How national green innovation shapes stock market capitalization in MENA countries?

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Abstract

As countries address the threat of climate change, many developing economies are diversifying their resources. Understanding the association between progress in green innovation and stock market valuation is therefore important for the transition to a low-carbon economy. This study examines the influence of green innovation at the country level on the market value of domestic listed firms across 11 Middle East and North Africa (MENA) countries from 2014 to 2023. The findings reveal a paradoxical relationship between innovation and market valuation. Although a positive correlation suggests that sustainability signals stock market strength, the regression results indicate a negative, statistically significant effect when heterogeneity and endogeneity are controlled for. These results indicate that country heterogeneity matters and that green innovation currently imposes a short-term financial burden rather than generating a valuation premium in MENA stock markets. This may reflect high costs and the reallocation of resources towards conventional energy and research and development (R&D), positioning these economies in the early phase of the transition to a low-carbon economy. This paper contributes to the literature by identifying green innovation development as a significant determinant of stock market valuation. It also suggests that policymakers should prioritise policy-led development, including intellectual property protection, R&D subsidies, and tax credits, to offset transition costs and help green innovation to strengthen stock market resilience and achieve low-carbon economies in the MENA region.

Introduction

Climate change has increased the need for market mechanisms that support a low-carbon transition. For instance, the Russia–Ukraine war sharply increased energy price volatility, which directly affected firm performance and risk profiles in energy-importing markets. In addition, the resource curse has prompted policy responses in global stock markets, showing the importance of national policy mechanisms in reducing external shocks and supporting the move to a low-carbon economy (Alazmi et al., 2023).

The paradoxical relationship between environmental sustainability and financial performance has become a major area of finance and economic research as countries confront economic instability and climate change. Global acknowledgement of environmental degradation has reached a threshold at which the Paris Agreement and the United Nations' Sustainable Development Goals (SDGs) place unprecedented pressure on countries to transition to low-carbon economies (Sinha et al., 2020). In this context, national green innovation (GI) can play a vital role in reducing environmental degradation. GI is defined as the development of green or sustainable operational processes, products, or technologies that decrease transition risks, lessen over-dependence on conventional resources, and improve resource efficiency. It has become an important tool for attaining these national sustainability targets (Suo et al., 2024). A strand of the literature has emphasised the regulatory and operational costs of such transitions, whereas more recent

work suggests that GI can serve as a significant driver of firms' competitive advantage and valuation in stock markets.

The high degree of volatility in conventional resource prices generated by the Russia–Ukraine war highlights the urgent need for countries to strengthen GI development to attain market stability and energy security (Alazmi et al., 2023). The Middle East and North Africa (MENA) countries occupy a distinct and complex place in this transition. Energy-importing countries are exposed to the resource curse and geopolitical shocks. As a result, many economies are heavily dependent on conventional resources, and their development paths are largely facilitated by conventional energy sources. This dependency has contributed to environmental issues. In 2017, the MENA region accounted for approximately 7.33% of global CO_2 emissions, despite generating only approximately 4% of global GDP (Omar, 2019; World Bank, 2018). Furthermore, Saudi Arabia and several other countries in the region rank among the world's top polluters in terms of per capita CO_2 emissions. In response, many countries have initiated sustainability agendas, such as Saudi Arabia's Vision 2030, to diversify their resource bases and expand the role of green innovation and renewable energy in their energy mixes (Mahmood et al., 2023).

As these countries move towards a low-carbon economy, their stock markets serve as an important indicator of investor confidence and financial market strength during the transition. According to signalling theory, Bergh et al. (2019) suggest that a firm's commitment to GI sends a credible signal to stakeholders regarding its long-term financial stability and governance, hence enhancing its market value. By reducing information asymmetry, firms' green initiatives can build market trust and attract more investors (Huang and Shen, 2024). The resource-based view (RBV) suggests that GI can function as a distinctive asset that provides firms with a sustainable competitive advantage in oil-dependent economies, thereby decreasing the cost of capital and market value (Suo et al., 2024).

Despite the importance of GI as a driver of resilient markets, limited attention has been paid to its effect on aggregate market valuation. In addition, most of the existing literature focuses on developed economies or BRIICS countries (Brazil, Russia, India, Indonesia, China, and South Africa; Makeeva et al., 2024; Sinha et al., 2020), whereas MENA countries remain underexamined and cross-country comparative analyses are limited. Although many MENA countries have pursued green innovation, it remains unclear whether national green initiatives translate into valuation premiums for listed firms in specific institutional settings (Babiker, 2016). The region also shows marked heterogeneity in institutional governance and innovation infrastructure. Gulf Cooperation Council (GCC) states such as Saudi Arabia and the United Arab Emirates (UAE) have made substantial state-led investments in renewable energy and environmental patent protection, whereas North African economies such as Egypt and Morocco continue to face structural constraints in financing green innovation (Elkebti et al., 2025).

This study addresses these gaps by examining the relationship between the level of national GI development and the market value of listed firms across 11 countries: Bahrain, Egypt, Saudi Arabia, Israel, the UAE, Qatar, Kuwait, Morocco, Jordan, Turkey, and Oman. It uses an annual panel dataset covering 2014 to 2023. Several econometric methods are employed to capture the dynamic effects across diverse stock markets. The study analyses how national GI affects aggregate market valuation. It also examines the role of macroeconomic control variables in shaping this relationship and compares the effects across MENA markets with different levels of development.

This study makes three contributions. First, it fills a gap in the MENA literature by providing empirical evidence on the outcomes of sustainability-oriented innovation in a region long associated with fossil-fuel dependence. Second, it offers practical insights for policymakers and practitioners by showing that the transition to a low-carbon economy is not simply an environmental issue; it is also linked to stock market complexity. Third, by identifying the signalling mechanisms connected with sustainability, the study shows how sustainability initiatives can reduce transition risk and strengthen firms' resilience to economic shocks and the resource curse. Because the resource curse remains a major challenge, understanding these dynamics is important for assessing whether the MENA region's low-carbon transition will support environmental quality and long-term stock market prosperity or create further difficulties.

Literature Review

A substantial body of literature examines the relationship between GI and stock market valuation from the perspectives of environmental management and firm financial performance. As both developing and developed economies seek to meet the targets of the Paris Agreement, GI has become a strategic asset that can help firms achieve competitive advantage and reduce transition risks (Sinha et al., 2020). This review

synthesises the theoretical foundations of GI, its impact on firm performance and market capitalization, and its relevance to capital markets.

This study draws on several complementary theoretical frameworks. First, the Porter Hypothesis suggests that effective environmental regulation can stimulate green innovation, improve market competitiveness, and offset potential compliance costs (Porter and Van der Linde, 1995; Zhang et al., 2024).

Second, signalling theory suggests that a firm's investment in GI acts as a credible signal to external stakeholders, indicating strong management quality and long-term financial viability. When this signal is communicated effectively, it can reduce information asymmetry between managers and investors by disclosing environmental performance, an important aspect of GI, and thereby lowering uncertainty and strengthening market trust (Lin et al., 2021). Risk disclosure also helps address agency problems such as adverse selection and moral hazard by reducing conflicts of interest between managers and owners. In addition, disclosing sustainability performance, such as Environmental, Social, and Governance (ESG) scores, signals ethical behaviour and managerial transparency, reducing information asymmetry and limiting the withholding of bad news from the market (Hafez and Ebrahim, 2024).

Third, GI can be viewed as a distinctive strategic resource that enables firms to achieve sustainable financial gains and higher market value, which is consistent with the RBV (Makeeva et al., 2024). Agency theory likewise suggests that when firms disclose environmental performance, including GI activities, they strengthen their legitimacy in the eyes of market participants and improve financial performance (Hafez and Moawad, 2024).

Moreover, the Innovation Claudia Curve (ICC) suggests that the relationship between technological innovation and its environmental consequences follows an inverted U-shape (Sinha et al., 2020). According to this theory, environmental degradation rises during the initial stages of innovation implementation. Once innovation reaches a certain threshold, however, its effects begin to reduce carbon emissions (Mensah et al., 2018). This framework also helps explain developments at the firm-operational level. In the first stage of the ICC, firms often face high costs because substantial financial resources are diverted from current operations to fund research and development; this can reduce short-term market valuation (Semenova et al., 2024). At this stage, the financial burden and the diversion of resources towards GI outweigh any perceived valuation premium. As firms approach the turning point of the curve, the transition to the technique effect allows efficiency gains to support stronger long-term financial performance (Hashmi and Alam, 2019). At a later stage, these gains can turn the initial financial constraint into a valuation premium and lead to more sustainable market capitalisation over time. Although signalling theory suggests that GI indicates management quality in emerging markets, that signal may be weakened by the high initial costs of moving away from oil dependence, where conventional resources remain relatively cheap (Semenova et al., 2024).

A strand of empirical literature provides contradictory findings; some studies show that GI has a positive effect on firm valuation, whereas others report a negative effect. Evidence from China indicates that GI can significantly increase market value; Shu et al. (2024), for example, found that a one-unit increase in GI can raise Tobin's Q by about 18 units. Firms that report large numbers of green patents are also often found to earn higher profits and improve financial performance through greater transparency in environmental disclosure (Wurlod and Noailly, 2018). Another comparative study of Egypt and the United States shows that GI can strengthen firms' ability to absorb exogenous shocks during crises (Pasha and Wahba, 2024).

Other studies, however, report a negative relationship. Semenova et al. (2024) show that, although GI improves long-term financial performance, it may lead to weaker short-term outcomes because of high initial R&D expenditure and the substantial resources required for implementation. Some studies also identify a U-shaped relationship in which the initial costs of innovation reduce performance before the technique effect, that is, improved efficiency, eventually outweighs the scale effect, namely increased economic activity (Xie et al., 2022).

A growing body of research examines how GI influences capital-market efficiency. Stock price informativeness (SPI), defined as the degree to which stock prices incorporate firm-specific information, is positively affected by GI (Grewal et al., 2021; Huang and Shen, 2024). By increasing the transparency of firms' environmental commitments, GI can make stock prices more informative, which is especially beneficial for firms operating in weak institutional settings (Huang and Shen, 2024). GI also functions as a risk-mitigation tool. Firms with strong environmental performance face lower stock price crash risk because GI strengthens investor confidence and reduces the likelihood that managers will withhold negative news (Liu et al., 2022; Suo et al., 2024).

The MENA countries provide a distinctive setting for understanding GI as a strategic tool in the green economic transition because of the region's dependence on fossil fuels and its efforts to diversify resource bases (Sinha et al., 2020). In this transition, stock exchanges serve as important barometers of progress towards national sustainability targets such as Saudi Arabia's Vision 2030 (Kahia et al., 2023).

The existing literature on the MENA context highlights marked cross-country heterogeneity in green innovation development. GCC economies, led by Saudi Arabia and the UAE, have taken a proactive approach to national green initiatives, including green innovation development. Saudi Arabia, for example, accounted for 37% of regional green patents between 2010 and 2016, a trend that coincided with growth in the market capitalisation of the Tadawul stock exchange (Kahia et al., 2023; Mahmood et al., 2023). By contrast, North African countries such as Egypt and Morocco face structural barriers to financing innovation, which weakens the link between green initiatives and market valuation (Wagan et al., 2025). This pattern is consistent with evidence from the MENA region showing that GI may initially increase national emissions through greater economic activity, the scale effect, until a threshold is reached at which it begins to generate positive spillover effects for neighbouring countries and support a low-carbon transition across the region (Bilal et al., 2022; Mahmood et al., 2023).

Although part of the literature suggests that GI enhances firm value and stabilises capital markets, research on MENA countries still reveals a clear empirical gap. Existing studies tend to focus on individual countries, such as Saudi Arabia and Tunisia (Ghorbal et al., 2022; Kahia et al., 2023). There is therefore a need for a comprehensive cross-country panel-data analysis that accounts for regional institutional differences and examines how national-level green progress translates into market-capitalisation premiums or constraints for listed firms. This study addresses that gap by examining the financial consequences of the green transition in the MENA region over time.

Research Design

This study uses a panel dataset covering 2014 to 2023 to capture the dynamic effect of the shift to a low-carbon economy, measured through green innovation development, on market valuation in the MENA region. The sample comprises 11 countries: Bahrain, Egypt, Saudi Arabia, Israel, the UAE, Qatar, Kuwait, Morocco, Jordan, Turkey, and Oman. These countries represent a range of market structures, including active stock exchanges in both the resource-dependent GCC and the more diversified North African economies, allowing the analysis to capture national sustainability targets from both micro- and macro-level perspectives.

In this study, the data were compiled from several sources. GI (GreenInnov) was measured as the total number of environmental patents divided by the total number of patents, using data from the World Intellectual Property Organization (WIPO). This is a common proxy for assessing the effectiveness of environmental policy in promoting green innovation in emerging markets. It may also reflect firms' environmental practices in response to pollution penalties and external pressures such as market turbulence associated with the transition to a low-carbon economy, thereby sending a sustainable signal to market participants and increasing market capitalisation, as suggested by signalling theory (Qiu et al., 2020; Semenova et al., 2024). The dependent variable is the natural logarithm of the annual market capitalisation (MarketCapt) of domestic listed firms in each country, retrieved from the London Stock Exchange. This proxy is used to assess equity-market performance in MENA countries (Hassan et al., 2024).

For the control variables, GDP was measured as the natural logarithm of real GDP in US dollars. Inflation (Infla) was measured as the annual change in the Consumer Price Index (CPI). The market-liquidity variables (MLM1 and MLM2) were measured using the turnover of traded stocks divided by GDP and the turnover of traded share value relative to total domestic market value, respectively. The financial-intermediation variables (FIM1 and FIM2) were measured as the ratios of broad money supply M3 to GDP and domestic credit to the private sector to GDP, respectively. Savings (Sav) were measured as gross domestic savings. These control variables help contextualise the empirical findings on GI and MarketCapt by showing how macroeconomic conditions can provide stability and a credible signal to market participants, as suggested by signalling theory (Cherif and Gazdar, 2010). All control variables were obtained from the World Bank.

Research Methodology

This study uses several econometric approaches, with the fixed-effects model as the main specification and the generalised method of moments as a robustness check. This choice is important because it helps

control for unobserved country-specific and time-invariant heterogeneity that could otherwise bias the results.

The baseline model is specified as follows

$\ln(MarketCapt_{i,t}) = \beta_0 + \beta_1 GreenInnov_{c,t} + \beta_2 ControlsVar_{i,t} + \alpha_i + \gamma_t + \epsilon_{i,t}$,

where $\ln(MarketCapt_{i,t})$ represents the log of the total market capitalisation of country i in year t, $GreenInnov_{c,t}$ denotes the national GI level of country c in year t, $ControlsVar_{i,t}$ includes a vector of macroeconomic control variables, and α_i and γ_t represent country and time fixed effects, respectively, capturing differences in national institutional settings and common global time effects. $\epsilon_{i,t}$ is the error term.

To assess the validity of the findings, several diagnostic and robustness tests were performed. First, the Variance Inflation Factor (VIF) was used to confirm that multicollinearity remained below the threshold of 5; the mean VIF is reported in Table 3. Second, the Hausman test was used to justify the choice of fixed effects over random effects; the results are also presented in Table 3. The fixed-effects model is used to control for country-specific characteristics, ensuring that the findings reflect within-country variation rather than being driven by unobserved heterogeneity. In addition, to address the potential dynamic relationship between innovation and market value, the generalised method of moments (GMM) was employed. The GMM specification uses first-difference lags and lagged dependent and independent variables as internal instruments to reduce unobserved time-invariant individual effects and limit instrument proliferation. To assess the validity of the GMM model, Hansen and Sargan tests and the Arellano–Bond AR (1) and AR(2) tests were used to examine serial correlation in the residuals, instrument exogeneity, over-identifying restrictions, and the absence of second-order serial correlation (Blundell and Bond, 1998). The results of these validity tests are presented in Table 3.

Research Findings and Discussion

The empirical findings are presented and interpreted within the research framework. To begin, the descriptive statistics in Table 1 outline the main characteristics of the variables across the 11 MENA countries from 2014 to 2023. Market capitalization (MarketCapt) shows a mean value of 20.388, with a range from 21.23 to 28.43. This high valuation level reflects the maturing nature of MENA capital markets. The standard deviation of 1.2305 points to economic heterogeneity within the sample, contrasting the large, more developed Gulf markets with the smaller and often more volatile exchanges in North Africa.

GreenInnov has a mean value of 4.086 and a maximum of 9.282. This suggests that, although some MENA countries are making substantial progress in environmental technology development, there is a significant gap across the region. Supporting evidence confirms this disparity: Saudi Arabia accounts for a dominant 37% share of regional green patents between 2010 and 2016, followed by the UAE and Egypt, whereas Oman and Morocco contribute much smaller shares. The relatively high standard deviation of 1.659 for GreenInnov confirms that the green transition is progressing at different speeds across the region, often driven by state-led frameworks such as Saudi Arabia's Vision 2030. Most control variables show relatively steady mean values and standard deviations, whereas MLM2 and FIM2 display substantial volatility, indicating differences in market functioning across countries.

Table 1: Descriptive Statistics

Variable	mean	sd	min	max
MarketCapt	20.388	1.2305	21.23	28.43
GreenInnov	4.086	1.659	1.3272	9.282
Infla	4.937	9.82833	-2.4302	72.209
Sav	29.5021	16.1423	0.14732	68.652
GDP	11.382	0.45389	10.4821	12.033
MLM1	19.255	21.6872	0.83522	120.673
MLM2	39.8202	52.2349	17.4705	388.3724
FIM1	64.2134	23.2786	3.44223	138.3428
FIM2	85.5262	20.3712	37.10877	128.6732

Notes: MarketCapt = log of the sum of the market capitalization of listed firms; GreenInnov = total number of environmental patents divided by total patents; Infla = annual change in the Consumer Price Index (CPI); Sav = share of gross domestic savings minus consumption expenditure from GDP; GDP = natural logarithm

of real GDP in US dollars; MLM1 = turnover of traded stocks divided by GDP; MLM2 = turnover of traded share value relative to total domestic market value; FIM1 = ratio of broad money supply M3 to GDP; FIM2 = domestic credit to the private sector divided by GDP.

Building on the descriptive statistics, the correlation matrix provides insight into the relationships among the variables. As shown in Table 2, GI is positively and significantly correlated with MarketCapt (0.2218***). This suggests that national commitments to green innovation may send a credible signal to market participants about institutional quality and long-term market stability, as proposed by signalling theory (Spence, 1973; Suo et al., 2024). In MENA markets, higher national GI may reduce information asymmetry and attract institutional investors, increasing market value (Huang and Shen, 2024). Most control variables also show significant correlations with MarketCapt, indicating that market liquidity (MLM1 and MLM2) and macroeconomic stability (GDP and Sav) drive market valuation (Chan et al., 2014; Cherif and Gazdar, 2010).

Table 2: Correlation Matrix

	MarketCapt	GreenInnov	Infla	Sav	GDP	MLM1	MLM2	FIM1	FIM2
MarketCapt	1								
GreenInnov	0.2218***	1							
Infla	-0.0388	0.103	1						
Sav	0.4772***	0.1833**	-0.42***	1					
GDP	0.7454***	0.202***	0.3562**	0.139	1				
MLM1	0.672***	0.246***	0.0514	0.3024**	0.6019	1			
MLM2	0.34***	0.04712	0.2368***	-0.0333	0.72***	0.527***	1		
FIM1	-0.0309	-0.057	-0.34***	0.35***	-0.37**	-0.282*	-0.33**	1	
FIM2	-0.2038	0.0632	-0.0642	-0.48***	-0.23**	-0.29*	-0.2***	0.32***	1

Notes: *** p < 0.01, ** p < 0.05, * p < 0.1

Although the descriptive statistics and the correlation matrix suggest a positive relationship, the estimated models indicate the opposite, which adds depth to the interpretation of the current stage of ICC development in the MENA countries. As shown in Table 3, the fixed-effects and GMM results offer a paradoxical view of how GI influences MarketCapt in the MENA region once confounding effects, heterogeneity, and endogeneity are controlled for. The correlation matrix shows a significant positive association between GI and market capitalization (0.2218***), suggesting that environmental commitment is recognised as a sign of sound governance, in line with signalling theory (Gul et al., 2011; Suo et al., 2024). The regression results, however, point to short-term financial pressure and the challenges associated with the early stage of the ICC.

The findings show that the coefficient for GreenInnov is negative and statistically significant in the fixed-effects model (-0.05325). The effect is even larger in the GMM model (-0.51073), which serves as a robustness check. These negative coefficients suggest that national-level GI acted as a short-term burden on firm valuation in MENA markets during the transition to a green economy. A critical reading of the wider literature reveals a similar pattern of short-term financial trade-offs. Studies of European and North American firms show that GI can reduce short-term financial performance because substantial resources are withdrawn from current operations to fund R&D and cover the pioneer costs of new green technologies (Ruggiero and Lehkonen, 2017; Semenova et al., 2024). These findings are consistent with Xie et al. (2022), who identify a U-shaped relationship between innovation and firm performance, in which the initial phase of environmental investment, the scale effect, imposes considerable costs before the technique effect produces more positive returns at higher levels of development, as suggested by the ICC (Borsatto et al., 2020). In the MENA countries, many economies remain in the early stages of innovation and economic diversification, so the scale effect of implementing green technologies appears to outweigh the technique effect of improved efficiency, leading to negative effects on market capitalization (Mahmood et al., 2023; Zhang et al., 2022). This directly connects the study's findings to the ICC by showing that GI can have different effects at different stages of development. The negative effect of GI on MarketCapt supports the ICC's proposition that firms in the early phase of green innovation development struggle to use green

technology as a value-relevant asset that can enhance legitimacy, reduce risk, and improve market capitalization until a later threshold is reached.

Furthermore, GDP is the strongest determinant of market capitalization identified in the models, with a positive and significant coefficient of 1.3317 in the fixed-effects model and 2.0531 in the GMM model. This suggests that, for firms listed on MENA exchanges, overall economic stability remains the main determinant of market capitalization. Regional studies, including research on Saudi Arabia, also find a positive association between per capita GDP and stock market growth (Kahia et al., 2023). In developing economies, the scale effect, defined as the increase in industrial activity and energy consumption, remains the dominant challenge during the early growth phases of the ICC (Bai et al., 2019; Mahmood et al., 2023). The R-squared value of 0.8481 in the fixed-effects model indicates that the variables in the model, including economic growth, innovation, and market infrastructure, explain nearly 85% of the variation in market capitalization.

Lastly, the estimated models highlight the important role of macroeconomic variables. MLM1 has a significant positive effect, with a coefficient of 0.0141 in the fixed-effects model and 0.0262 in the GMM model. FIM1 is also positive, with coefficients of 0.0070 and 0.0208, respectively. These results support theories that stress the importance of robust financial infrastructure in enabling the green transition. In the MENA region, well-functioning financial intermediaries and liquid markets provide channels through which firms can access the capital needed for sustainable innovation (Paramati et al., 2017; Sadorsky, 2009). The positive effect of GI is often shaped by a country's income level, which reflects the role of domestic capital inflows in promoting stock market development in these economies (Shahbaz et al., 2018; Yu et al., 2022).

The estimated models add to the evidence of a dynamic transition in MENA stock markets. Although GI currently appears as a financial burden in the models (-0.053), signalling theory and the RBV suggest that this may represent a temporary entry cost (Makeeva et al., 2024; Suo et al., 2024). As these economies continue to grow, as indicated by the substantial GDP coefficient, the integration of green technologies may become increasingly value-relevant for long-term resource efficiency and for reducing stock price crash risk (Huang and Shen, 2024; Suo et al., 2024).

Table 3: Estimated Model Findings

Models	Fixed Effect		GMM Model	
Variable	Coefficient	Standard error	Coefficient	Standard error
Constant	6.9717	5.3247	23.8181**	9.28247
MarketCapt			-0.82000*	0.60052
GreenInnov	-0.053**	0.0438	-0.51073*	0.22384
GDP	1.3317***	0.59214	2.05312**	0.82358
MLM1	0.01412***	0.005256	0.0262**	0.00468
MLM2	-0.0047***	0.00152	-0.0049*	0.00167
FIM1	0.0070**	0.0045	0.0208***	0.00504
Sav	0.0063171	0.0065	-0.0092	0.02236
Infla	-0.0066215	0.0058	0.00337	0.00919
FIM2	-0.00482*	0.0042	-0.00082	0.00368
R-Square	0.8481			
Hausman test	Prob. = 0.0000			
Mean VIF	2.54			
Sargan test statistic			39.9670	
Sargan test (p)			Prob > chi2 = 0.2390	
Hansen test			Prob > chi2 = 0.512	
AR (1)			Pr > z = 0.022	
AR (2)			Pr > z = 0.624	

Notes: *** p < 0.01, ** p < 0.05, * p < 0.1.

Conclusion

This study provides a panel-data analysis of the interaction between national GI development and the market value of listed firms in 11 MENA countries. It aims to determine whether the region's shift towards environmental sustainability translates into a tangible financial premium or a market challenge in MENA stock markets.

The empirical findings present a complex picture of market valuation and reveal a paradox within the green transition in MENA economies. First, the correlation matrix shows a significant positive relationship between GI and market capitalization. This finding is consistent with the study's hypothesis that higher levels of national sustainability initiatives are associated with more resilient and better-functioning stock markets. The positive correlation suggests that investors generally view GI as an indicator of future economic resilience and financial stability (Gul et al., 2011). The estimated models, however, provide a more critical and nuanced picture. After controlling for confounding effects, heterogeneity, and endogeneity, the results show a statistically significant negative effect. This suggests that, from 2014 to 2023, the implementation of national GI imposed a short-term financial burden on the market capitalization of firms in the MENA region. This result is strongly supported by earlier research showing that firms investing in environmental innovation often experience weaker short-term financial outcomes because resources are diverted from current operations to fund R&D and implementation costs (Semenova et al., 2024). It is also consistent with the early phase of the ICC, in which the scale effect, the expansion of innovation-related economic activity, outweighs the technique effect, the efficiency gains from green technology diffusion. As a result, green technology remains costly for firms and may not yet be regarded by market participants as value-relevant information.

Furthermore, GDP emerges as a major determinant of market value, with a significant positive coefficient. This suggests that the scale effect, understood here as the current stage of development and the growth of economic activity, remains more important than GI in shaping the aggregate market value of listed firms at this stage of green development (Mahmood et al., 2023; Zhang and Chen, 2022). MLM1 and FIM1, as proxies for financial market stability and strength, were also found to be important structural facilitators of stock market maturity in these economies.

This study also contributes to theoretical work in environmental economics and finance. Signalling theory suggests that GI serves as a credible signal of governance quality and environmental performance disclosure, thereby reducing information asymmetry and agency costs. Market responses to this signal, however, are inconsistent, reflecting cross-country heterogeneity. The positive correlation points to the value relevance of the signal, whereas the negative regression effect suggests that market participants also perceive a high opportunity cost associated with environmental initiatives, which depresses stock market capitalization. In this sense, greenness may be viewed as a long-term asset but as a short-term liability. The findings also provide regional evidence for the ICC argument that the relationship between national GI and listed firms' market capitalization may follow an inverted U-shaped or U-shaped pattern (Sinha et al., 2020). The MENA region appears to be in the early phase, where the costs of adopting green technologies, the scale effect, exceed the efficiency gains, the technique effect, thereby placing downward pressure on market value, as shown in the estimated models. In addition, GI contributes to stock price informativeness by encouraging the incorporation of value-relevant environmental information into stock prices. By improving the transparency of environmental disclosure, GI may help developing and developed economies move away from synchronised market behaviour driven mainly by macroeconomic factors such as fossil fuel prices, financial development, and economic growth, thereby improving capital allocation and supporting the transition to a low-carbon economy and the development of stock markets (Huang and Shen, 2024).

The empirical evidence from this study leads to several recommendations for policymakers, practitioners, and financial institutions in the MENA region. Given the negative short-term effect of GI on market capitalization, listed firms appear to bear much of the financial weight of national sustainability agendas. Policymakers should therefore develop incentive-based frameworks to support initiatives such as Vision 2030 by introducing tax credits and R&D subsidies that can offset the financial constraints faced by firms. The region also shows marked heterogeneity. GCC countries have led green patent development, with Saudi Arabia holding a 37% regional share, whereas North African economies such as Egypt and Morocco continue to face structural economic constraints.

Policymakers could also develop a regional framework for green innovation that supports financing, encourages patent activity, and promotes green technological spillovers across MENA countries, thereby ensuring a more balanced pattern of green growth. Alternatively, GCC countries may focus on refining

their market signals, while North African countries focus on overcoming structural financing challenges that currently make GI a heavier financial burden. Moreover, practitioners and corporate managers must recognise that GI is a long-term green national commitment. In the early stages of development, firms may experience an immediate reduction in market value due to high initial investment costs. Over time, however, GI can help firms build competitive advantage and attract investors who prioritise Environmental, Social, and Governance criteria. To strengthen the GI signal, firms should improve the transparency of their environmental disclosure practices. Greater transparency reduces uncertainty and mitigates the risk of stock price crashes, making firms more attractive to market participants. Furthermore, the positive coefficients for market liquidity and financial intermediation indicate that a firm's ability to convert innovation into value depends on the maturity of the stock exchange. MENA nations should therefore continue to reform their capital markets to improve trading depth and credit access, both of which are essential channels for financing green transitions. GI can improve the performance of individual firms and support the overall development and resilience of stock markets.

This study shows that the effect of GI on stock market capitalization in MENA countries is characterised by a paradoxical innovation–valuation relationship. The region is currently facing the high costs associated with the scale effect of a low-carbon transition, as evidenced by the negative regression results, yet there is an underlying positive correlation. This highlights the role of green innovation in risk mitigation and suggests that such growth may become not only financially robust but also environmentally sustainable and resilient to global climate change, as observed in previous studies of developed economies.

This study has some limitations. First, the dataset includes only specific MENA countries and covers a limited time frame, which limits the generalisability of the findings. Second, this study uses only one country-specific factor, GI, as a measure of national green technological development during the transition, which limits the broader assessment of other influential national factors. Future research should therefore examine firm-level case studies and the role of intellectual property protection indices as moderating variables to further understand how the MENA region can manage the innovation–valuation paradox. Further studies could also compare GCC and non-GCC countries to address the heterogeneous scale and technique effects of the ICC.

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