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Does Environmental Regulation Affect Green Organisational Innovation? Managerial Environmental Concern as a Moderator of Firm Performance in Jordan's Agri-Food Industrial Sector

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Abstract: *The growing challenges of climate change and pollution have intensified the demand for sustainable business strategies. This study examines how environmental regulations (REG) influence the implementation of green organisational innovation (GOI) in Jordan's agri-food industrial sector. Additionally, it investigates whether GOI positively impacts firm environmental and financial performance (FEP and FFP) and explores how managerial environmental concern (MEC) moderates this relationship. This study adopts a cross-sectional design method by using stratified sampling to collect data from MSMEs operating in Jordan's agri-food industrial sector. Data analysis was performed using partial least squares structural equation modelling (PLS-SEM) based on 250 completed responses. The results reveal that REG significantly drives GOI, which subsequently enhances both FEP and FFP. However, MEC negatively moderates the GOI-performance relationship, suggesting an excessive focus on MEC may reduce the effectiveness of GOI. The study also highlights the dual role of MEC and its impact on GOI and firm performance. This study advances GOI research in developing economies by integrating ecological modernisation theory (EMT), the Porter hypothesis, and natural resource-based view (NRBV). It advises firms to balance regulatory compliance with*

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flexibility and policymakers to establish adaptive frameworks that promote GOI. Focusing on Jordan's agri-food sector, it offers insights for sustainability and competitiveness.

Keywords: Environmental regulation; Financial performance; Environmental performance; Green organisational innovation; Managerial environmental concern
JEL Classification: L53, Q58, O31

1. Introduction

Environmental concerns like water contamination, pollution, and climate change have escalated rapidly (Wei et al., 2012), with business executives contributing seriously towards addressing these issues through implementing effective environmental management practices. In the industrial sector, green innovation has become a critical strategy for improving business and environmental performance. Tang et al. (2018) note that the effect of green innovation on profitability depends on innovation type. Przychodzen et al. (2016) highlight that organisational culture and managerial factors influence the effectiveness of green innovation. Thus, improving business performance requires management to understand the relative benefits and challenges of each type of green innovation. Since organisational performance is more likely to improve through green organisational innovation (GOI) and green process innovations than through green product innovations, management should initially focus on GOI (Al-Hanakta et al., 2023). Accordingly, the present study emphasises GOI, particularly through integrating green innovation into value chain activities and creating systems to share knowledge on innovation among employees (Chen et al., 2006).

While the benefits of green innovation are evident, Zhang et al. (2017) find that profit is not always maximised since not every organisation can allocate sufficient resources for its adoption. Several studies find no relationship between firm financial performance (FFP) and green innovation, even if its effects on firm environmental performance (FEP) are apparent. Management decisions regarding green innovation , influenced by environmental concerns and strategic choices, are more impactful than merely adopting best practices (Xue et al., 2019). He and Wang (2023) urge policymakers to strengthen the positive influence of environmental regulations (REG) on green innovation by adopting innovation-driven development strategies, as well as boosting innovation in technology, processes, and operations. The present study aims to examine how REG influences the implementation of GOI in agri-food industrial firms in Jordan. As governments worldwide tighten environmental regulations, the findings of this study can inform policymakers on its effects on corporate innovation strategies, and thereby encourage policies that foster sustainable business practices.

While prior studies do not comprehensively investigate factors like GOI and managerial environmental concern (MEC) in enhancing firm performance, these factors dictate the failure or effectiveness of environmental management. The significance of the GOI metric due to firm performance remains critical because the external business climate is often volatile. GOI encompasses the support of green processes and innovations of green products (Birkinshaw et al., 2008) while allowing for green practices. This firm-level discretion means that managerial attitudes are critical to helping firms achieve sustainability. MEC determines the levels of sustainable development and firm performance because managers' concern for the environment drives green innovation and increased competitiveness of the organisation (Qui et al., 2010). MEC significantly contributes to the improvement of GOI through environmentally friendly practices (Birkinshaw et al., 2008). Studies have previously reported the positive impact of MEC on green innovation adoption, thereby suggesting its importance in implementation (Saudi et al., 2019; Ben Amara & Chen, 2020; Tang et al., 2018). Furthermore, Ahmed et al. (2023) observe that managerial commitment, and not just concern, moderates the relationship between green innovation and both environmental and organisational performance, incorporating human resource practices for a broader framework. Hence, this study fills this gap by applying MEC as a moderating variable that connects green innovation to firm performance in the agri-food industry of Jordan.

A number of studies point to the fact that the adoption of green innovation yields enhanced financial performance alongside improved environmental standing (Hizarci-Payne et al., 2021; Geng et al., 2021; Setyawati et al., 2020). Accordingly, the second objective of this study is to evaluate the positive impacts of GOI on a FEP and FFP performance in the agri-food sector in Jordan. How MEC and REG shape this relationship remains unclear; hence, the third aim of this paper is to elucidate the moderating role of MEC on the impact of GOI on FEP and FFP. MEC is considered a moderating variable in this study, influenced by ecological modernisation theory (EMT), affecting the FFP-GOI relationship, as detailed in Section 2. This study will address the following research questions: does REG influence the implementation of GOI in agri-food industrial firms in Jordan? Does GOI positively impact FEP and FFP in the agri-food industries in Jordan? How does MEC moderate the impact of GOI on FFP and FEP?

The present study offers several theoretical contributions and practical implications. It introduces a unique conceptual framework that examines the link between REG, GOI, and MEC in driving firm performance within Jordan's agri-food sector. This research extends the existing literature by focusing on the stress of both GOI and the moderating effects of MEC, contextualising how firms can utilise GOI for sustainable development. Additionally, the framework employs EMT, the Porter hypothesis, and the natural resource-based view (NRBV) to describe how REG and MEC influence the nexus between GOI and firm performance to construct a sound theoretical basis for further investigations. This study also contributes to the literature by focusing on the under-researched area of the agri-food industrial sector in Jordan, where the impact of MEC and REG on GOI is less understood. The emphasis on the performance-enhancing effect of MEC provides useful guidance to decision-makers, and suggests that REG needs to be tailored to create an atmosphere that supports GOI for organisations to be able to reconcile sustainability ambitions with economic efficiencies. This study will show that decision-makers need to devise a strategy that reconciles GOI with MEC, because too much restraint can restrict GOI as well as diminish organisational productivity. Environmental strategies ought to be accompanied by flexible structural elements; thus, decision-makers should create incentives meant to foster GOI rather than constrain innovation.

This rest of this paper is arranged as follows: Section 2 provides a review of related literature; Section 3 explains the methods; Sections 4 and 5 cover the findings and discussion respectively; Section 6 contains the implications; Section 7 addresses the research limitations and future research; and Section 8 concludes the paper.

2. Literature Review

2.1 Environmental regulation and green organisational innovation

One of the most widely recognised drivers of GOI is REG. As per Porter and Linde (1995), well-designed and stringent environmental policies can stimulate the "innovation offset" effect, which not only reduces compliance costs, but also enhances productivity and competitiveness—an idea central to the Porter hypothesis. Zhang and Song (2021) further highlight that the impact of REG is dependent on the regulatory design approach (prescriptive rather than economic instruments) and the context of the industry focus. Supporting this argument, Kesidou and Wu (2020) use empirical evidence to demonstrate that increased regulatory enforcement in China's 11th Five-Year Plan resulted in significantly higher green patenting activity. Regardless, the literature still focuses on developed or rapidly developing countries, neglecting the impact of REG on developing economies. This gap is filled here by analysing the REG–GOI relationship in the agri-food value chain in Jordan to illustrate how regulation motivates innovation in developing frameworks.

2.2 Green organisational innovation and firm performance

GOI pertains to the adoption of contemporary management systems, processes, and practices that proactively engender a sustainable ecological footprint. Geng et al. (2021) and Setyawati et al. (2020) explore how GOI enhances operational efficiency and overall FFP through cost savings by enhancing efficiency and attracting eco-conscious stakeholders. The impact of GOI on firm performance is industry-specific and varies according to innovation type (Tang et al., (2018). These studies, while useful, seem to concentrate on advanced economies, neglecting developing countries, specifically the agri-food value chain and the GOI concept. Hence, this study will focus on the effect of GOI on FEP and FFP of agri-food firms in Jordan.

2.3 Managerial environmental concern as a moderating factor

MEC relates to how managers incorporate the environment into the decision-making processes. MEC is the main motivator of green innovation and firm performance, as it affects resource allocation and strategic directions (Qi et al., 2010; Xue et al., 2019). Ahmed et al. (2023) build upon this argument by illustrating how MEC impact is moderated by organisational human resource practices and managerial commitment. Regardless, most studies concentrate on the direct impacts of MEC, with few examining its moderating influence, especially in agri-food contexts. This study, therefore, proposes MEC as a moderator of the GOI-firm performance relationship, expanding the discourse on MEC and sustainability impacts.

2.4 Theoretical framework

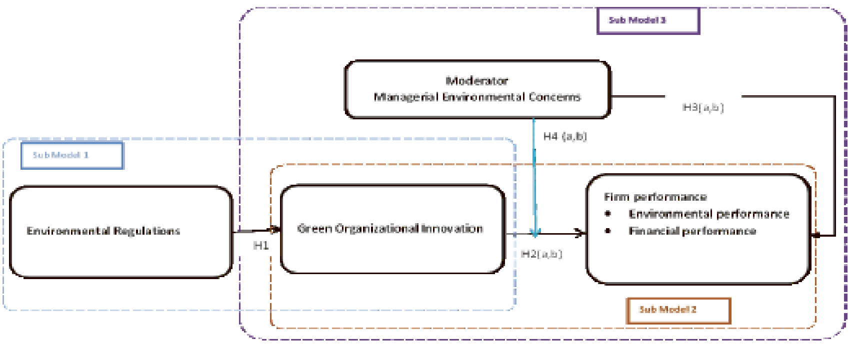
Three key theories form the basis of this study. EMT proposes that innovations at the organisational and technological levels can resolve ecological problems while improving economic productivity simultaneously (Murphy & Gouldson, 2000; Revell & Blackburn, 2007). According to this theory, environmental problems as areas for improvement and competitive edge, allowing companies to intertwine ecological and economic objectives through strategic actions undertaken in advance (Murphy & Gouldson, 2000; Tang et al., 2017). MEC illustrates the level of attention executives give to sustainability and how it guides their choices, thus shaping priorities at a higher level (Qi et al., 2010; Xue et al., 2019). This study utilises EMT to discuss the roles of GOI and MEC in advancing sustainability in the agri-food value chain.

The Porter hypothesis claims that appropriately formulated REG can provoke innovation and boost competitiveness (Porter & van der Linde, 1995). It assumes that companies under some regulations tend to innovate, which in turn improves the environment as well as the economy (Dong et al., 2019, Porter & van der Linde, 1995, Jing Peng et al., 2021; Zhang & Song, 2021). This research applies the Porter hypothesis to analyse the effect of REG on GOI in the agri-food value chain in Jordan. NRBV, meanwhile, underlines the significance of ecological resources and organisational capabilities in attaining a sustained competitive advantage (Hart, 1995, 2005). It proposes that businesses that build 'green' organisational capabilities and integrate their business strategies with ecological policies are more competitive (Wang et al., 2021). The present study utilises NRBV logic to reason how GOI and MEC together influence firm performance.

2.5 Conceptual model

As noted above, this study relies on EMT, the Porter hypothesis, and NRBV to claim that competitiveness and long-term success are enhanced by increasing green innovation and environmental regulation. Green regulation leads to GOI which improves FEP and FFP. MEC moderates the relationship between GOI and firm performance. The proposed research model, alongside its corresponding variables and hypotheses, is presented in Figure 1.

Figure 1: Conceptual model



2.6 Hypothesis development

A deductive approach grounded in EMT, Porter's hypothesis, and the NRBV is adopted in this work. As per the Porter hypothesis, green innovation can be stimulated through the intersection of economic and environmental objectives, which is reinforced by empirical studies. REG induces the "Porter effect" phenomenon, particularly in emerging markets such as China (Dong et al. (2019), while REG benefits employment and innovation (Yang et al. (2020). Jing Peng et al. (2021) further state that strict REG fosters the localisation of eco-innovative knowledge and technology diffusion, thus incentivising green innovation. The impact of REG is dependent on the type of regulation policy used (Zhang & Song, 2021). While command-and-control policy metrics dampen innovation, all REG types advance green innovation. Luo et al. (2021) build on these frameworks, observing the universally positive impact of REG granularly across regions. With integrated EMT, REG motivates businesses toward the adoption of GOI as a form of compliance-driven strategic realignment. Hence, it is proposed that:

H_1 REG positively affects GOI

According to NRBV, firms gain a competitive advantage by leveraging green capabilities to mitigate impacts on the environment and increase efficiency (Hart, 1995). Wang et al. (2021) associate the benefits of GOI with improved performance by lowering resource expenditures and capturing financial investments from environmentally-conscious stakeholders. Khan and Johl (2019) illustrate how certain systems, such as ISO 14001, improve operational efficiency and risk mitigation. Geng et al. (2021) and Setyawati et al. (2020) focus on the importance of GOI for SMEs, while Ch'ng et al. (2021) highlight its contribution to stabilising financial returns. EMT frames GOI as the ability to transform challenges into opportunities that closely align with sustainability demands within the agri-food sector (Murphy & Gouldson, 2000; Tang et al., 2017). Barriga Medina et al. (2022) further explain this by showing the contribution of eco-innovation (including GOI) to performance through efficient use of resources and differentiation in the market. Therefore, it is proposed that:

H_2 GOI has a positive impact on firm performance
H_{2a} GOI has a positive impact on FEP
H_{2b} GOI has a positive impact on FFP

EMT underscores the initiative of management to progress toward sustainability. Testa et al. (2016) demonstrate that MEC directly propels green innovation, and Dangelico (2015) connects the emphasis on environmental issues in the antecedent processes to the success of green initiatives. MEC fortifies absorptive capacity, allowing firms to transform green initiatives into enhanced performance (Xue et al., 2019). Song et al. (2021) further argue that MEC helps foster green human resource practices, which is consistent with the findings of Ahmed et al. (2023) on the moderating role of human resources and managerial commitment. Saudi et al. (2019) show that MEC greatly improves sustainable performance through sharp alignment of reporting manager's goals with the environment. Hence, it is proposed that:

H_3 MEC has a positive impact on firm performance

H_{3a} MEC has a positive impact on FEP

H_{3b} MEC has a positive impact on FFP

Przychodzen et al. (2016) state that managers significantly contribute to translating green innovation into achieving organisational performance. EMT highlights that managers are crucial to the execution of aligning innovation and sustainability (Murphy & Gouldson, 2000; Tang et al., 2017); the higher the MEC associated with a firm, the more resources are allocated towards green initiatives, which in turn leads to greater investment in green innovations and performance (Papagiannakis et al., 2014; Testa et al., 2016). As reiterated by Ahmed et al. (2023), the impact of green innovation is strengthened by managerial commitment as well as green HR policies, which is consistent with EMT focusing on organisational structure and NRBV on intangible resources attributed to competitive edge.

Saudi et al. (2019) add the moderating influence of MEC on the relationship between GOI and sustainable performance. Adopting green practices results in positive environmental and financial benefits to firms (Wang et al., 2021), particularly when there is an early consideration of the environmental needs which guarantees strategic fit (Dangelico, 2015). Unlike previous studies that concentrate on product innovation (e.g., Tang et al., 2017), this study investigates the moderation of MEC on the GOI–performance link. MEC strengthens the ability of a firm to manage environmental issues and enhance green innovation capabilities (Song et al., 2021). EMT suggests that MEC drives the transformation of environmental problems into strategic opportunities that green practices seek to achieve. MEC is regarded by NRBV as an intangible resource that enhances GOI's value and ensures a competitive advantage. In light of these insights, it is proposed that:

H_4 MEC positively moderates the GOI-firm performance relationship

H_{4a} MEC positively moderates the GOI-FEP relationship

H_{4b} MEC positively moderates the GOI-FFP relationship

3. Methodology

3.1 Research design and sampling

A quantitative cross-sectional design was adopted to evaluate the impact of REG, GOI, and MEC on firm performance. A deductive approach was used to test the hypotheses; the primary data were collected via a structured, closed-ended questionnaire adapted from validated instruments. The sample consisted of MSMEs in Jordan's agri-food industrial sector, which comprises 638 firms across 11 sub-sectors such as processed meat, dairy products, and preserved fruits and vegetables (JCI, 2021). Responses were gathered from top and middle-level managers (e.g., CEOs, production, and marketing managers) involved in environmental and operational strategy decisions. Stratified random sampling ensured proportional representation across sub-sectors. G*power software was used to calculate the minimum sample size at 85, with a power of 0.80 and an effect size of 0.15. A total of 250 out of 400 surveys were completed and returned after the pilot study, resulting in a 62.5 % response rate.

3.2 Measures of the constructs

This study used a closed-ended questionnaire as part of a quantitative approach, comprising 30 items to assess various variables. Environmental regulation included 'command and control' (five items) and 'market-based' regulation (five items), adapted from Hojnik and Ruzzier (2016). GOI was measured with a two-item scale from Chen et al. (2006), while MEC was assessed using four items from Eiadat et al. (2008). Firm performance was defined to include both financial and environmental performance, with four items each for financial and environmental performance adapted from Li and Ye (2011), Li et al. (2019), and Daugherty et al. (2002).

3.3 Data collection method

Data were collected from MSMEs in the agri-food sector in Jordan using an online anonymous questionnaire from May to July 2024 in an attempt to mitigate non-response bias. The literature review informed the development of the six-part structured closed-ended questionnaire, which included demographic information in section 1, and REG, GOI, MEC, and firm performance in sections 2 through 6. It was recommended that general managers or other suitably senior staff complete the survey. Validity was confirmed through pilot testing with academic experts. Responses were measured on a five-point Likert scale ranging from 1 for strongly disagree to 5 for strongly agree.

3.4 Data analysis techniques

Ahmed et al. (2024) recommend PLS-SEM as an appropriate tool for data analysis and as such, PLS-SEM with SmartPLS 4.0 was employed for the analysis of data in this study. The measurement model was assessed for convergent validity, reliability (Cronbach's alpha and composite reliability), and discriminant validity (using the HTMT matrix and the Fornell-Larcker criterion (FLC). The structural model examined the inter-variable relationships through regression analysis (R^2 and f^2), predictive relevance (Q^2), and hypothesis testing for both direct and indirect effects.

4. Findings

4.1 Descriptive statistics

The data were screened for outliers and missing values; after the screening, no responses were discarded, giving a final sample size of 250 responses (see Table 1 for the descriptive statistics).

Table 1: Descriptive statistics of the sample

	Frequency	Percentage (%)
Firm ownership structure		
State-owned (SO)	18	7.20
Private-company (PC)	175	70.00
Joint-venture (JV)	29	11.60
Foreign-owned company (FO)	28	11.20
Firm age		
3–5 years	47	18.80
5–10 years	43	17.20
10–25 years	40	16.00

	Frequency	Percentage (%)
25–50 years	59	23.60
50–100 years	61	24.40
Firm size		
5–25 people	54	21.60
25–50 people	64	25.60
50–100 people	69	27.60
= > 100 people	63	25.20
Respondent position		
CEO	55	22.00
General manager (GM)	57	22.80
Legal person (LP)	15	6.00
R&D manager (R&DM)	21	8.40
Production manager (PM)	36	14.40
Marketing manager (MM)	31	12.40
Head of a department	35	14.00
Agri-food industry sub-sector		
Processed and preserved meat	27	10.80
Dairy products	17	6.80
Processed/ preserved fruits and vegetables	34	13.60
Cocoa, chocolate, and sugar confectionery	17	6.80
Processed fish and crustaceans	15	6.00
Macaroni and pasta products	16	6.40
Bakery and Arabic sweets	27	10.80
Animal and vegetable fats and oils	16	6.40
Products from the milling industry	26	10.40
Animal feed	20	8.00
Other food products	35	14.00

4.2 Multivariate normality

Multivariate normality was assessed using the Web Power tool, as recommended by Cain et al. (2017). The data was not normally distributed, with multivariate skewness of 12.018 ($p < 0.01$) and kurtosis of 68.821 ($p < 0.01$). Hence, bootstrapping techniques were applied to ensure robust standard errors in the structural model assessment.

4.3 Common method bias

Following Kock's (2015) recommendations, a collinearity assessment was performed to ensure the study was free from common method bias (CMB). The variance inflation factor (VIF) was calculated for all constructs regressed against a random variable, with VIF values below 5.0. A VIF of less than 0.5 was obtained (Table 2), indicating minimal risk of single-source bias.

Table 2: Full collinearity analysis

Construct	V1	REG	GOI	MEC	FEP	FFP
VIF	1.054	1.598	1.611	1.973	2.625	2.885

Notes: REG = environmental regulation, GOI = green organisational innovation, MEC = managerial environmental concern, FEP = firm environmental performance, FFP = firm financial performance

4.4 Assessment of the measurement of model

The measurement model was assessed for factor loadings, reliability, and convergent and discriminant validities. Items with factor loadings below 0.5 were removed only if the removal can improve the average variance extracted (AVE) and composite reliability (CR), as per Sarstedt et al. (2022). Accordingly, MEC3, MEC4, and REG8 were excluded due to low loadings, indicating limited contribution to their constructs. The remaining items had loadings ranging from 0.595 to 0.926, all exceeding the 0.5 threshold as shown in Table 3 (Sarstedt et al., 2021).

CR was calculated to measure the scales' reliability (Figure 2 and Table 3). Hair et al. (2019) specifically recommend a value exceeding 0.7, and in this analysis, the CR values range from 0.86 to 0.94. Furthermore, CR is evaluated along with convergent validity, which is measured with AVE, on the condition that it is no less than 0.5 (Hair et al., 2019). This study met the requirements as all five constructs were recorded to have AVE values from 0.65 to 0.89, thus meeting the expectation of having all five constructs exceed the minimum requirement of 0.5. With these results, the measures were found to be satisfactorily reliable along with the convergent validity results.

This study assessed discriminant validity using HTMT, Fornell-Larcker criterion, and cross-loading. First, factor loadings were examined, with all items surpassing the 0.5 threshold, as presented in Table 3. Next, the HTMT ratio was used to evaluate discriminant validity, with values below 0.9 (Table 4) confirming the validity (Hair et al., 2020). Finally, the Fornell-Larcker criterion was applied, and Table 5 indicates that the square root of each AVE exceeded the correlation between factors, confirming that the constructs are distinct and meet the discriminant validity criteria (Ahmed et al., 2021; Fornell & Larcker, 1981).

Figure 2: Measurement model

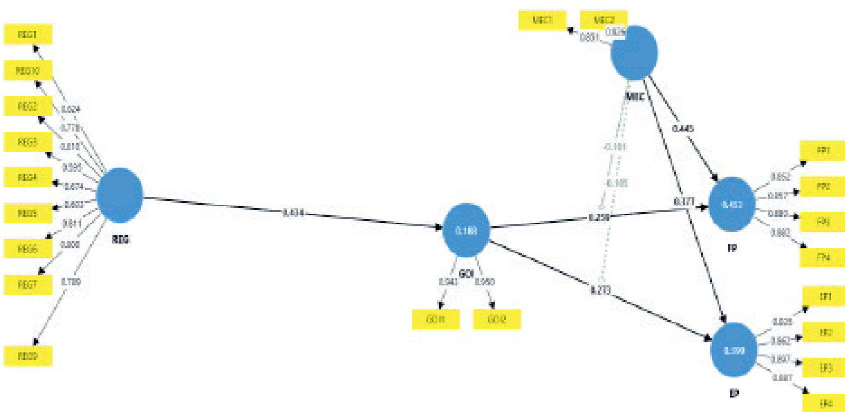


Table 3: Measurement model

Construct	Items	Loadings	Reliability analysis	CR	AVE
Firm environmental performance	FEP1	0.835		0.926	0.758
	FEP2	0.862			
	FEP3	0.897			
	FEP4	0.887	0.894		
Firm financial performance	FFP1	0.852		0.924	0.753
	FFP2	0.857			
	FFP3	0.880			
	FFP4	0.882	0.891		
Green organisational innovation	GOI1	0.943		0.945	0.896
	GOI2	0.950	0.884		
Managerial environmental concern	MEC1	0.851		0.883	0.791
	MEC2	0.926	0.742		

Construct	Items	Loadings	Reliability analysis	CR	AVE
	REG1	0.624		0.902	0.508
	REG10	0.778			
	REG2	0.610			
	REG3	0.595			
Environmental regulation	REG4	0.674			
	REG5	0.693			
	REG6	0.811			
	REG7	0.800			
	REG9	0.789	0.884		

Notes: Items MEC3, MEC4, and REG8 have low loadings and were deleted; AVE = average variance extracted; CR = composite reliability

Table 4: Heterotrait-monotrait ratio (HTMT)

No	Construct	1	2	3	4	5	6
1	Firm environmental performance						
2	Firm financial performance	0.857					
3	Green organisational innovation	0.567	0.594				
4	Managerial environmental concern	0.677	0.751	0.673			
5	Regulation	0.529	0.542	0.454	0.580		
6	MEC × GOI	0.330	0.347	0.247	0.387	0.310	

Table 5: Fornell-Larcker criterion

No	Construct	1	2	3	4	5
1	Firm environmental performance	0.871				
2	Firm financial performance	0.766	0.868			
3	Green organisational innovation	0.507	0.529	0.947		
4	Managerial environmental concern	0.567	0.625	0.545	0.889	
5	Regulation	0.504	0.502	0.434	0.494	0.713

4.5 Assessment of the structural model

Different criteria were used in this study to determine the fitness and relevance of the developed model. The first step is the assessment of the in-sample predictive power using the R^2; the observed R^2 values for FEP, FFP, and GOI were 0.390, 0.453, and 0.188, respectively. The findings indicate that the R^2 values of 0.75, 0.50, and 0.25 were substantial, moderate, and weak respectively, but acceptable for the suggested model, as suggested by Hair et al. (2019) (see Table 6). Secondly, to evaluate the effects of the construct, Cohen's f^2 (Cohen, 2013) was used as a measure of effect size. These findings indicate that values over 0.02, 0.15, and 0.35 indicate minor, medium, and major effects respectively, as stated in Tables 7 and 8.

Thirdly, an omission distance of 10 was employed in the blindfolding procedure to evaluate the model's predictive relevance. Q^2 values greater than zero were observed for all endogenous constructs, indicating predictive relevance. PLS-Predict was applied to check the predictive performance of the model (Shmueli et al., 2016). This technique uses a holdout sample and a 10-fold cross-validation approach to generate predictions at the item or construct level. Shmueli et al. (2016) noted that lower item differences in the PLS-LM model suggest strong predictive power, whereas higher differences imply weak relevance. Predictive power is considered low when the minority is at a low level, and moderate when the majority is low. As shown in Table 9, the model demonstrated modest predictive power, with most item differences in the PLS-LM method found to be low. Lastly, the standardised root mean square residual (SRMR) assessed PLS-SEM model fit. The SRMR for the saturated model was 0.08, similar to the criterion for acceptable model fit. Following PLS-SEM best practices, SRMR is the most robust and widely accepted fit measure, especially for theory construction or exploratory research (Hair et al., 2019; Henseler et al., 2015).

The evaluation of the study's hypotheses after analysing the relationships between the constructs of the proposed model is seen in the structural model in Figure 3. Additionally, a standard t-value > 1.96 or a p-value < 0.05 was used as the benchmark for accepting the hypotheses (Hahn & Ang, 2017), together with standard errors as recommended (Hair et al., 2019). Other benchmarks in this investigation such as confidence intervals and effect sizes were added to the p-value criteria (see Tables 7 and 8). Seven hypotheses were examined, including five direct hypotheses and two related to moderation effects.

The results of the implemented bootstrapping technique with 5,000 resamples suggest a positive and direct link between REG and GOI (t-value = 8.789, coefficient = 0.434, p-value = 0.000), supporting H_1 (Table 7). Furthermore, the results revealed that GOI is positively associated with FEP (*t*-value = 5.368, coefficient = 0.273, *p*-value = 0.000) and FFP (*t*-value = 4.588, coefficient = 0.259, *p*-value = 0.000), thereby confirming H_{2a} and H_{2b} (Table 7). Similarly, MEC positively influences FEP (*t*-value = 6.888, coefficient = 0.377, *p*-value = 0.000) and FFP (*t*-value = 8.789, coefficient = 0.445, *p*-value = 0.000), thus validating H_{3a} and H_{3b} (Table 7). Furthermore, the results of the two moderating hypotheses are presented in Table 8. As per H_{4a}, MEC moderates the GOI-FEP relationship, but the PLS-SEM findings suggest that MEC negatively moderates the GOI-FEP relationship (*t*-value = 2.188, coefficient = -0.105, *p*-value = 0.029. H_{4b} also proposed that MEC moderates the GOI-FFP relationship; however, the results were statistically significant as it indicates a negative coefficient (*t*-value = 2.340, coefficient = -0.101, *p*-value = 0.019).

Table 6: Regression analysis or R-squared values

	R^2	R^2 adjusted
Firm environmental performance	0.390	0.382
Firm financial performance	0.453	0.446
Green organisational innovation	0.188	0.185

Table 7: Path coefficients and hypothesis testing

Hypothesis	**Relationship**	**Std. beta**	**Std. error**	**T-value**	**P-value**	**BCI LL**	**BCI UL**	**F^2**	**Inner VIF**
Direct effect									
Model 1									
H_1	REG ≥ GOI	0.434	0.049	8.789	0.000	0.330	0.523	0.232	1.000
Model 2									
H_{2a}	GOI ≥ FEP	0.273	0.051	5.368	0.000	0.171	0.37	0.086	1.428
H_{2b}	GOI ≥ FFP	0.259	0.057	4.588	0.000	0.147	0.366	0.086	1.428
Model 3									
H_{3a}	MEC ≥ FEP	0.377	0.055	6.888	0.000	0.263	0.478	0.153	1.527
H_{3b}	MEC ≥ FFP	0.445	0.050	8.928	0.000	0.342	0.535	0.237	1.527

Table 8: Results of moderation analysis

Hypothesis	Relationship	Std. beta	Std. error	T-value	P-value	BCI LL	BCI UL	F^2	Inner VIF
Indirect effect									
Model 3									
H_{4a}	MEC x GOI ≥ FEP	-0.105	0.048	2.188	0.029	-0.197	-0.011	0.021	1.134
H_{4b}	MEC x GOI ≥ FFP	-0.101	0.043	2.340	0.019	-0.182	-0.014	0.022	1.134

Table 9: PLS prediction

	Q²predict	PLS-SEM_ RMSE	PLS-SEM_ MAE	LM_ RMSE	LM_ MAE	PLS-LM	
						RMSE	MAE
FEP1	0.267	0.599	0.488	0.61	0.491	-0.011	-0.003
FEP2	0.251	0.572	0.465	0.577	0.46	-0.005	0.005
FEP3	0.248	0.647	0.527	0.651	0.526	-0.004	0.001
FEP4	0.299	0.641	0.525	0.644	0.517	-0.003	0.008
FFP1	0.297	0.597	0.479	0.608	0.48	-0.011	-0.001
FFP2	0.319	0.569	0.459	0.576	0.459	-0.007	0.000
FFP3	0.327	0.625	0.51	0.628	0.505	-0.003	0.005
FFP4	0.297	0.633	0.522	0.651	0.531	-0.018	-0.009
GOI1	0.144	0.825	0.676	0.76	0.606	0.065	0.070
GOI2	0.169	0.894	0.751	0.843	0.683	0.051	0.068

5. Discussion

This study provides further evidence that the environmental sustainability shift represents an opportunity for firms aiming to enhance FFP (Hermundsdottir & Aspelund, 2021; Porter & Kramer, 2011), with potential improvements across various dimensions. In this study, Model 1 (Table 7 and Figure 1) tested H_1, which posited that REG significantly drives GOI. The findings confirm this relationship, supporting the Porter hypothesis (Porter & van der Linde, 1995). This aligns with Zhang and Song (2021), who emphasise the role of regulatory stringency in promoting green innovation, and Luo et al. (2021), who observe the heterogeneous yet positive effects of REG across industries. Borsatto and Bazani (2021) further demonstrate how agri-food regulatory frameworks incentivise organisational innovation, such as integrating green strategies into value chains. Similarly, He and Wang (2023) and Pan et al. (2019) highlight that policy-driven mechanisms, including tax incentives and technical subsidies, reduce financial barriers to GOI adoption.

In Model 2, the second hypothesis (H_{2a}, H_{2b}) advances that GOI has a positive impact on FEP and FFP. The evidence suggests that GOI practices, like fostering green knowledge-sharing at the operational level and integrating sustainability into value chains, contributed to energy and materials cost savings, which is consistent with Geng et al. (2021) and Setyawati et al. (2020). On the financial side, GOI benefits such as market differentiation and the creation of new domestic markets reflected findings by Atalay et al. (2013) and Xu et al. (2022), who highlight the competitive advantage of green innovation. However, this contrasts with studies by Almeida and Wasim (2023) and Ryszko (2016), which found weak or non-significant links between GOI and FFP. In the case of the Jordanian agri-food industry, where SMEs function in ecologically sensitive environments, GOI may yield more immediate cost-saving benefits (such as waste reduction) compared to the capital-intensive industries.

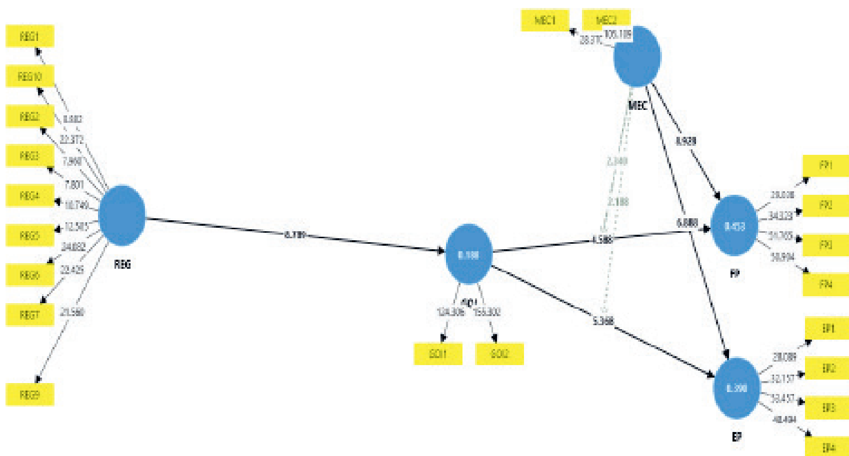
In Model 3, the third hypothesis (H_{3a}, H_{3b}) assessed the direct effects of MEC. The results indicate that MEC positively influenced both FEP and FFP, consistent with Testa et al. (2016) and Xue et al. (2019), who identify MEC as a key factor in directing resources toward green initiatives. Managers prioritising environmental strategies often invested in waste-reducing technologies, enhancing profitability—supporting NRBV, which highlights intangible assets like MEC as sources of competitive advantage. The findings also align with Mo et al. (2022), who describe MEC as a "snooping consequence" linking external pressures and internal green innovation capabilities. Likewise, Song et al. (2021) note the role of MEC in fostering green human resource practices, while Saudi et al. (2019) emphasise its integration of environmental goals into strategic decision-making.

Model 3 (Table 8 and Figure 1) also assessed the fourth hypothesis (H_{4a}, H_{4b}) on the moderating effect of MEC. The analysis found that MEC has a significant negative moderating effect on the relationship between GOI and FEP, and GOI and FFP. This implies that at a point, excessive compliance or risk mitigation focus set forth by managers stifled innovation to a point where strategies became overly cautious. Even though this finding contradicts Ahmed et al. (2023), Le and Govindan (2024) and Saudi et al.

(2019), who report positive moderation effects, it aligns with Tang et al. (2018), who state that managerial overemphasis on environmental goals could lead to suboptimal resource allocation.

In conclusion, this study supports all five direct hypotheses (H_1, H_{2a}, H_{2b}, H_{3a}, and H_{3b}) and confirms the significance of the moderating hypotheses (H_{4a} and H_{4b}) despite their negative effects. These findings highlight how REG, GOI, and MEC interact to influence FEP and FFP, as shown in Figure 3.

Figure 3: Structural model



6. Conclusion

This research evaluated the role of REG in fostering GOI within the agri-food industry in Jordan, along with its effect on FFP and FEP; the moderating role of MEC was also evaluated. The findings show that regulation greatly enhances GOI, while MEC has mixed impacts—affecting FEP and FFP positively, but acting as a negative moderator to the GOI–performance relationship when overly focused on compliance. This study collapses EMT, the Porter hypothesis, and the NRBV into a unified framework for green innovation in developing economies, thereby offering both practical and theoretical contributions. The paradox of MEC was also underscored, stressing the significance of balancing compliance with innovative flexibility. In a practical sense, firms need to actively pursue adaptive green strategies while policymakers need to encourage innovation rather than command it. Additionally, the study fills a significant research gap concerning governance in the agri-food sector of Jordan, thereby promoting sustainability and enhanced competitiveness through GOI and MEC.

The theoretical implications of this study are in advancing REG, GOI, and MEC literature in the context of underdeveloped economies, particularly in agri-food sector. It integrates EMT, the Porter hypothesis, and NRBV to create a framework for understanding how regulatory pressures and MEC influence GOI. The study demonstrates how REG drives GOI, in line with the Porter hypothesis, how GOI impacts both financial and environmental performance, in line with NRBV, and how MEC moderates these relationships, in line with EMT. It challenges EMT by showing that excessive MEC may hinder innovation and extends NRBV by applying it to MSMEs in emerging economies. Lastly, the study addresses gaps in GOI literature by focusing on Jordan's agri-food sector, which has yet to be studied in green innovation.

As for practical implications, this study highlights the potential negative impact of excessive MEC on GOI and firm performance as driven by overly rigid, compliance-focused practices. Addressing the negative impact of excessive MEC on GOI and firm performance requires organisations to seek equilibrium between the flexibility of operational structures and environmental objectives while pursuing dynamic, proactive GOI initiatives instead of attempting to mitigate risk. Strategic adaptability should be championed at the MEC level as aligned with the shifting industry dynamics, such as in Jordan's agri-food sector, for better sustainability and profitability synergies. Furthermore, organisations and politicians must also create regulatory systems that support GOI and discourage compliance-centred governance. Policymakers focus on creating policies that are not excessively restrictive to maintain competitiveness and meet environmental goals.

Several limitations must be noted. First, the focus on Jordan's agri-food industry may limit the generalisability of the findings to other sectors or regions. Future research should extend this investigation to include different industries or regions with varying regulatory environments and innovation capacities. Second, the cross-sectional nature of this study may not fully capture the long-term effects of MEC and GOI on firm performance. Finally, future studies should consider additional factors, such as market demand, collaboration, and business opportunities, to provide a more comprehensive understanding of the dynamics driving GOI in developing economies.

CRediT author statement

Nour Othman Qatanani: Conceptualisation, Methodology, Software, Investigation, Writing—original draft. **Nour Othman Qatanani, Keshminder Singh**: Validation, Formal analysis, Writing—Review and editing. **Keshminder Singh, Azlin Shafinaz Arshad**: Visualisation, Supervision.

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