ISSN: 2658-8455
Volume 6, Issue 9 (2025), pp. 652-670.

IJAFAME
International Journal of Accounting, Finance, Auditing, Management & Economics

Assessing the Influence of ESG Indicators on Corporate Financial Performance: Evidence from Panel Data Analysis

Najlae YACHOU, *(PhD, PA)*
Interdisciplinary Laboratory of Applied Research (LIDRA)
Research Team on Entrepreneurship and Sustainable Development (EREDD)
International University of Agadir, Morocco

Correspondence address :	Business School Technopole d'Agadir, Bab Al Madina, Qr Tilila, BP 8143, Agadir. ISIAM Business School Morocco (Agadir) +212611247152
Disclosure Statement :	Authors are not aware of any findings that might be perceived as affecting the objectivity of this study and they are responsible for any plagiarism in this paper.
Conflict of Interest :	The authors report no conflicts of interest.
Cite this article :	YACHOU, N. (2025). Assessing the Influence of ESG Indicators on Corporate Financial Performance: Evidence from Panel Data Analysis. *International Journal of Accounting, Finance, Auditing, Management and Economics*, *6*(9), 652–670.
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Received: 25/07/2025 *Accepted:20/09/2025*

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Abstract

The approach combines an international literature review and an empirical panel data analysis of French (CAC 40) and American (S&P 500) companies from 2021 to 2024. Three econometric panel data models (fixed effects, fixed effects with time dimensions, and random effects) were tested using Python.
Results show that ESG scores do not have an immediate significant effect on ROA. However, sectors such as technology and energy exhibit clearly higher profitability regardless of ESG scores. These findings suggest that ESG initiatives may produce long-term positive financial effects.
The study also highlights limitations related to the small sample size and availability of ESG data, while underlining the importance of further research in this field. It concludes that despite the lack of a direct short-term link, ESG criteria remain a strategic lever to strengthen company resilience and competitiveness.

Keywords: ESG criteria, financial performance, ROA, sustainability, econometric models, listed companies, fixed effet analysis, random effet analysis.
JEL Classification : G30, G32, M14, Q56, C33
Paper type: Empirical research

ISSN: 2658-8455
Volume 6, Issue 9 (2025), pp. 652-670.

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1. Introduction

In recent decades, the growing importance of sustainability and corporate social responsibility has profoundly reshaped the way firms are evaluated and managed. Beyond financial metrics, stakeholders are increasingly attentive to non-financial dimensions that reflect a company's contribution to sustainable development. In this context, the integration of Environmental, Social, and Governance (ESG) criteria into corporate strategy has become a central issue for both academic researchers and business practitioners (Friede, Busch, & Bassen, 2015; Khan, Serafeim, & Yoon, 2016). ESG factors are not only associated with ethical imperatives but are also perceived as potential drivers of long-term financial performance and risk management.

Empirical evidence highlights the growing influence of ESG considerations on investor behavior. For instance, global sustainable investment reached more than $35 trillion in assets under management in 2020, representing 36% of all professionally managed assets worldwide (GSIA, 2021). Similarly, regulatory bodies in Europe and North America are strengthening disclosure requirements and integrating ESG reporting into corporate governance frameworks. This evolution reflects a paradigm shift: firms are no longer judged solely on profitability but also on their environmental impact, social practices, and governance mechanisms.

The academic literature, however, remains divided on the financial consequences of ESG integration. While some studies document a positive relationship between ESG performance and financial outcomes (Eccles, Ioannou, & Serafeim, 2014; Albuquerque, Koskinen, & Zhang, 2019), others suggest that ESG initiatives may generate additional costs without guaranteeing superior returns (Krüger, 2015). Meta-analyses further illustrate this complexity by showing that the ESG–financial performance link is often context-dependent, varying across sectors, regions, and methodological approaches (Friede et al., 2015; Busch & Friede, 2018). These conflicting results highlight the need for continued investigation using robust datasets and appropriate econometric tools.

This research contributes to this ongoing debate by examining the impact of ESG criteria on the financial performance of listed companies, with a particular focus on firms operating in the United States and France. These two countries offer contrasting institutional and cultural environments: the U.S. capital market is characterized by shareholder primacy and market-driven dynamics, whereas France reflects a stakeholder-oriented governance model with stronger state involvement and regulatory frameworks (Aguilera & Jackson, 2010). Such differences provide a fertile ground for analyzing whether the financial impact of ESG practices is universal or context-specific.

From a methodological perspective, the study relies on a panel dataset constructed from Refinitiv ESG scores and Yahoo Finance financial indicators, covering multiple sectors over the period 2021–2024. Return on Assets (ROA) is used as the primary indicator of financial performance, while control variables such as firm size, sector, and geographical location are introduced to ensure robustness. The analysis employs panel econometric techniques (fixed effects and random effects models), implemented using Python, to rigorously assess the relationship between ESG performance and firm profitability.

The main contribution of this article is threefold. First, it enriches the literature on ESG–performance relations by providing updated empirical evidence based on recent data from two major economies. Second, it highlights the role of institutional and geographic contexts in shaping the financial outcomes of ESG practices. Third, it combines a theoretical framework with a quantitative methodology, thereby offering both conceptual insights and practical implications for managers, investors, and policymakers.

The remainder of the paper is structured as follows. The first section develops the conceptual and theoretical framework, reviewing the main definitions of ESG criteria and the principal findings of prior research on their link with financial performance. The second section details the data and methodology, including variable construction and econometric specifications. The third section presents and discusses the empirical results, while the final section concludes with the theoretical contributions, managerial implications, and limitations of the study.

2. Literature Review

The integration of Environmental, Social, and Governance (ESG) criteria into corporate practices has become a major topic in economic and financial research. These criteria, which promote sustainable and responsible practices, are often associated with improved financial performance. However, this relationship is not uniform, and results vary depending on sectoral, geographical, and methodological contexts. A detailed analysis of several studies reveals general trends while highlighting case-specific features.

The Robeco report (2024), titled *ESG and Financial Performance: A Systematic Review*, offers a synthesis of numerous empirical studies on the impact of ESG practices. Using a systematic review method, researchers found that approximately 62.6% of cases show a positive correlation between ESG practices and companies' financial performance.

However, this relationship strongly depends on industry sectors and methodological approaches, underlining the need for contextual analysis to assess the real impact of ESG criteria. These findings align with the meta-analysis by Friede, Busch, and Bassen (2015), titled *ESG Criteria and Financial Performance: A Meta-analysis of 2,000 Studies*. By aggregating the results of more than 2,000 studies, these researchers confirm that ESG practices generate long-term financial benefits, although initial costs may be observed. These costs, however, are often offset by more effective risk management and increased business resilience.

The ability of ESG criteria to reduce risk is also emphasized in the study by Zhang et al. (2025, UK), titled *ESG Criteria as Tools for Financial Risk Management*. Using an econometric analysis based on logistic regression models, this research shows that companies with high ESG scores are statistically less likely to face severe financial difficulties. These results reinforce the idea that ESG criteria do not only have a direct financial impact but also play a key role in reducing operational and financial risks. This risk-mitigating role is confirmed by a 2023 study from the Netherlands titled *Corporate Resilience to Economic Uncertainty: The Role of ESG Criteria*. Using linear regression models and risk scenario simulations, the study finds that companies with strong ESG scores are better prepared to cope with economic uncertainties, resulting in improved overall performance.

Beyond risk management, ESG practices also contribute to value creation. This dimension is explored in the study by Ioannou and Serafeim (2022), titled *Creating Value through ESG: Investor Perspectives*. Combining financial data analysis with investor surveys, the authors show that companies seriously integrating ESG criteria benefit from higher market valuations and greater profitability. These advantages are explained by reduced financial risks and increased investor confidence, as such firms are perceived to be better prepared for future challenges. Moreover, value creation also extends to innovation, as shown in another American study published in 2024 titled :*ESG and Innovation: Strengthening Business Competitiveness*. Focusing on companies in the technology and industrial sectors, the study reveals that investments in ESG initiatives promote innovation, thereby enhancing competitiveness and sustainability in the medium and long term.

Regional and sectoral specificities also play a key role in the ESG–financial performance relationship. A 2023 study conducted at the University of Quebec in Montreal (Canada), titled *ESG Criteria and Financial Performance: A Sectoral Analysis in Canada*, highlights that

ISSN: 2658-8455
Volume 6, Issue 9 (2025), pp. 652-670.

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the impact of ESG practices varies depending on sectors and economic contexts. For example, in emerging markets, a 2022 Indian study titled *The Impact of ESG Criteria in Emerging Markets: An Indian Perspective* uses comparative analysis methods to examine the effect of ESG practices on corporate financial performance. The researchers demonstrate that companies with strong ESG practices benefit from better stock performance and reduced financing costs, largely due to being perceived as lower risk by investors. These findings are echoed in a 2023 German study titled *Integrating ESG Criteria into European Industrial Sectors*, which focuses on the energy, automotive, and industrial sectors. Using sectoral analysis, the researchers show that integrating ESG criteria leads to better resource management and lower costs associated with environmental risks, resulting in increased profitability.

However, the analysis of the ESG–financial performance link cannot be fully understood without addressing the methodological limitations in the literature. A central issue lies in the variability of ESG ratings across different agencies. Chatterji, Levine, and Toffel (2009) show that these ratings are weakly correlated, revealing significant differences in the criteria and weightings used. This heterogeneity makes it difficult to draw robust conclusions based on ESG scores, as a company well-rated by one agency may be deemed underperforming by another. This issue is further examined by Berg, Koelbel, and Rigobon (2022), who identify three main sources of discrepancy: differences in conceptual definitions, methodological choices in measuring indicators, and aggregation strategies for ESG dimensions. These methodological divergences lead to "aggregate confusion," complicating the empirical use of ESG ratings. Other authors, such as Krüger (2015), also highlight the risk of endogeneity in empirical studies: companies that are already performing well may be more inclined to adopt ESG policies, making it difficult to establish causality.

Finally, Christensen, Serafeim, and Sikochi (2022) warn about the gap between ESG disclosures and actual practices, particularly in cases of greenwashing, which undermines the reliability of available ESG data.

Other literature provides nuanced insights into the relationship between ESG (Environmental, Social, and Governance) practices and corporate financial performance. Giese et al. (2019) demonstrate that ESG integration can enhance equity valuation, reduce downside risk, and improve risk-adjusted returns. Khan, Serafeim, and Yoon (2016) emphasize that the financial impact of ESG is strongest when firms focus on *material* ESG issues specific to their industry. Similarly, Fatemi et al. (2015) and Servaes and Tamayo (2013) show that CSR activities positively influence firm value, particularly when supported by strong customer awareness and strategic alignment. However, ESG controversies can undermine these benefits, as shown by Aouadi and Marsat (2018), who highlight the negative valuation effects of ESG-related scandals. The role of institutional investors is also central; Dyck et al. (2019) find that large shareholders can drive stronger ESG adoption, while Kölbel et al. (2020) argue that investor influence is most effective through active engagement rather than mere capital allocation. Moreover, Brammer, Brooks, and Pavelin (2006) show that stock market responses to CSR initiatives vary by domain, underlining the importance of disaggregated ESG analysis. Renneboog, Ter Horst, and Zhang (2008) conclude that socially responsible investments generally yield comparable returns to traditional portfolios, suggesting that ESG integration does not come at a cost. Finally, Kotsantonis, Pinney, and Serafeim (2016) challenge common myths, clarifying that ESG integration is not only viable but often beneficial in investment decision-making. Collectively, these studies confirm that ESG, when strategically implemented and materially relevant, can contribute positively to both financial and reputational outcomes.

Taken together, these studies make it clear that ESG practices are not limited to ethical or environmental imperatives. They are also a strategic lever to enhance financial performance,

strengthen corporate resilience, and create long-term value. However, this relationship is neither automatic nor uniform. The works of Robeco (2024) and Friede, Busch, and Bassen (2015) show that the benefits of ESG practices heavily depend on sectoral contexts and methodological approaches. Similarly, the research of Zhang et al. (2025), Ioannou and Serafeim (2022), as well as studies conducted in Germany (2023), Canada (2023), India (2022), and the United States (2024), all emphasize the importance of a contextualized approach to maximizing the benefits of ESG initiatives. The interaction between ESG criteria and company's financial performance is thus complex and multidimensional, requiring in-depth analysis that considers both local and sector specificities. This integrated perspective enables a better understanding of how companies can leverage ESG practices to meet stakeholder expectations while reinforcing their long-term competitiveness and sustainability.

Considering this literature, two hypotheses guide our empirical investigation. The first, following studies that find no systematic or universal impact of ESG on financial outcomes (e.g., Krüger, 2015; Berg, Koelbel, & Rigobon, 2022), is the null hypothesis (H0): there is no significant relationship between ESG criteria and the financial performance of companies. Conversely, drawing on meta-analyses and empirical works that document a positive association between ESG and firm profitability or resilience (Friede, Busch, & Bassen, 2015; Khan, Serafeim, & Yoon, 2016), we posit the alternative hypothesis (H1): ESG criteria have a significant effect on the financial performance of companies.

3. Research Methodology

This research adopts a quantitative approach based on panel data analysis to study the relationship between ESG (Environmental, Social, and Governance) criteria and corporate financial performance, measured by ROA (Return on Assets). The main objective is to determine whether ESG scores significantly influence financial performance and to explore how this impact may vary according to sectoral specificities and differences between French and American companies.

To achieve this objective, two main hypotheses were formulated and subjected to statistical tests. The first hypothesis (**H1**) suggests that there is a significant effect between ESG criteria and corporate financial performance. Conversely, the null hypothesis (**H0**) states that no significant relationship exists between these two dimensions.

The data used for this study comes from reliable sources and includes financial and extra-financial information on a sample of companies. The main variables analyzed include the overall ESG score, which reflects the extra-financial performance of companies by integrating environmental, social, and governance dimensions, as well as ROA, a key indicator of asset profitability. Other explanatory variables, such as the sector of activity and the country (France or United States), were also considered, while control variables, such as firm size and sectoral specificities, were integrated to ensure the robustness of the results.

The statistical analysis was performed using Python, a powerful tool for processing and analyzing complex data. Three econometric models based on panel data were applied to test the hypotheses and examine the relationships between the variables. The first model, called the biases, is related to unobserved factors. The second model, fixed-effects with entity-specific and temporal effects, integrates both firm-specific fixed effects and temporal variations, such as global trends or economic fixed-effects model, allows controlling for firm-specific characteristics that do not vary over time, to reduce shocks.

Finally, the third model, random effects, is based on the hypothesis that the specific effects of entities and periods are random and uncorrelated with the explanatory variables, which allows for the inclusion of sectoral and geographical variables in the analysis.

The analysis process unfolded in several stages. First, the three models were estimated to

ISSN: 2658-8455
Volume 6, Issue 9 (2025), pp. 652-670.

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International Journal of Accounting, Finance, Auditing, Management & Economics

evaluate the relationship between ESG criteria and ROA.
The results obtained for each model were then compared using statistical tests, such as the Hausman test, to determine which one best fits the data. Subsequently, the significance of the explanatory variables was examined to identify the factors having a notable impact on financial performance. The interactions between ESG scores, country, and sector of activity were also analyzed to detect cross-effects or notable differences between French and American companies. Finally, the models were evaluated based on their explanatory power (R-squared), overall significance (F-statistic), and the relevance of the explanatory variables.
In summary, this methodology is based on a rigorous analysis of panel data, allowing for an in-depth exploration of the links between ESG criteria and corporate financial performance. The combined use of fixed-effects, fixed-effects with specific effects, and random-effects models ensures the reliability of the obtained results.
This approach contributes to a better understanding of the impact of ESG practices on corporate financial performance in different economic contexts, while considering the particularities specific to each sector and each country.

3.1. Data Collection

- ***Data Sources***

For this study, the necessary data will be collected from recognized financial sources, such as Refinitiv, LSEG (London Stock Exchange Group), Yahoo Finance, Investing.com, and the annual reports of the companies. Additionally, the annual reports of the studied companies will be used.

- ***Sample***

The sample represents all the companies studied in the article

Tableau 1: Sample parameters

Country	Sector	Corporate	Symbol	Description
USA	Energy	Exxon Mobil	XOM	Exploration, production, and distribution of oil and natural gas.
		Chevron Corp	CVX	Key player in oil and gas, renewable energy projects.
	Technology	Apple Inc	AAPL	Consumer electronics, software, and digital services.
		Microsoft Corp	MSFT	Software, cloud services, artificial intelligence.
	Finance	JPMorgan Chase & Co	JPM	American bank, sustainable finance.
		Bank of America Corp	BAC	Banking institution, support for ESG projects.

Pays	Secteur	Entreprise	Symbole	Description
France	Energy	Total Energies SE	TTE	Integrated multinational, renewable energies and carbon reduction.
		Engie SA	ENGI	Production and distribution of green energy.
	Technology	Dassault Systèmes SE	DSY	3D software, simulation, digital transformation.
		Atos SE	ATO	Digital services, cloud, cybersecurity, sustainability.
	Finance	BNP Paribas SA	BNP	European bank, responsible finance and ESG.
		Société Générale SA	GLE	French bank, sustainable finance, ESG integration.

Source: Author elaboration

- ***Analysis Period***

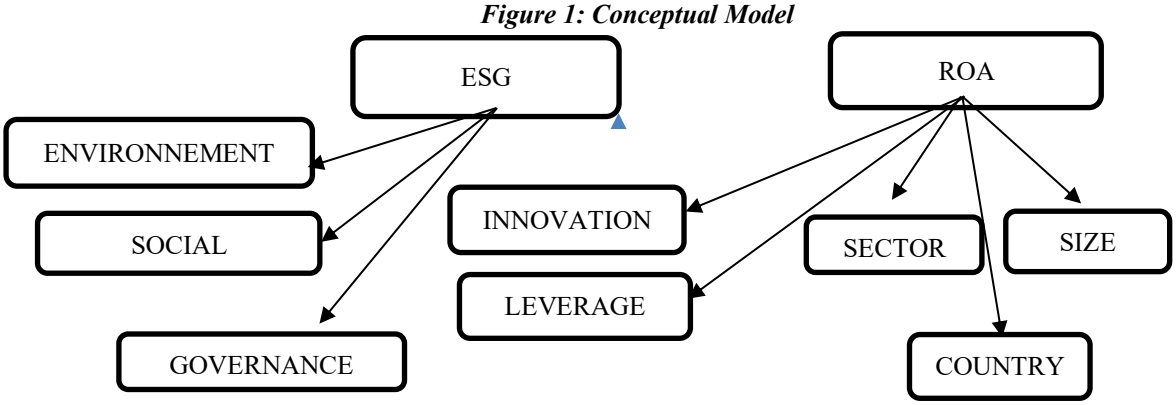
The analysis period chosen for this study covers **four years, from 2021 to 2024**, as these years were marked by significant changes in how companies integrate environmental, social, and governance (ESG) issues into their operations.

3.2. Research Model and Variable Definition

❖ ***Variables Collected***

- **Independent Variables (ESG):** Global ESG scores as well as specific scores for the Environmental (E), Social (S), and Governance (G) dimensions.
- **Dependent Variable (ROA):** Measured as the ratio of net income to total assets, to assess corporate profitability.
- **Control Variables:**
  - **Firm Size:** Logarithm of total assets.
  - **Sector of Activity:** Categorical variable representing the three selected sectors.
  - **Innovation:** Measured by the ratio of research and development (R&D) expenses to sales.
  - **Leverage:** Ratio of total debt to total assets.

Figure 1: Conceptual Model



Source: Author elaboration

The conceptual model is based on three main types of variables: independent variables, dependent variables, and control variables. These variables are defined and justified to address the research problem, which aims to analyze the impact of ESG (Environmental, Social, and Governance) criteria on the financial performance of publicly traded companies, while taking into account sectoral and geographical differences. The characteristics of the variables used in the analysis model are presented in the table below.

Table 2: Model Variables Characteristics

Variable	Type	Measure unit	Source	Description
ROA (Return on Assets)	Dependent Variable	Net income / Total assets (%)	(Bloomberg, Refinitiv)	Measure of financial performance.
E (Environnement)	Independent Variable	ESG Score (0 to 100)	MSCI ESG Ratings, Sustainalytics	Indicator of environmental performance.
S (Social)		ESG Score (0 to 100)	MSCI ESG Ratings, Sustainalytics	Indicator of social performance.
G (Governance)		ESG Score (0 to 100)	MSCI ESG Ratings, Sustainalytics	Indicator of corporate governance.

ISSN: 2658-8455
Volume 6, Issue 9 (2025), pp. 652-670.

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Firm Size	Control Variable	Logarithm of total assets	(Bloomberg, Refinitiv)	Measures the size of the company.
Activity Sector		(Energy, Technology, Finance)	(GICS, NAICS)	Indicates the sector in which the company operates.
Innovation		Ratio R&D / Sales (%)	Rapports financiers des enterprises	Measures of research and development expenditures.
Leverage		debt / Total assets (%)	(Bloomberg, Refinitiv)	Indicator of the company's financial structure.

Source: Author elaboration

❖ ***Research equation***

The impact of ESG on financial performance is modeled using a panel data equation:

$$ROA_{it}=\alpha+\beta_1 ESG_{it} + \beta_2 E_{it} + \beta_3 S_{it} + \beta_4 G_{it} + \gamma Controls_{it} + \mu_i + \varepsilon_{it}$$

Where:

- ROA_{it}= Return on Assets for firm i at time t
- $ESG_{it}, E_{it} S_{it}, G_{it}$ = ESG scores
- $Controls_{it}$ = Control variables (size, sector, innovation, leverage)
- μ_i = Firm-specific fixed effects
- ε_{it} = Error term

4. Results and discussion

4.1. Descriptive analysis in Panel Model

- ***Fixed-Effects Panel Model***

Table 3. Fixed Effects Panel Regression Results (Entity-Specific Effects)

Variable	Coefficient	Std. Error	t-statistic	p-value	95% Confidence Interval
Constant	-0.0295	0.5795	-0.0508	0.9598	[-1.2071 ; 1.1482]
Environmental Score	0.0003	0.0033	0.0995	0.9214	[-0.0064 ; 0.0071]
Social Score	-0.0044	0.0137	-0.0891	0.9891	[-0.0066 ; 0.0065]
Leverage (Debt-to-Assets)	0.1259	0.1635	0.7698	0.4467	[-0.2064 ; 0.4582]
Firm Size (Log of Assets)	-0.0022	0.0509	-0.0441	0.9651	[-0.1056 ; 0.1011]
Innovation	0.4025	0.3857	1.0435	0.3041	[-0.3814 ; 1.1864]

Source: computed by author

The results of the fixed-effects panel regression indicate that the explanatory power of the model remains modest. The R^2 within is 0.1520, suggesting that only 15.20% of the variation in financial performance (ROA) within firms over time is explained by the selected variables. The F-statistic (1.2188, p = 0.3216) further confirms that, taken jointly, the explanatory variables do not exert a statistically significant influence on ROA. However, the poolability test (F = 5.9286, p = 0.0000) strongly rejects the null hypothesis of homogeneity across firms, thereby justifying the use of a fixed-effects specification. This result highlights the importance

of controlling for firm-specific unobserved heterogeneity when analyzing financial performance.

Regarding the individual coefficients, the constant (-0.0295, p = 0.9598) is non-significant and, as expected in a fixed-effects framework, carries little interpretative value since the entity-specific effects absorb most of the baseline variation. Concerning the ESG dimensions, both the Environmental Score (0.0003, p = 0.9214) and the Social Score (-0.00004429, p = 0.9891) display negligible and statistically insignificant coefficients. This implies that no robust link is detected between ESG performance and ROA in this sample. Among the control variables, leverage (0.1259, p = 0.4467) shows a positive but non-significant relationship with financial performance, while firm size (-0.0022, p = 0.9651) exerts a slightly negative but insignificant effect. Finally, innovation (0.4025, p = 0.3041) presents a positive coefficient that suggests a favorable association with ROA, although the relationship remains statistically insignificant.

Overall, the findings suggest that while firm-specific heterogeneity significantly shapes financial performance, the explanatory variables included in the model—particularly ESG dimensions—do not exhibit significant effects on ROA. These results therefore do not provide empirical support for a systematic relationship between ESG performance and firm profitability within the studied context.

- ***Fixed-Effects Model (with entity-specific and temporal effects)***

Table 4: Fixed-Effects Model Result with entity-specific and temporal effects

Variable	**Coefficient**	**Std. Error**	**t-statistic**	**p-value**	**95% Confidence Interval**
Constant	-0.5006	0.8390	-0.5967	0.5550	[-2.2113 ; 1.2106]
Environmental Score	0.0008	0.0037	0.2162	0.8302	[-0.0067 ; 0.0082]
Social Score	-0.0005	0.0035	-0.1335	0.8946	[-0.0076 ; 0.0067]
Leverage (Debt-to-Assets)	0.0681	0.2150	0.3167	0.7536	[-0.3705 ; 0.5066]
Firm Size (Log of Assets)	0.0372	0.0698	0.5325	0.5982	[-0.1053 ; 0.1797]
Innovation	0.2815	0.4380	0.6427	0.5252	[-0.6119 ; 1.1749]

Source: computed by author

The fixed-effects panel regression results reveal that the overall explanatory power of the model remains limited. The within R^2 is 0.1173, indicating that only 11.73% of the variation in ROA within firms is explained by the explanatory variables. This relatively low percentage reflects the modest ability of the model to account for changes in financial performance. Moreover, the F-statistic (0.5946, p = 0.7042) confirms that, when considered jointly, the explanatory variables do not have a statistically significant effect on ROA. In contrast, the poolability test (F = 4.5104, p = 0.0002) strongly rejects the null hypothesis of homogeneity across firms and time. The extremely low p-value demonstrates the importance of unobserved heterogeneity, thereby justifying the use of a fixed-effects model specification.

Turning to the individual parameter estimates, the constant (-0.5006, p = 0.5550) is not statistically significant, which is expected in fixed-effects models since entity-specific effects absorb much of the baseline variation. Regarding the ESG dimensions, the coefficients of both the Environmental Score (0.0008, p = 0.8302) and the Social Score (-0.0005, p = 0.8946) are close to zero and statistically insignificant, indicating no evidence of a systematic relationship between ESG performance and financial performance. Among the control variables, Leverage (0.0681, p = 0.7536), Firm Size (0.0372, p = 0.5982), and Innovation (0.2815, p = 0.5252) all

ISSN: 2658-8455
Volume 6, Issue 9 (2025), pp. 652-670.

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show positive signs but fail to reach statistical significance. These findings suggest that, although innovation and firm size may exhibit a positive tendency, their effects on ROA are not robust in the present sample.

In summary, while the poolability test validates the use of a fixed-effects model to capture firm-specific heterogeneity, none of the explanatory variables—including ESG dimensions, leverage, firm size, or innovation—display a statistically significant effect on financial performance. This evidence does not support the hypothesis of a direct link between ESG performance and ROA in the analyzed context.

- ***Random-Effects Panel Model***

Table 5: Random effect model results

Variable	Coefficient	Erreur Std.	T-stat	P-value	IC Inf.	IC Sup.
Constant	-0.0594	0.0625	-0.9500	0.3476	-0.1855	0.0668
Environmental_Score	-9.71e-06	7.93e-05	-0.1224	0.9032	-0.0002	0.0002
Social_Score	8.33e-05	8.20e-05	1.0164	0.3063	-7.8e-05	0.0002
Governance_Score	-4.45e-05	0.0001	-0.3195	0.7509	-0.0003	0.0002
Debt-to-Assets Ratio	0.0100	0.0158	0.6312	0.5318	-0.0209	0.0409
Log_Size_Assets	0.0040	0.0034	1.1600	0.2526	-0.0029	0.0109
Innovation	0.0478	0.0143	3.3376	0.0013	0.0198	0.0759
Sector_Technologies	0.0882	0.0181	4.8828	0.0000	0.0518	0.1247
Sector_Energie	0.0499	0.0145	3.4392	0.0013	0.0206	0.0791
Country_USA	0.0002	0.0045	0.0356	0.9718	-0.0089	0.0093

Source: computed by author

The overall explanatory power of the model is relatively strong, with an R^2 (Overall) of 0.9459. However, the results indicate that most explanatory variables do not have a statistically significant effect on ROA, as their p-values are all greater than the 0.05 threshold. Specifically, the Environmental Score shows a very low coefficient with a p-value of 0.9032, suggesting no significant effect on ROA. The Social Score also has a low coefficient with a p-value of 0.4962, which means it does not clearly influence ROA. Similarly, the Governance Score (p-value 0.7509), the leverage ratio measured by Debt-to-Assets (p-value 0.7514), firm size expressed as the logarithm of assets (p-value 0.2526), and the Innovation variable (p-value 0.2700) all fail to reach statistical significance. These findings collectively imply that, despite the high overall explanatory power of the model, none of these individual predictors demonstrate a meaningful effect on firm performance measured by ROA.

Regarding geographical effects, the analysis compares companies located in the United States with those in France. The estimated coefficient is 0.0002, suggesting that being located in the United States is associated with a very small average increase in ROA compared to a French company. However, the p-value of 0.9718 is extremely high, indicating that this effect is not statistically significant. Furthermore, the confidence interval ranges from −0.0089 to 0.0093, which includes zero, confirming the absence of any significant difference in ROA based on geographical location.

Table 6: Panel Model Results on Firm Performance (ROA)

Variable	**Modèle 1 : Fixed effects**	**Modèle 2 :** Fixed-Effects Model temporal effects	**Modèle 3 :** Random-Effects
R-squared (Within)	0.1520	0.1173	0.0455
R-squared (Overall)	-	-	0.9459
R-squared (Between)	-	-	0.9958
F-statistic	1.2188 (p = 0.3216)	0.5946 (p = 0.7042)	81.592 (p = 0.0000)
F-test for Poolability	5.9286 (p = 0.0000)	4.5104 = 0.0002)	-

Source: computed by author

Based on the provided results, the Random-Effects model (Modèle 3) appears to have the highest explanatory power and overall significance, as indicated by its high R-squared values and highly significant F-statistic. However, the F-test for Poolability results for the Fixed-Effects models suggest that a simple pooled OLS model is not appropriate, and a model that accounts for panel-specific effects is necessary. This information helps guide the selection of the most appropriate panel data regression model for the study.

4.2. Comparison with the Hausman Test

The purpose of the Hausman test is to compare the fixed-effects model and the random-effects model to determine which one is econometrically valid.

Table 7: Hausman test

Test	**Result**
Hausman Test	Comparison Fixed Effects vs. Random Effects
Test Statistic	-0.4757
Degrees of Freedom	6
P-value	1.0000
Conclusion	Fail to reject H_0: Random effects are appropriate.

Source: computed by author

The null hypothesis (H_0) assumes that the entity-specific effects are not correlated with the explanatory variables, which implies that the random-effects model is valid and more efficient. Conversely, the alternative hypothesis (H_1) assumes that such a correlation exists, in which case the fixed-effects model should be preferred. In this study, the Hausman test yields a statistic of –0.4757, a negative value that may result from numerical rounding or variance differences when matrices are nearly singular. With 6 degrees of freedom and a p-value of 1.0000, the test outcome indicates that the null hypothesis cannot be rejected. Since this p-value is far above the conventional 0.05 threshold, there is no statistical evidence that the entity-specific effects (companies) are correlated with the explanatory variables. Therefore, the use of the random-effects model is justified, as it provides more efficient estimations with lower variance under the validity of H_0.

ISSN: 2658-8455
Volume 6, Issue 9 (2025), pp. 652-670.

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4.3. Discussion

4.3.1 Discussion of the obtained results

- ***The technology sector as a driver of profitability***

The results indicate a significant and positive effect of the technology sector on return on assets (ROA). This finding can be attributed to the ability of these companies to generate high margins, thanks to sustained innovation dynamics and the commercialization of high-value-added products. The sector also benefits from significant economies of scale, allowing for the amortization of fixed costs over a growing volume of revenue. Furthermore, the global digitalization trend, accelerated by the COVID-19 pandemic, strongly stimulated demand for technologies. Between 2021 and 2024, this trend was supported by incentive public policies: in the United States, the IRA[1] (2022) encouraged investments in green technologies and artificial intelligence, while in France, the PFR[2] promoted the digitalization of SMEs and support for innovation.

- ***The energy sector: a strategic contribution***

The energy sector also shows a positive and significant association with ROA. This performance is based on the stability of energy demand, even during economic slowdowns, as well as the ability of companies to benefit from high prices in energy markets (oil, gas, electricity). Nevertheless, this sector remains constrained by high infrastructure costs and increasing environmental regulations.
Modernization efforts were observed in both countries during the 2021-2024 period. In the United States, the BIL[3] (2021) allowed for significant investments in renewable energies. In France, the Climate and Resilience Law[4] (2021) strengthened energy transition objectives by supporting low-carbon energy sources.

- ***ESG scores: a delayed influence on performance***

ESG (environmental, social, governance) scores do not show a significant effect on ROA. This absence of immediate impact can be explained by the time lag between ESG investments and financial returns. Indeed, the benefits of responsible practices such as emission reduction or improved working conditions generally materialize in the long term.
During the studied period, notable regulatory advances were recorded:

- In France, the PACTE Law[5] encouraged companies to integrate ESG considerations into their strategy.
- In the United States, the SEC[6] proposed ESG disclosure standards, aiming to increase transparency and strengthen incentives for sustainable practices.

- ***Debt-to-Assets Ratio: Controlled Financial Management***

The debt-to-assets ratio does not have a significant effect on ROA, suggesting prudent debt management among the observed companies. This result may reflect a strategic use of debt as a financing lever, associated with effective control mechanisms.
Between 2021 and 2024, economic conditions influenced debt levels. In France, the PGE [7](State Guaranteed Loan) supported company cash flow during the health crisis. In

[1] *IRA : inflation reduction act*
[2] *PFR: plan france reliance*
[3] *BIL : Bipartisan Infrastructure Law*
[4] *CRL : Climate and Resilience Law*
[5] *PACTE Law : Plan d'Action pour la Croissance et la Transformation des Entreprises*
[6] *SEC : Securities and Exchange Commission*
[7] *PGE : Prêt Garanti par l'État*

the United States, low-interest rate policies favored access to financing to support growth.

- ***Asset Size: A Secondary Determinant of ROA***

Firm size, measured by the logarithm of assets, has no significant effect on profitability. While large companies may benefit from scale advantages, they can also face organizational inefficiencies. Conversely, smaller structures can compensate for their size with their agility and ability to innovate quickly.
During the 2021-2024 period, support policies targeted companies of all sizes:

- The Plan France 2030 strengthened measures supporting innovative startups and SMEs.
- In the United States, the SBIR[8] program contributed to financing innovative projects carried out by small businesses.

- ***Innovation: A Long-Term Competitiveness Lever***

Innovation, although a key element of competitiveness, does not appear as a significant determinant of ROA in the short term. This can be explained by the inherent delays in making research and development investments profitable, which are often long and uncertain.
Between 2021 and 2024, several policies encouraged innovation. In France, the CIR[9] (Research Tax Credit) was maintained as a central tool for supporting research and development. In the United States, the CHIPS[10] Act 2022 strengthened national semiconductor production capacities, a strategic sector for technological innovation.

- ***France-United States Comparison: Contrasting Economic Environments***

The analysis does not reveal a significant difference in financial performance (ROA) between French and American companies. However, the two countries operate in distinct economic contexts:

- The United States offers a competitive environment, fluid access to capital markets, and an entrepreneurial culture oriented towards innovation and risk-taking.
- In France, companies benefit from strong public support, particularly in the areas of ecological transition and innovation, but must contend with a more restrictive regulatory framework.

These specificities intensified between 2021 and 2024. In the United States, economic policies favored a rapid recovery through massive investments in infrastructure and technology. In France, initiatives such as the Plan France Relance prioritized a strategy of resilience and long-term sustainability. These approaches illustrate the differentiated priorities of the two countries.

4.3.2. Research Limitations

- **Limited sample size**: Due to the costs associated with accessing paid databases, the sample analyzed was limited in the number of companies and sectors. This may restrict the scope of the results and limit their generalization to the entire economic fabric.
- **Selection bias related to data sources**: Only companies publishing ESG data accessible via commercial databases could be included. This may introduce bias by excluding companies potentially less transparent on these aspects and reduce the representativeness of the sample.
- **Limited geographical scope**: The analysis focused on a restricted number of countries. A more geographically extended sample would have allowed for observing broader contextual variations in the relationship between ESG criteria and financial performance.

[8] *SBIR : Small Business Innovation Research*
[9] *CIR : Crédit d'Impôt Recherche*
[10] *CHIPS : creating Helpful Incentives to Produce Semiconductors*

ISSN: 2658-8455
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- **Omission of unobserved contextual variables**: Certain important explanatory variables, particularly institutional, cultural, or cyclical factors, could not be integrated into the models due to their unavailability. This may influence the results and limit the precision of the interpretations.
- **Perspectives for methodological improvement**: These limitations highlight the interest of future research mobilizing more complete data, covering a greater diversity of companies, sectors, and countries, and integrating complementary econometric approaches to refine the analysis.

5. Conclusion

The theoretical review demonstrates that ESG (Environmental, Social, and Governance) criteria have become a crucial aspect of corporate strategy, shaping both financial performance and long-term sustainability. Empirical evidence shows that companies integrating ESG practices can enhance profitability, mitigate operational and financial risks, and foster innovation. By synthesizing findings from multiple studies across sectors and geographies, this research confirms the relevance of ESG as a strategic tool that goes beyond ethical considerations to create tangible financial and societal value.

Methodologically, the study applied a quantitative panel data approach, combining ESG scores with corporate financial indicators for selected companies in the USA and France. The research design accounted for both aggregate ESG scores and individual E, S, and G dimensions, alongside control variables such as firm size, sector, innovation, and leverage. The conceptual model and econometric panel analysis provided a rigorous framework to examine the relationship between ESG adoption and corporate financial performance, while considering sectoral and geographical influences.

In general terms, the study integrates theoretical and empirical insights to provide a comprehensive understanding of the ESG–financial performance link. The analysis demonstrates that ESG adoption contributes positively to Return on Assets (ROA), highlighting a multifaceted relationship influenced by sectoral, geographical, and organizational factors. The findings bridge the gap between theory and practice, illustrating how ESG strategies can be operationalized to generate value and strengthen corporate resilience.

The study's contributions are both theoretical and empirical. Theoretically, it distinguishes the Environmental, Social, and Governance dimensions and clarifies their specific effects on corporate performance. Empirically, it offers evidence from a dual-country sample, providing insights into sectoral and geographical variations in ESG impacts. These contributions inform corporate managers, investors, and policymakers on how ESG adoption can reinforce long-term competitiveness, innovation, and sustainable growth.

Finally, the research opens several promising avenues for future exploration. Subsequent studies could investigate the dynamic interplay between ESG practices and technological innovation, explore ESG impacts in emerging markets, or examine the role of digital integration in enhancing ESG performance. By highlighting these opportunities, the study provides actionable guidance for both academics and practitioners while maintaining an optimistic outlook on the transformative potential of ESG strategies for sustainable corporate development.

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Appendices

Modèle à effets fixes (avec effets spécifiques par entité) :
PanelOLS Estimation Summary

Dep. Variable:	ROA	R-squared:	0.1520
Estimator:	PanelOLS	R-squared (Between):	-1.4644
No. Observations:	52	R-squared (Within):	0.1520
Date:	Tue, Jun 03 2025	R-squared (Overall):	-1.3795
Time:	18:03:40	Log-likelihood	186.94
Cov. Estimator:	Unadjusted		
		F-statistic:	1.2188
Entities:	13	P-value	0.3216
Avg Obs:	4.0000	Distribution:	F(5,34)
Min Obs:	4.0000		
Max Obs:	4.0000	F-statistic (robust):	1.2188
		P-value	0.3216
Time periods:	4	Distribution:	F(5,34)
Avg Obs:	13.000		
Min Obs:	13.000		
Max Obs:	13.000		

Parameter Estimates

	Parameter	Std. Err.	T-stat	P-value	Lower CI	Upper CI
const	-0.0295	0.5795	-0.0508	0.9598	-1.2071	1.1482
Environmental_Score	0.0003	0.0033	0.0995	0.9214	-0.0064	0.0071
Social_Score	-4.429e-05	0.0032	-0.0137	0.9891	-0.0066	0.0065
Endettement_Dette_Actifs	0.1259	0.1635	0.7698	0.4467	-0.2064	0.4582
Taille_Log_Actifs	-0.0022	0.0509	-0.0441	0.9651	-0.1056	0.1011
Innovation	0.4025	0.3857	1.0435	0.3041	-0.3814	1.1864

F-test for Poolability: 5.9286
P-value: 0.0000
Distribution: F(12,34)

Parameter Estimates

	Parameter	Std. Err.	T-stat	P-value	Lower CI	Upper CI
const	-0.5006	0.8390	-0.5967	0.5550	-2.2118	1.2106
Environmental_Score	0.0008	0.0037	0.2162	0.8302	-0.0067	0.0082
Social_Score	-0.0005	0.0035	-0.1335	0.8946	-0.0076	0.0067
Endettement_Dette_Actifs	0.0681	0.2150	0.3167	0.7536	-0.3705	0.5066
Taille_Log_Actifs	0.0372	0.0698	0.5325	0.5982	-0.1053	0.1797
Innovation	0.2815	0.4380	0.6427	0.5252	-0.6119	1.1749

F-test for Poolability: 4.5104
P-value: 0.0002
Distribution: F(15,31)

Modèle à effets fixes (avec effets spécifiques par entité et temporels) :
PanelOLS Estimation Summary

Dep. Variable:	ROA	R-squared:	0.0875
Estimator:	PanelOLS	R-squared (Between):	-10.376
No. Observations:	52	R-squared (Within):	0.1173
Date:	Tue, Jun 03 2025	R-squared (Overall):	-9.8253
Time:	18:03:40	Log-likelihood	187.68
Cov. Estimator:	Unadjusted		
		F-statistic:	0.5946
Entities:	13	P-value	0.7042
Avg Obs:	4.0000	Distribution:	F(5,31)
Min Obs:	4.0000		
Max Obs:	4.0000	F-statistic (robust):	0.5946
		P-value	0.7042
Time periods:	4	Distribution:	F(5,31)
Avg Obs:	13.000		
Min Obs:	13.000		
Max Obs:	13.000		

Parameter Estimates

	Parameter	Std. Err.	T-stat	P-value	Lower CI	Upper CI
const	-0.0594	0.0625	-0.9500	0.3476	-0.1855	0.0668
Environmental_Score	-9.71e-06	7.933e-05	-0.1224	0.9032	-0.0002	0.0002
Social_Score	8.328e-05	0.0001	0.6864	0.4962	-0.0002	0.0003
Governance_Score	-4.447e-05	0.0001	-0.3195	0.7509	-0.0003	0.0002
Endettement_Dette_Actifs	0.0100	0.0312	0.3188	0.7514	-0.0531	0.0730
Taille_Log_Actifs	0.0040	0.0034	1.1600	0.2526	-0.0029	0.0109
Innovation	0.0478	0.0428	1.1177	0.2700	-0.0385	0.1341
Sector_Technologies	0.0882	0.0181	4.8828	0.0000	0.0518	0.1247
Sector_Énergie	0.0499	0.0145	3.4392	0.0013	0.0206	0.0791
Country_USA	0.0002	0.0045	0.0356	0.9718	-0.0089	0.0093

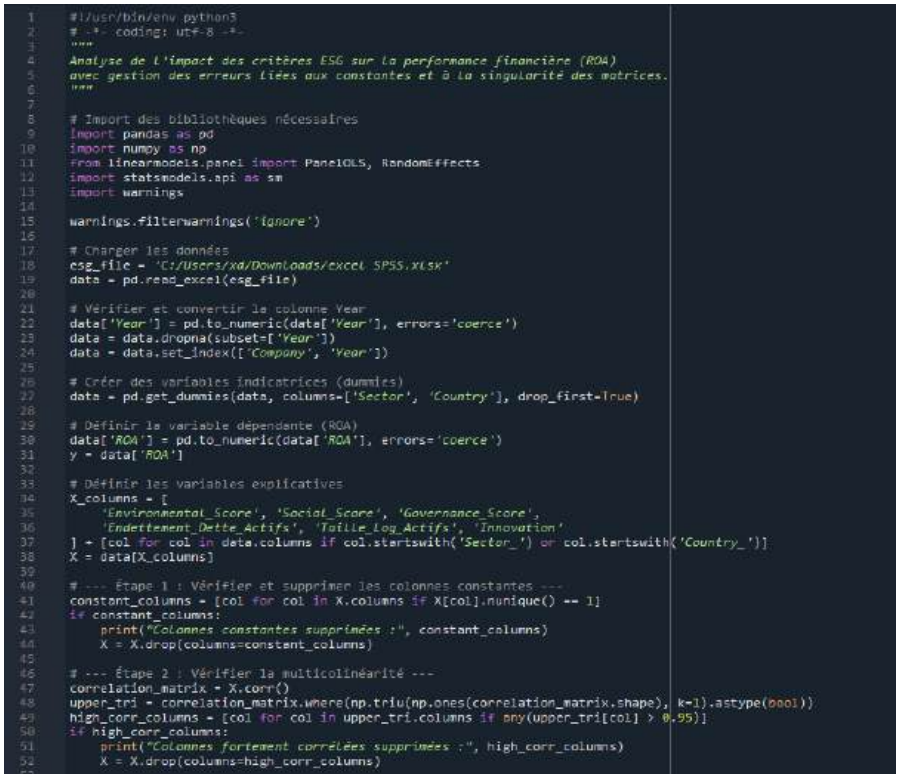
Modèle à effets aléatoires :
RandomEffects Estimation Summary

Dep. Variable:	ROA	R-squared:	0.9459
Estimator:	RandomEffects	R-squared (Between):	0.9958
No. Observations:	52	R-squared (Within):	0.0455
Date:	Tue, Jun 03 2025	R-squared (Overall):	0.9459
Time:	18:03:40	Log-likelihood	181.87
Cov. Estimator:	Unadjusted		
		F-statistic:	81.592
Entities:	13	P-value	0.0000
Avg Obs:	4.0000	Distribution:	F(9,42)
Min Obs:	4.0000		
Max Obs:	4.0000	F-statistic (robust):	81.592
		P-value	0.0000
Time periods:	4	Distribution:	F(9,42)
Avg Obs:	13.000		
Min Obs:	13.000		
Max Obs:	13.000		

Test de Hausman : comparaison Effets Fixes vs. Effets Aléatoires
Hausman test statistic : -0.4757
Degrees of freedom : 6
P-value : 1.0000
→ Non-rejet de H0 : les effets aléatoires sont appropriés.

ISSN: 2658-8455
Volume 6, Issue 9 (2025), pp. 652-670.

IJAFAME
International Journal of Accounting, Finance, Auditing, Management & Economics



```python
#!/usr/bin/env python3
# -*- coding: utf-8 -*-
"""
Analyse de l'impact des critères ESG sur la performance financière (ROA)
avec gestion des erreurs liées aux constantes et à la singularité des matrices.
"""

# Import des bibliothèques nécessaires
import pandas as pd
import numpy as np
from linearmodels.panel import PanelOLS, RandomEffects
import statsmodels.api as sm
import warnings

warnings.filterwarnings('ignore')

# Charger les données
esg_file = 'C:/Users/xd/Downloads/excel SPSS.xlsx'
data = pd.read_excel(esg_file)

# Vérifier et convertir la colonne Year
data['Year'] = pd.to_numeric(data['Year'], errors='coerce')
data = data.dropna(subset=['Year'])
data = data.set_index(['Company', 'Year'])

# Créer des variables indicatrices (dummies)
data = pd.get_dummies(data, columns=['Sector', 'Country'], drop_first=True)

# Définir la variable dépendante (ROA)
data['ROA'] = pd.to_numeric(data['ROA'], errors='coerce')
y = data['ROA']

# Définir les variables explicatives
X_columns = [
    'Environmental_Score', 'Social_Score', 'Governance_Score',
    'Endettement_Dette_Actifs', 'Taille_Log_Actifs', 'Innovation'
] + [col for col in data.columns if col.startswith('Sector_') or col.startswith('Country_')]
X = data[X_columns]

# --- Étape 1 : Vérifier et supprimer les colonnes constantes ---
constant_columns = [col for col in X.columns if X[col].nunique() == 1]
if constant_columns:
    print("Colonnes constantes supprimées :", constant_columns)
    X = X.drop(columns=constant_columns)

# --- Étape 2 : Vérifier la multicolinéarité ---
correlation_matrix = X.corr()
upper_tri = correlation_matrix.where(np.triu(np.ones(correlation_matrix.shape), k=1).astype(bool))
high_corr_columns = [col for col in upper_tri.columns if any(upper_tri[col] > 0.95)]
if high_corr_columns:
    print("Colonnes fortement corrélées supprimées :", high_corr_columns)
    X = X.drop(columns=high_corr_columns)
```

```python
# --- Étape 3 : Vérifier le ratio observations/colonnes ---
if X.shape[0] <= X.shape[1]:
    print("Attention : Le nombre d'observations est inférieur ou égal au nombre de variables explicatives.")
    print(f"Nombre d'observations : {X.shape[0]}, Nombre de variables explicatives : {X.shape[1]}")

# --- Étape 4 : Ajouter une constante ---
if 'const' not in X.columns:
    X = sm.add_constant(X, has_constant='skip')
    print("Constante ajoutée à X.")

# --- Modèle à effets fixes ---
print("\nModèle à effets fixes (avec effets spécifiques par entité) :")
model_fixed = PanelOLS(y, X, entity_effects=True, drop_absorbed=True)
results_fixed = model_fixed.fit()
print(results_fixed.summary)

# --- Modèle à effets fixes avec effets temporels ---
print("\nModèle à effets fixes (avec effets spécifiques par entité et temporels) :")
model_fixed_time = PanelOLS(y, X, entity_effects=True, time_effects=True, drop_absorbed=True)
results_fixed_time = model_fixed_time.fit()
print(results_fixed_time.summary)

# --- Modèle à effets aléatoires ---
print("\nModèle à effets aléatoires :")
model_random = RandomEffects(y, X)
results_random = model_random.fit()
print(results_random.summary)
```

```python
# --- Test de Hausman ---
print("\nTest de Hausman : comparaison Effets Fixes vs. Effets Aléatoires")

# Aligner les coefficients sur les variables communes
b = results_fixed.params
B = results_random.params

# Restreindre à l'intersection des coefficients (certains peuvent être "absorbés" dans le modèle fixe)
common_coef = b.index.intersection(B.index)

# Calcul des différences de coefficients et des matrices de covariance
b = b[common_coef]
B = B[common_coef]

vb = results_fixed.cov.loc[common_coef, common_coef]
vB = results_random.cov.loc[common_coef, common_coef]

diff = b - B
V_diff = vb - vB

# Calcul de la statistique de Hausman
from numpy.linalg import inv
from scipy.stats import chi2

hausman_stat = float(diff.T @ inv(V_diff) @ diff)
df = len(diff)
p_value = chi2.sf(hausman_stat, df)

print(f"Hausman test statistic : {hausman_stat:.4f}")
print(f"Degrees of freedom     : {df}")
print(f"P-value                : {p_value:.4f}")

# Interprétation
if p_value < 0.05:
    print("→ Rejet de H0 : Les effets fixes sont préférables.")
else:
    print("→ Non-rejet de H0 : Les effets aléatoires sont appropriés.")
```