a diverse sample of firms in the Mediterranean region. By allowing us to incorporate firm-level and country-level controls, fixed effects for firms and years, OLS enables a comprehensive analysis that can isolate the specific impact of CCE while accounting for potential confounding factors. Moreover, OLS regression offers clear interpretability of coefficients, allowing us to directly quantify the marginal effect of CCE on financial performance metrics.

EMPIRICAL FINDINGS

DESCRIPTIVE STATISTICS

Table 2 presents the summary statistics. The means of the financial performance variables—Return on Assets (ROA) (1), Return on Equity (ROE) (2), and Tobin's Q (3)—are 0.04, 6.34, and 0.88, respectively. Our primary independent variable, CCE has a mean of 1.361, which is comparable to the mean reported by Sautner et al. (2023) of 1.070. This suggests that most companies exhibit a moderate level of exposure to climate change risks, although there is significant variation among individual firms."

Table 2. Descriptive Statistics

Variable	Mean	Std. Dev.	Min	Max
ROA	.04	.193	-.387	3.768
ROE	6.34	28.792	-9.764	598.161
TobinQ	.88	4.255	.001	89.747
CCE	1.361	2.516	0	13.918
CAPEX	.101	.621	0	9.178
CASH	.033	.152	0	1.803
LEV	.444	2.332	0	41.628
MTB	.002	.003	-.017	.029
BDiv	11.193	14.965	0	46.15
innov	41.548	34.44	0	99.895
Growth	54.3	54.707	0	194.899
GDP	10.642	.555	0	11.534
FDI_GHT	1.031	29.153	-60.792	544.262
gov score	14.301	23.893	0	71.43

Table 3 presents a breakdown of CCE data by country. The results indicate that companies across various countries in the Mediterranean region face differing degrees of risks associated with climate change. The countries with the highest levels of CCE are Romania (2.851), the Czech Republic (2.574), and Spain (2.573). In contrast, other countries, such as Estonia (0.230), Malta (0.328), and Morocco (0.354), exhibit lower levels of exposure to climate change.

Table 3. Climate Change Exposure (CCE) by Country

Country	CCE	Country	CCE
Austria	2.200	Iceland	0.620
Belgium	1.318	Ireland	0.811

Cyprus	0.861	Italy	1.530
Czech	2.574	Luxembourg	0.920
Denmark	0.987	Malta	0.328
Egypt	0.942	Netherlands	0.887
Estonia	0.230	Poland	1.651
Finland	1.523	Portugal	2.054
France	1.492	Romania	2.851
Germany	1.438	Slovenia	0.807
Greece	0.677	Spain	2.573
Hungary	0.483	Sweden	1.029

MAIN RESULTS

Table 4 presents the results. Columns (1), (2), and (3) of Table 4 display the results with Return on Assets (ROA), Return on Equity (ROE), and Tobin's Q as dependent variables, respectively. The coefficients for CCE are negative and statistically significant, with p-values equal to 0.05 for the first two financial performance measures (column 1: coefficient = -0.00176; column 2: coefficient = -0.215) and a p-value less than 0.05 for the last measure (column 3: coefficient = -0.00152).

All else equal, the financial performance measured by ROA of a typical sample firm with average CCE would decrease by approximately 14.21 % (= 0.00226 * 2. 516 /0.04). In the same way, the predicted decrease in ROE (Tobin's Q) represents approximately 13.52% (9.56%) due to an increase in CCE. Thus, the effect on ROA is the most important. Therefore, our hypothesis is supported.

From the perspective of legitimacy theory, these findings highlight the critical role of organizational responsiveness to environmental challenges as a means of maintaining societal approval and institutional support. By demonstrating that CCE negatively affects financial performance, the results suggest that firms that fail to proactively manage their environmental strategies risk losing their social license to operate in an increasingly environmentally conscious market. The negative implications for performance indicate that stakeholders are increasingly assessing corporate legitimacy in the context of climate adaptation and mitigation strategies. Consequently, firms in the Mediterranean region must regard climate change management not merely as a financial necessity but as a fundamental strategic approach to preserving their organizational legitimacy and sustaining their competitive positioning in a rapidly changing global business environment.

These results align with those of previous studies (Huang et al., 2018; Ozkan et al., 2022; Almaghrabi, 2023), which indicate that high exposure to climate change results in significantly adverse economic consequences for a firm's financial performance.

The adjusted R-squared values suggest that our models (including control variables) explain between 13% and 73% of the variation in financial performance. These values exceed those found in prior studies evaluating the effect of climate risk on financial performance (Huang et al., 2018). These findings imply that companies in the Mediterranean region are significantly affected by exposure to climate change and require more robust adaptation strategies.

Table 4. Impact of Climate Change Exposure (CCE) on Financial Performance (FP)

VARIABLES	(1) ROA	(2) ROE	(3) TobinQ
CCE	-0.00176**	-0.215**	-0.00152***
	(0.000853)	(0.096)	(0.00052)
CAPEX	0.0402*	4.523	-0.319
	(0.0242)	(5.112)	(0.254)
CASH	0.282***	-1.332	-0.0512
	(0.0586)	(1.632)	(0.130)
LEV	-0.00655	0.803	1.107***
	(0.00467)	(0.966)	(0.0864)
MTB	1.058**	0.239***	0.666
	(0.494)	(0.055)	(0.196)
BDiv	5.43e-05	0.00312	0.000979
	(0.000162)	(0.00831)	(0.000773)
innov	6.37e-05	-0.00805	-0.000734*
	(9.84e-05)	(0.0124)	(0.000433)
Growth	0.00277***	-0.0988	-0.00202
	(0.001)	(0.124)	(0.00379)
GDP	0.00916	-0.658	-0.143***
	(0.0135)	(0.945)	(0.0415)
FDI_GHT	1.08e-05	3.71e-05	-6.49e-05
	(1.60e-05)	(0.000589)	(4.72e-05)
gov_score	0.00716	0.00266**	0.000267***
	(0.00779)	(0.00115)	(0.000101)
Constant	-0.111	10.41	1.783***
	(0.146)	(10.15)	(0.457)
Year effect	Yes	Yes	Yes
Country effect	Yes	Yes	Yes
Observations	6,261	4,931	5,231
R-squared	0.136	0.132	0.736
Number of firms	566	522	556

Robust standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1

ADDITIONAL EVIDENCE

The moderating effect of the Environmental Performance Index (EPI)

Understanding environmental performance is crucial for elucidating the relationship between CCE and firm performance, as it provides a contextual framework that includes broader institutional and national environmental governance landscapes. In this study, we use the Environmental Performance Index (EPI), developed by Yale and Columbia Universities, as a moderating variable. The EPI offers a standardized

rating system and numerical evaluation of the environmental performance of government policies globally. This index, which ranges from 0 to 100 and assesses 180 countries, is published biennially and is based on 40 performance indicators derived from accessible data. This allows for meaningful comparisons between countries and over time, enabling us to evaluate the state of sustainability worldwide, track environmental trends, quantify the effectiveness of environmental policies, identify best practices, and guide nations toward sustainable development.

Table 5 shows the moderating effect of the EPI on the relationship between CCE and financial performance. Our results indicate that the interaction between CCE and the EPI is negative and statistically significant at the 1% level; specifically, the coefficient for the interaction term, CCE×EPI, in column 1 is -0.000930 ($p < 0.01$).

This negative relationship can be attributed to direct costs associated with extreme weather events, increased operational expenses for adapting production processes, and the necessity for additional investments to enhance climate resilience (Huang et al., 2018; Ozkan et al., 2023). The negative interaction suggests that EPI, which is intended to reinforce companies' resilience to climate risks, is not effectively mitigating the adverse impacts of climate change. This may indicate that current environmental efforts are insufficient or poorly aligned with the specific challenges faced by the region. Therefore, companies must adopt proactive and anticipatory strategies to mitigate their exposure to climate change.

Table 5. The Moderating Effect of the Environmental Performance Index (EPI) on the Relationship Between Climate Change Exposure (CCE) and Financial Performance (FP)

VARIABLES	**(1)** ROA	**(2)** ROE	**(3)** tobinQ
CCE	-0.00181**	-0.261**	-0.00223**
	(0.000906)	(0.130)	(0.00116)
EPI	-0.00158	0.169	-0.0164
	(0.0168)	(0.528)	(0.0258)
CCE×EPI	-0.000930***	-0.0524***	-0.00279***
	(0.00024)	(0.0142)	(0.00097)
CAPEX	0.0402*	4.526	-0.318
	(0.0239)	(5.112)	(0.254)
CASH	0.282***	-1.368	-0.0496
	(0.0583)	(1.623)	(0.130)
LEV	-0.00655	0.801	1.107***
	(0.00463)	(0.966)	(0.0865)
MTB	0.1058**	0,238***	0.685***
	(0.0495)	(0.0474)	(0.209)
BDiv	7.29e-05	0.000699	0.00110
	(0.000253)	(0.00943)	(0.000929)
innov	6.54e-05	-0.00825	-0.000724*
	(9.22e-05)	(0.0122)	(0.000430)

Growth	0.00078***	-0.00998	-0.000193
	(0.0001))	(0.0123)	(0.000387)
GDP	0.00925	-0.662	-0.141***
	(0.0134)	(0.949)	(0.0414)
FDI_GHT	1.04e-05	8.97e-05	-6.71e-05
	(1.73e-05)	(0.000567)	(4.86e-05)
gov_score	6.76e-05	-0.00218	0.000245
	(6.92e-05)	(0.00453)	(0.000299)
Constant	-0.112	10.49	1.758***
	(0.146)	(10.16)	(0.457)
Country fixed effet	Yes	Yes	Yes
Year fixed effect	Yes	Yes	Yes
Observations	6,261	4,931	5,231
R-squared	0.136	0.132	0.736
Number of firms	566	522	556

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Less polluting vs. more polluting companies

CCE varies between less polluting and more polluting companies. By dividing the sample into these two categories, we can assess how CCE impacts firms with differing environmental footprints, recognizing that sensitivity to and capacity for adaptation to climate risks are not uniform across industries.

Table 6 presents the relationship between CCE and the financial performance of companies classified by their pollution levels (less polluting vs. more polluting). The negative coefficients for CCE in less polluting sectors suggest that exposure to climate change adversely affects the financial performance of companies in these industries. This indicates that firms in less polluting sectors may be more sensitive to climate change impacts, potentially leading to weaker financial outcomes.

In contrast, for the most polluting industries, the negative effects of CCE are significantly greater (ROA: -0.00348***, ROE: -0.285***, Tobin's Q: -0.00585**) compared to their less polluting counterparts (ROA: -0.00190***, ROE: -0.0532, Tobin's Q: -0.00299**). This disparity supports the findings of Matsumura et al. (2014) regarding the relationship between carbon intensity and firm value.

These results suggest that industries with higher pollution levels experience more severe consequences on financial performance due to their exposure to climate risks. This increased vulnerability could be attributable to stricter environmental regulations and heightened pressure from stakeholders to adopt sustainable practices (Porter and Kramer, 2011). While companies in less polluting sectors are also affected, the impact is less pronounced, likely due to their greater capacity to manage climate risks and integrate sustainability measures into their strategies.

Table 6. Relationship Between Climate Change Exposure (CCE) and Financial Performance (FP) Across Less Polluting and More Polluting Companies

VARIABLES	Less polluter industries			Most polluter industries		
	(1)	(2)	(3)	(4)	(5)	(6)
	ROA	ROE	tobinQ	ROA	ROE	tobinQ
CCE	-0.00190***	-0.0532	-0.00299**	-0.00348***	-0.285***	-0.00585**
	(0.00020)	(0.0843)	(0.00152)	(0.00082)	(0.075)	(0.00285)
CAPEX	0.0484	-2.690	-0.00844	0.0319	4.859	-0.0991
	(0.0370)	(9.857)	(0.460)	(0.0230)	(4.026)	(0.298)
CASH	0.166*	-1.160	0.0217	0.425***	-3.929	-0.0133
	(0.0867)	(1.337)	(0.183)	(0.0521)	(4.465)	(0.175)
LEV	-0.00724	-0.0802	1.187***	-0.00590	2.106	0.955***
	(0.00643)	(0.885)	(0.0849)	(0.00393)	(1.358)	(0.134)
MTB	0.00202***	0.00558***	0.881	0.001405	0.00179**	0.717**
	(0.00643)	(0.002108)	(4.799)	(0.001265)	(0.00894)	(0.328)
BDiv	-0.000146	0.0145	0.00182	0.000257*	-0.0135	0.000285
	(0.000247)	(0.0109)	(0.00142)	(0.000145)	(0.0116)	(0.000426)
innov	0.000208	-0.00694	-0.00142*	-0.000124	-0.00829	-4.02e-06
	(0.000154)	(0.00588)	(0.000755)	(7.56e-05)	(0.0229)	(0.000180)
Growth	0.000159	0.000260	-0.000440	0.000329***	-0.0138	6.50e-05
	(0.000107)	(0.00406)	(0.000349)	(6.80e-05)	(0.0221)	(0.000828)
GDP	0.0223	1.069	-0.157**	0.00494	-3.385**	-0.134**
	(0.0258)	(1.182)	(0.0762)	(0.00887)	(1.526)	(0.0566)
FDI_GHT	0.00233	-0.000618	-0.00947	-0.00232	0.00602	-0.00148
	(0.00224)	(0.000732)	(0.0070)	(0.00184)	(0.00740)	(0.00367)
gov_score	0.000642	0.00328	0.000611	0.00645	-0.00802	-0.00945
	(0.000142)	(0.00452)	(0.000582)	(0.00542)	(0.00708)	(0.000121)
Constant	-0.256	-6.909	1.947**	-0.0582	39.50**	1.631***
	(0.280)	(13.11)	(0.845)	(0.0942)	(17.18)	(0.580)
Country effect	Yes	Yes	Yes	Yes	Yes	Yes
Year effect	Yes	Yes	Yes	Yes	Yes	Yes
Observations	3,280	2,619	2,746	2,981	2,312	2,485
R-squared	0.157	0.055	0.724	0.238	0.205	0.808
Number of firms	307	283	302	259	239	254

Robust standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1

Before vs. after the Paris agreement

During the sample period from 2001 to 2022, a significant international treaty for climate change, the Paris Agreement, was adopted by nations around the globe. The Paris Agreement was agreed upon by 196 parties at COP 21 in Paris on December 12, 2015, and it entered into force on November 4, 2016.

Its primary objective is to limit the increase in global average temperature to well below 2°C and to continue efforts to restrict the temperature rise to 1.5°C above pre-industrial levels. All the Mediterranean countries included in this study adopted the Paris Agreement relatively quickly after it was opened for signature, with EU countries leading the way, followed by Iceland and then Egypt a few months later.

To analyze whether our results differed before and after the adoption of the Paris Agreement, we divided the sample period into two sub-periods: the period before the commitment (2001-2015) and the period after the commitment (2016-2022).

Table 7 illustrates a significant change in the impact of climate change before and after the Paris Agreement. The negative effects of CCE intensified considerably following the agreement (ROA: -0.00883***, ROE: -0.0900***, Tobin's Q: -0.00961***) compared to the previous period (ROA: -0.00172*, ROE: -0.673*, Tobin's Q: -0.00186*). The variable CCE demonstrates a significantly negative impact on financial performance both before and after the Paris Agreement, with a more pronounced effect post-agreement (ROA: coefficient of -0.00172 before the agreement versus -0.00883 after). This finding suggests an increase in companies' sensitivity to climate risks after 2015, which may be attributed to the implementation of stricter environmental regulations and heightened compliance pressures.

Table 7. Relationship Between Climate Change Exposure (CCE) and Financial Performance (FP) Before and After the Paris Agreement

VARIABLES	Before Paris agreement			After Paris agreement		
	(1)	(2)	(3)	(4)	(5)	(6)
	ROA	ROE	tobinQ	ROA	ROE	tobinQ
CCE	-0.00172*	-0.673*	-0.00186*	-0.00883***	-0.0900***	-0.00961***
	(0.00101)	(0.37320)	(0.00099)	(0.00137)	(0.0138)	(0.00174)
CAPEX	0.0683	7.238	0.769*	0.0349	2.550	0.570
	(0.0429)	(5.201)	(0.421)	(0.0318)	(1.979)	(0.382)
CASH	0.422***	-6.169*	0.119	0.291***	-3.430*	-0.0662
	(0.119)	(3.517)	(0.0964)	(0.0821)	(1.888)	(0.320)
LEV	-0.00905*	1.321	0.992***	-0.00610	-0.377	1.109***
	(0.00468)	(1.110)	(0.148)	(0.00700)	(0.463)	(0.119)
MTB	6.942	1,523*	0.0403	9.751*	941.4***	-0.0441
	(4.397)	(835.6)	(2.311)	(4.986)	(357.0)	(1.290)
BDiv	-0.000365	0.00990	0.000806	-0.000152	-0.0103	0.00362
	(0.000243)	(0.0165)	(0.000698)	(0.000257)	(0.0106)	(0.00293)
innov	0.000153*	-0.00859	-0.000509	0.000121	-0.00296	9.29e-05
	(8.23e-05)	(0.0150)	(0.000319)	(0.000175)	(0.00530)	(0.000379)
Growth	0.000303***	-0.0170	0.000303	0.000337***	0.00267	-0.000710*
	(0.000101)	(0.0209)	(0.000344)	(9.15e-05)	(0.00388)	(0.000401)
GDP	-0.00422	-0.465	-0.0963*	0.0598	0.351	0.00637
	(0.0178)	(0.963)	(0.0564)	(0.0394)	(3.002)	(0.287)

FDI_GHT	3.32e-07	7.90e-05	-1.48e-05	0.00123	-0.0958	-0.0199**
	(6.13e-06)	(0.000526)	(2.80e-05)	(0.000843)	(0.0850)	(0.00874)
gov_score	0.000277	0.00142	0.000168	0.000292**	-0.00222	0.000427
	(0.00507)	(0.00402)	(0.000280)	(0.000130)	(0.00438)	(0.000808)
Constant	0.0375	7.875	1.181**	-0.653	0.729	-0.0392
	(0.185)	(10.02)	(0.585)	(0.428)	(31.82)	(3.215)
Country effect	Yes	Yes	Yes	Yes	Yes	Yes
Year effect	Yes	Yes	Yes	Yes	Yes	Yes
Observations	3,003	2,819	2,991	3,258	2,112	2,240
R-squared	0.108	0.149	0.647	0.195	0.250	0.605
Number of firms	363	341	362	556	513	546

Robust standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1

CONCLUSION

This study examined the effects of CCE on the financial performance of firms in the Mediterranean region. Analyzing a dataset of 566 firms operating across 24 countries in the Mediterranean region, we found that CCE negatively affects financial performance. This finding highlights the significant impact of climate change risks on financial outcomes.

Our findings reveal distinct implications for organizational adaptation and resilience capabilities, each requiring coordinated but differentiated actions from both firms and governments. The Environmental Performance Index (EPI) serves as a crucial moderator, demonstrating how national-level environmental governance influences firms' responses to climate-related risks.

For adaptation strategies, our findings clearly distinguish between firm-level responsibilities and necessary government support. At the firm level, organizations must focus on three temporal horizons: short-term adaptation (1-2 years) requires developing internal climate risk assessment protocols and implementing flexible operational procedures; medium-term adaptation (2-5 years) involves investing in technological transformation and supply chain redesign; and long-term adaptation (5+ years) necessitates fundamental business model transformation. Government responsibilities in supporting adaptation include: short-term establishment of clear reporting guidelines and incentive structures; medium-term development of sector-specific support programs and funding mechanisms; and long-term creation of comprehensive policy frameworks that facilitate systemic business transformation.

Regarding resilience enhancement, the division of responsibilities is equally distinct. Firms must focus on: short-term development of emergency response capabilities and risk management systems (1-2 years); medium-term investment in system redundancy and stakeholder relationship building (2-5 years); and long-term development of organizational flexibility and industry network creation (5+ years). The corresponding government responsibilities include: immediate establishment of emergency support mechanisms; medium-term development of regional cooperation frameworks; and long-term investment in critical infrastructure and climate monitoring systems.

The role of government extends beyond support to include regulatory oversight and enforcement. Governments must establish clear accountability mechanisms for corporate climate action while providing the necessary infrastructure and policy framework for successful implementation. This includes developing climate-related disclosure requirements, setting industry-specific emission reduction targets, and creating incentive structures that reward both adaptation and resilience investments.

Corporate responsibilities, beyond implementing specific measures, include transparent reporting of climate risks and actions, active participation in industry-wide initiatives, and collaboration with government agencies in policy development. Firms must also ensure their climate strategies align with national and regional climate objectives while maintaining their competitive position.

The investment community plays a crucial connecting role between corporate and government initiatives. Investors should evaluate both firms' implementation of required measures and their utilization of government support mechanisms. This evaluation should consider the effectiveness of adaptation and resilience strategies across different time horizons.

Future research directions emerge from this complex interplay of corporate and government responsibilities. Researchers should investigate how different combinations of corporate initiatives and government support affect financial performance. Studies should examine the effectiveness of various policy instruments in promoting corporate climate action, while also analyzing how firms' responses to government initiatives vary across different institutional contexts. Additionally, future studies should investigate how different combinations of adaptation and resilience strategies affect financial performance across various time horizons. Studies should examine whether firms that excel in both capabilities outperform those that focus predominantly on one aspect. Also, research should explore how the timing and sequencing of adaptation versus resilience investments affect their effectiveness in enhancing financial performance.

The temporal dimension of both corporate and government actions represents a critical area for future investigation, particularly in understanding how their coordination affects outcomes. Comparative studies across the Mediterranean region could provide valuable insights into the effectiveness of different government-corporate cooperation models. Such research would be particularly valuable in developing more targeted and effective policy interventions that optimize the division of responsibilities between the public and private sectors.

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APPENDIX A: VARIABLES DEFINITION

Variables	Measure
ROA	Operating income before depreciation divided by total assets.
ROE	Net income divided by shareholders' equity.
TobinQ	Market value divided by total assets.
CCE	Climate change Exposure as provided by Sautner et al. (2023), multiplied by 1000.
CAPEX	Capital expenditure divided by total assets.
CASH	Cash and cash equivalents divided by total assets
LEV	Long term debt scaled by total assets.
MTB	market value of equity divided by book value of equity
BDiv	Percentage of females on the board.
innov	Innovation score extracted from Refinitiv database.
Growth	Percentage increase in sales.
GDP	Natural logarithm of GDP per capita.
FDI_GHT	Foreign direct investment: Net inflows divided by total assets.
gov score	Governance score extracted from Refinitiv database.

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