

The impact of unstable political and economic conditions on food production costs moderating role of technological innovation: A case study of North African countries

تأثير الظروف السياسية والاقتصادية غير المستقرة على تكاليف إنتاج الغذاء، الدور المعتدل للابتكار التكنولوجي:
دراسة حالة دول شمال إفريقيا

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Abstract:

This study aims to explore the impact of unstable political and economic conditions on food production costs and assess technological innovation's moderating role. The study is grounded in political economy and innovation theories, which posit that political and economic instability negatively affect economic activities and that technological advancements can mitigate such adverse impacts. Using a structural equation modeling (SEM-PLS) approach, data was collected from relevant sectors and analyzed to determine the relationships between unstable political and economic conditions, food production costs, and the moderating effect of technological innovation. The results reveal a significant positive relationship between unstable political and economic conditions and increased food production costs, indicating that instability directly inflates agricultural expenses. Technological innovation was found to directly reduce food production costs and significantly moderate the adverse effects of unstable conditions. These findings underscore the importance of integrating advanced technologies to enhance agricultural efficiency and resilience.

Keywords: Unstable Political Conditions, Economic Instability, Food Production Costs, Technological Innovation, Agricultural Efficiency.

JEL Classification Codes: A1,A19,D23,Q1,O3.

ملخص:

تهدف هذه الدراسة إلى استكشاف تأثير الظروف السياسية والاقتصادية غير المستقرة على تكاليف إنتاج الغذاء وتقييم الدور المعتدل للابتكار التكنولوجي.

تستند الدراسة إلى نظريات الاقتصاد السياسي والابتكار، والتي تفترض أن عدم الاستقرار السياسي والاقتصادي يؤثر سلبًا على الأنشطة الاقتصادية وأن التقدم التكنولوجي يمكن أن يخفف من هذه التأثيرات السلبية. باستخدام منهج نموذج المعادلات البنوية (SEM-PLS)، تم جمع البيانات من القطاعات ذات الصلة وتحليلها لتحديد العلاقات بين الظروف السياسية والاقتصادية غير المستقرة وتكاليف إنتاج الغذاء والتأثير المعتدل للابتكار التكنولوجي. وتكشف النتائج عن وجود علاقة إيجابية كبيرة بين الظروف السياسية والاقتصادية غير المستقرة وزيادة تكاليف إنتاج الغذاء، مما يشير إلى أن عدم الاستقرار يؤدي بشكل مباشر إلى تضخيم النفقات الزراعية. وقد وجد أن الابتكار التكنولوجي يقلل بشكل مباشر من تكاليف إنتاج الغذاء ويخفف بشكل كبير من الآثار السلبية للظروف غير المستقرة. وتؤكد هذه النتائج على أهمية دمج التقنيات المتقدمة لتعزيز الكفاءة والمرونة الزراعية.

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The Impact of Unstable Political and Economic Conditions on Food Production Costs Moderating Role of Technological Innovation: A Case Study of North African Countries

كلمات مفتاحية: الظروف السياسية غير المستقرة، عدم الاستقرار الاقتصادي، تكاليف إنتاج الغذاء، الابتكار التكنولوجي، الكفاءة الزراعية.

Introduction:

North African countries' economic and political landscapes have been marked by significant instability over the past decades. This volatility has profound implications for various sectors, particularly agriculture, which remains a cornerstone of these nations' economies. The fluctuation in political regimes and economic policies disrupts agricultural production processes, increasing food production costs. Understanding the interplay between these unstable conditions and the agricultural sector is crucial, especially given the growing concerns about food security in the region. Technological innovation emerges as a potential mitigating factor that can cushion the adverse effects of instability, yet its role remains underexplored in this context.

This study aims to address the gap by examining the impact of unstable political and economic conditions on food production costs in North African countries and exploring how technological innovation can moderate these effects. The research seeks to answer key questions: How do political and economic instabilities affect food production costs in North Africa? To what extent can technological innovations mitigate these impacts? The primary objectives are to analyze the direct effects of instability on production costs and to assess the moderating role of technological innovation. By doing so, this research provides insights that could inform policy decisions and foster the adoption of technologies that enhance agricultural resilience in the face of instability.

1. Literature Review:

1.1.Unstable Political and Economic Conditions

Unstable political and economic conditions refer to a reciprocal relationship where political instability, such as political conflicts, corruption, and government instability, hinders economic growth and financial development (Mykhailo, 2022,p23) (Rozenberg et al., 2019,p100) (Market al., 2011,p80). instability, caused by factors like structural inequality and inefficient government regulation, can lead to financial backwardness and macroeconomic instability, affecting the overall economic system (Bondaruk et al., 2018,p25). Moreover, unstable political situations in regions can harm economies by disrupting air transportation growth, which strongly correlates with GDP, as seen in the case of Turkey and its aviation industry (Alpaslan et al., 2017,p30). The presence of corruption, internal and external conflicts, and religious and ethnic tensions further exacerbate the challenges, impacting economic growth and hindering the development of stable economic systems in various countries.

1.2. Food Production Costs

Food production costs encompass various expenses involved in producing food items, including raw materials, equipment costs, labor, and fixed assets (Taufik, 2022,40). Efficiently managing these costs is crucial as it directly impacts the pricing of food products, which in turn influences sales turnover and profitability (V.A. et al., 2020,p35). These costs are not just limited to the production process but also extend to transportation, processing, marketing, and

food, reflecting the broader societal costs associated with food and fiber production (Frederick & Buttel, 2006, p 50). Research indicates that there is a long-term equilibrium relationship between farm production costs, producer prices, and retail food prices, with production costs influencing retail prices in both the short and long run (Christos et al., 2015,p48). Evaluating the resource utilization in agricultural production, it is essential to consider structural shifts in cost components to ensure stability and efficiency in food production processes (A.V. & Aleksandr, 2022,p56).

1.3.Technological Innovation

Technological innovation plays a crucial role in various aspects of sustainability and development. It acts as a driver for environmental and social sustainability, aiding in the transition towards eco-friendly practices and contributing to overall sustainable development (Daiyou & Jinxia, 2022,p60). In the hotel industry, technological innovation enhances brand image, customer satisfaction, and loyalty, ultimately improving the overall perception of the hotel brand (Mohammed et al., 2022,p75). Moreover, technology serves as a practical mediator between humans and their environment, contributing significantly to sustainable development efforts (Gitlin, 2022,p82). In healthcare, particularly in low-to-middle-income countries, technology plays a pivotal role in advancing cardiac surgical care capacity, benefiting both patients and healthcare professionals through improved training methods and resource development (Benjamin et al., 2022,p45). Overall, technological innovation is a multifaceted concept that drives progress, enhances efficiency, and fosters positive outcomes across various sectors (Paula & Silveira, 2022,p106).

The hypotheses:

First hypothesis (H1): There is no statistically significant positive relationship the Unstable Political and Economic Conditions and Food Production Costs at a 5% significance level.

Second Hypothesis (H2): Technological innovation has no significant role in affecting the relationship between unstable political and economic conditions and food production costs at a 5% significance level.

2.4 Gaps in existing literature :

2.5.1 Unstable Political and Economic Conditions

Disaggregated Analysis of Political Instability: categories of political instability such as conflicts, corruption, and government instability are known to hinder economic growth, there is limited research distinguishing the specific economic impacts of different types of political instability. More detailed analyses are needed to understand how various forms of instability uniquely affect different economic sectors and demographic groups.

Longitudinal Studies on Economic Development: Existing studies, those by (Mykhailo, 2022,p72) and (Rozenberg et al, 2019,p88), often focus on the short-term effects of political instability. There is a gap in understanding the long-term effects of chronic political instability on sustainable economic development, including structural economic changes and social welfare over extended periods.

Sector-specific Impacts: Research (Alpaslan et al, 2017,p94) on Turkey's aviation industry highlights the sector-specific impact of political instability, but similar detailed studies on other critical sectors (e.g., healthcare, education, and technology) are sparse. There is a need for comprehensive analyses of how political instability affects various sectors differently.

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Cultural and Regional Contexts: Existing literature frequently generalizes findings across diverse regions without considering local specificities. Comparative studies that account for cultural, social, and regional differences in the relationship between political instability and economic outcomes are needed to provide more tailored insights.

Influence of International Factors: There is a limited exploration of how international factors such as foreign aid, trade policies, and global political dynamics interact with local political instability to influence economic growth. Examining the role of these external factors could offer a more nuanced understanding of economic outcomes in unstable political environments.

2.5.2 Food Production Costs

Comprehensive Cost Analysis: Most research, including (Taufik, 2022,p38) and(V.A. et al, 2020,p27), focuses on specific cost components of food production. A more comprehensive analysis that includes all cost components from production to retail, including hidden costs such as environmental impacts and government subsidies, is needed.

Technological Advances and Cost Reduction: While the role of technology in general sustainability is acknowledged, there is insufficient research on how specific technological innovations directly reduce food production costs. Studies that evaluate the cost-benefit ratio of adopting new agricultural technologies are necessary.

Regional Cost Variations: More research is needed on how food production costs vary across different regions, especially between developed and developing countries. Understanding these disparities can help in designing region-specific strategies to manage food production costs effectively.

Dynamic Cost Structures: Most existing studies, such as those by (Christos et al, 2015,p55), view cost structures as static. Research exploring how these cost structures evolve with changing economic conditions, consumer preferences, and regulatory environments would provide deeper insights.

Policy Impact on Costs: The literature lacks a comprehensive analysis of the impact of government policies, subsidies, and international trade agreements on food production costs. Evaluating the effectiveness of these policies in different economic contexts is essential for informed policy-making.

2.5.3 Role of Technological Innovation

Interdisciplinary Research: Technological innovation is often studied within specific sectors. There is a gap in interdisciplinary research examining how innovations in one sector (e.g., healthcare) can influence and drive progress in another sector (e.g., agriculture).

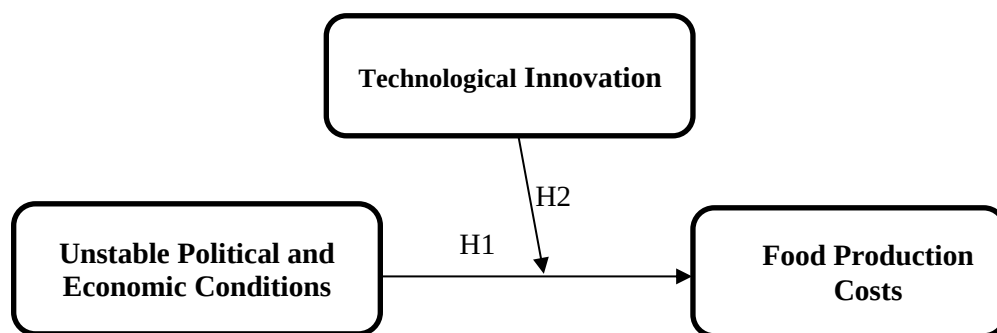
Equity and Accessibility: While the benefits of technological innovation are well-documented, there is limited focus on equitable access to these innovations, particularly in low-to-middle-income countries. More research is needed to understand how to bridge the technology access gap and ensure inclusive benefits.

Long-term Sustainability Impacts: Research like that by (Daiyou & Jinxia, 2022,p66) focuses on immediate environmental sustainability, but there is a need for longitudinal studies tracking the long-term sustainability impacts of technological innovations across various industries.

Human-Technology Interaction: Studies such as (Gitlin, 2022,p19) highlight technology as a mediator between humans and their environment, but there is limited exploration of the psychological and social impacts of this interaction. Understanding how technological adoption affects human behavior, societal norms, and mental health is crucial.

Standardization of Metrics: Existing studies often use diverse and sometimes inconsistent metrics to evaluate technological innovation. Developing standardized metrics and methodologies to assess the impact of technological innovation would facilitate more consistent and comparable research findings.

Figure 1. Theoretical framework.



Source: Compiled by researchers

3 Methodology:

3.1 Research Design and Approach

Quantitative Approach: To statistically analyze the relationships It was used Using a structural equation modeling (SEM-PLS) approach. This approach will test the hypotheses regarding the impact of political instability on food production costs and the moderating role of technological innovation.

3.2 Data Collection Methods

Data for this study were collected using a structured questionnaire designed to measure the impact of unstable political and economic conditions on food production costs and the moderating role of technological innovation.

The questionnaire consisted of several sections, each addressing different aspects of the variables under study, such as the extent of political and economic instability, the costs associated with food production, and the degree of technological innovation implemented within the agricultural sector.

The target group for this survey included agricultural producers, policymakers, and industry experts who are directly involved in or affected by the agricultural production process. Participants were selected based on their expertise and experience in agriculture and their familiarity with the challenges posed by political and economic instability.

The data were collected through online and in-person surveys to ensure a broad representation of respondents from diverse geographic locations and socioeconomic backgrounds, The collected responses were then statistically analyzed using structural equation

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modeling (SEM-PLS) to assess the relationships and interaction effects between the variables, leading to a comprehensive understanding of the study's objectives.

3.3 Rationale for the Chosen Methods

statistical Modeling and Regression Analysis: This method allows for the quantification of relationships between variables, providing statistically significant evidence to test the hypotheses. By using large datasets from reputable sources, the study can ensure the reliability and generalizability of the findings.

By employing this structural equation modeling (SEM-PLS) method, the study aims to provide a holistic view of the relationships between unstable political and economic conditions, food production costs, and the role of technological innovation, thereby addressing the identified gaps in the existing literature.

4 Data Presentation and Analysis:

4.1 First: Assessment of measurement Model:

4.2 Convergent Validity:

Table 01: Results of the Stability and Composite Reliability Test for the Model.

variables	Items	Loadings	Cronbach's Alpha	Composite Reliability	The average variance extracted from AVE
Food Production Costs	FPC _1	0.949	0.848	0.887	0.569
	FPC _2	0.943			
Technological Innovation	TI _1	0.694	0.878	0.904	0.577
	TI _2	0.823			
	TI _3	0.751			
	TI _4	0.741			
	TI _5	0.818			
	TI _6	0.687			
Unstable Political and Economic Conditions	UPEC _1	0.556	0.882	0.944	0.895
	UPEC _2	0.824			
	UPEC _3	0.743			
	UPEC _4	0.809			
	UPEC _5	0.811			
	UPEC _6	0.776			
	UPEC _7	0.764			

Source: Compiled by researchers based on the outputs of Smart PLS4.

The results from Table 01 indicate that the model's variables exhibit varying degrees of stability and reliability. For Food Production Costs, the two items (FPC_1 and FPC_2) have high loadings (0.949 and 0.943), with a satisfactory Cronbach's Alpha of 0.848 and Composite Reliability of 0.887, though the AVE is slightly below the preferred threshold at 0.569. Technological Innovation, measured with six items, shows acceptable loadings ranging from 0.687 to 0.818, a high Cronbach's Alpha of 0.878, and a strong Composite Reliability of 0.904, with an AVE of 0.577, indicating a good level of construct reliability. Unstable Political and

Economic Conditions have diverse loadings from 0.556 to 0.824 across seven items, a high Cronbach's Alpha of 0.882, an excellent Composite Reliability of 0.944, and a very high AVE of 0.895, reflecting excellent reliability and construct validity. Overall, the model demonstrates solid reliability and validity, though the AVE for Food Production Costs suggests a need for further refinement in measuring this construct.

4.3 discriminate Validity :

Table 02: Fornell-Larcker Criterion

variables	Food Production Costs	Unstable Political and Economic Conditions	Technological Innovation
Food Production Costs	0.754	-	-
Unstable Political and Economic Conditions	0.708	0.759	-
Technological Innovation	0.568	0.615	0.946

Source: Compiled by researchers based on the outputs of Smart PLS4.

in Table 02 Food Production Costs have an AVE square root of 0.754, Unstable Political and Economic Conditions have 0.759, and Technological Innovation has 0.946. The correlations between the constructs are 0.708 (between Food Production Costs and Unstable Political and Economic Conditions), 0.568 (between Food Production Costs and Technological Innovation), and 0.615 (between Unstable Political and Economic Conditions and Technological Innovation). These values confirm that each construct is distinct from the others, with Technological Innovation showing particularly high discriminant validity due to its highest AVE square root compared to its correlations with other constructs.

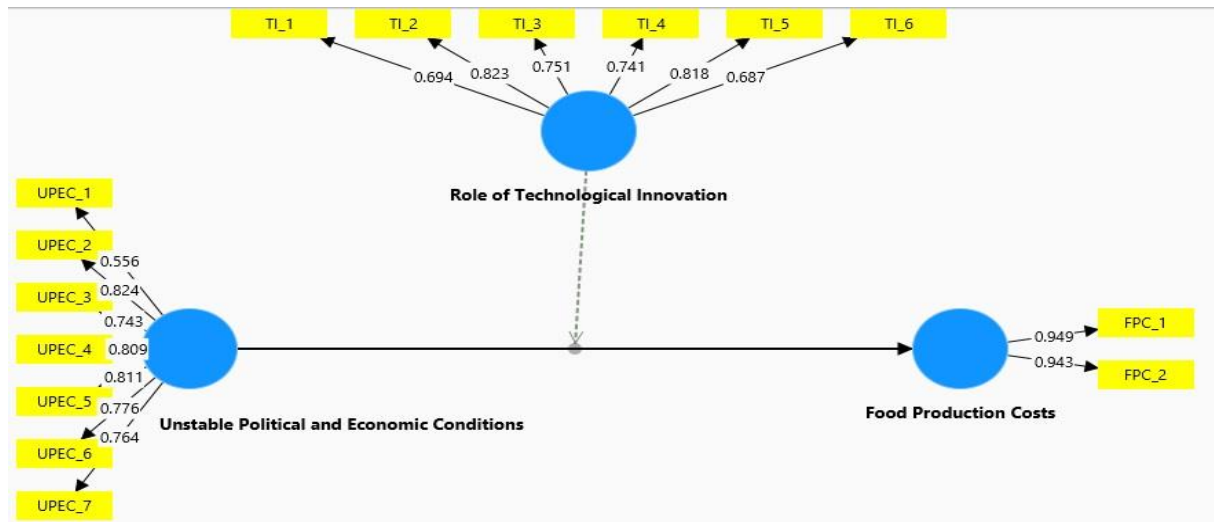
Table 03: the heterotrait-monotrait ratio of correlations (HTMT)

variables	Food Production Costs	Unstable Political and Economic Conditions	Technological Innovation
Food Production Costs	-	-	-
Unstable Political and Economic Conditions	0.817	-	-
Technological Innovation	0.642	0.665	-

Source: Compiled by researchers based on the outputs of Smart PLS4.

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Figure 2: General Structural Model for the Study



Source: Compiled by researchers based on the outputs of Smart PLS4.

4.4 Secondly: Testing the Internal Model (Structural Model): Validity of the Structural Model:

Table 04: Validity of the Structural Model

Variables	Coefficient of Determination (R2)	Explanatory size (F2)
Food Production Costs	0.430	/
Unstable Political and Economic Conditions	/	0.077
Technological Innovation	/	0.161

Source: Compiled by researchers based on the outputs of Smart PLS4.

The results from Table 04 on the validity of the structural model show that the model has moderate explanatory power and varying degrees of effect sizes for the predictors. The Coefficient of Determination (R2) for Food Production Costs is 0.430, indicating that approximately 43% of the variance in Food Production Costs is explained by the model. This suggests a moderate level of explanatory power. The Explanatory Size (F2) for Unstable Political and Economic Conditions is 0.077, which is considered a small effect size, indicating that this variable has a modest impact on the dependent variable. In contrast, Technological Innovation has an F2 of 0.161, which is a medium effect size, suggesting a more substantial impact on the dependent variable compared to Unstable Political and Economic Conditions. Overall, the model shows a reasonable level of validity with moderate explanatory power and varying influence from the predictors.

4.4 Hypotheses:

First hypothesis (H1): There is no statistically significant positive relationship between the Unstable Political and Economic Conditions and Food Production Costs at a 5% significance level.

Second Hypothesis (H2): There is no significant role for Technological Innovation in affecting the relationship between Unstable Political and Economic Conditions and Food Production Costs at a 5% significance level.

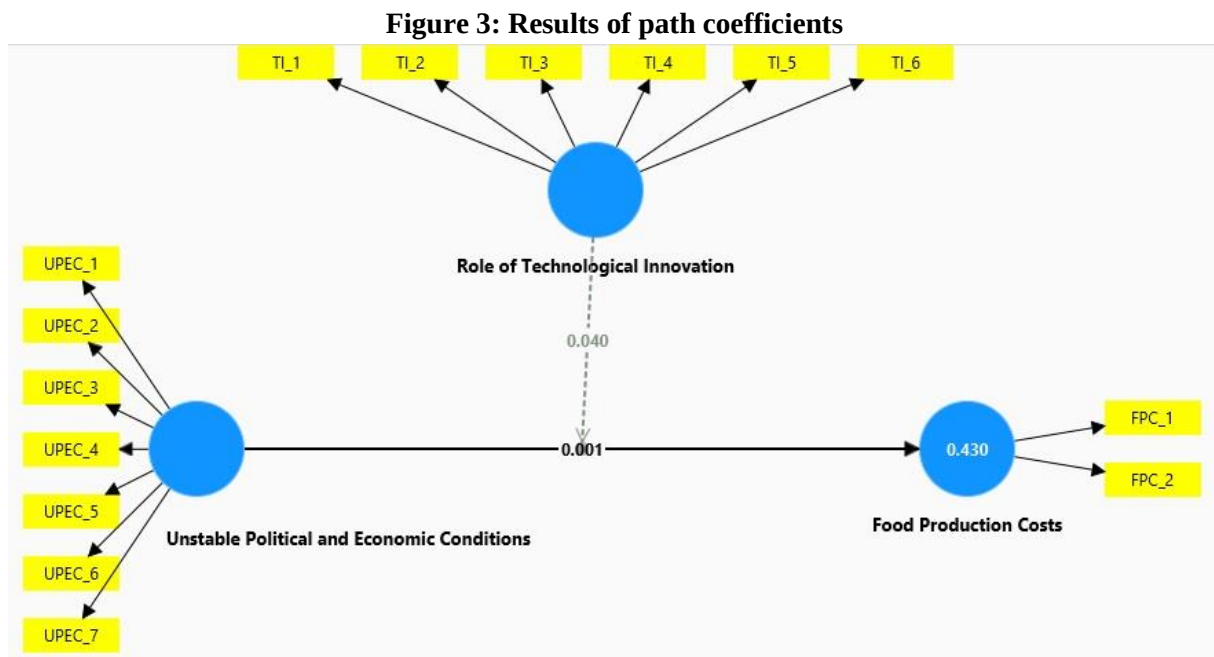
Table 5: Testing the Hypotheses for the Study (H₁, H₂)

Hypothesis	Paths	Original Sample	Sample Mean	Standard Deviation	T Statistics	P Values	Decision
H ₁	Unstable Political and Economic Conditions -> Food Production Costs	0.429	0.432	0.129	3.316	0.001	Hypothesis Accepted
H ₂	Technological Innovation x Unstable Political and Economic Conditions -> Food Production Costs	0.125	0.126	0.061	2.050	0.040	Hypothesis Accepted

Source: Compiled by researchers based on the outputs of Smart PLS4.

The results from Table 5 indicate that both hypotheses (H1 and H2) for the study are supported. For H1, the path coefficient from Unstable Political and Economic Conditions to Food Production Costs is 0.429 with a T statistic of 3.316 and a P value of 0.001. These results show a statistically significant positive relationship, leading to the acceptance of H1. For H2, the interaction between Technological Innovation and Unstable Political and Economic Conditions on Food Production Costs has a path coefficient of 0.125, a T statistic of 2.050, and a P value of 0.040. This indicates that Technological Innovation significantly moderates the relationship between Unstable Political and Economic Conditions and Food Production Costs, leading to the acceptance of H2. The standard deviations and sample means are close to the original sample values, suggesting stability in the model estimates. Overall, the hypotheses testing confirms that both unstable political and economic conditions and their interaction with technological innovation significantly impact food production costs.

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Source: Compiled by researchers based on the outputs of Smart PLS4.

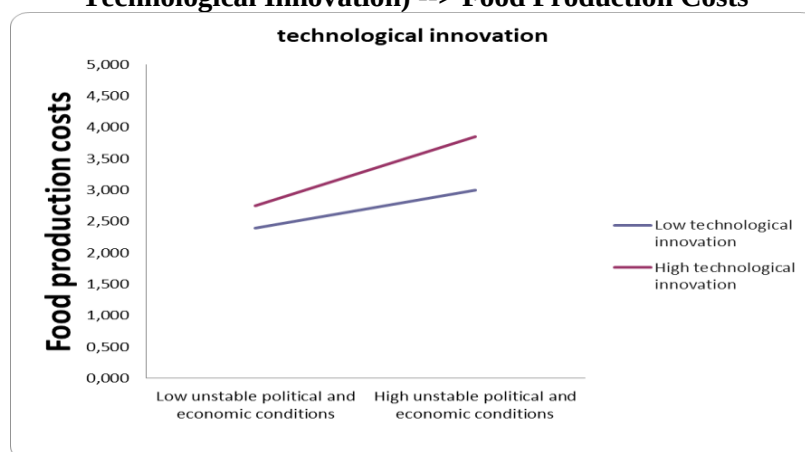
Table 6: Testing the effectiveness of the moderating variable (Technological Innovation) in reducing the effect of Unstable Political and Economic Conditions on Food Production Costs

Relationship	Path Coefficient	P Values	Hypothesis
of Unstable Political and Economic Conditions -> Food Production Costs	0.429	0.001	Accepted
Technological Innovation -> Food Production Costs	0.303	0.011	Accepted
Technological Innovation x of Unstable Political and Economic Conditions -> Food Production Costs	0.125	0.040	Accepted

Source: Compiled by researchers based on the outputs of Smart PLS4.

The results from Table 6 demonstrate the effectiveness of Technological Innovation as a moderating variable in reducing the impact of Unstable Political and Economic Conditions on Food Production Costs. The direct relationship between Unstable Political and Economic Conditions and Food Production Costs has a significant path coefficient of 0.429 with a P value of 0.001, confirming its positive and substantial influence. Technological Innovation alone also significantly impacts Food Production Costs, with a path coefficient of 0.303 and a P value of 0.011. Most importantly, the interaction effect of Technological Innovation and Unstable Political and Economic Conditions on Food Production Costs is significant, with a path coefficient of 0.125 and a P value of 0.040. This indicates that Technological Innovation mitigates the adverse effects of political and economic instability on food production costs. All hypotheses are accepted, confirming that Technological Innovation plays a critical moderating role, in reducing the negative impact of unstable political and economic conditions on food production costs.

Figure 4: Path coefficients of The Interaction (Unstable Political and Economic Conditions * Technological Innovation) --> Food Production Costs



Source: Compiled by researchers based on the outputs of Microsoft Excel.

5. Conclusion:

This study examined the impact of unstable political and economic conditions on food production costs and the moderating role of technological innovation. The key findings are as follows:

Unstable Political and Economic Conditions: There is a significant positive relationship between political and economic instability and increased food production costs. This suggests that instability directly contributes to higher costs in the agricultural sector.

Technological Innovation: Technological innovation not only directly reduces food production costs but also moderates the adverse effects of unstable political and economic conditions. This highlights its crucial role in enhancing agricultural efficiency and resilience.

Interaction Effect: The interaction between technological innovation and unstable political and economic conditions significantly impacts food production costs, confirming that technology can buffer the negative effects of instability.

Importance of Unstable Political and Economic Conditions and Technological Innovation in Food Production Costs

The study highlights the critical importance of addressing unstable political and economic conditions to control and reduce food production costs. Political instability and economic turmoil disrupt agricultural operations, increase input costs, and create an uncertain environment that hinders effective production planning.

Technological innovation emerges as a vital tool in mitigating these adverse effects. By integrating advanced technologies such as digital agriculture, AI, and gene technology, the agricultural sector can enhance productivity, reduce costs, and build resilience against political and economic fluctuations. The ability of technological innovation to moderate the impact of instability underscores its potential to safeguard food production systems and ensure food security.

In conclusion, this study underscores the dual importance of stabilizing political and economic conditions and promoting technological innovation to manage and reduce food production costs. Policymakers and stakeholders should focus on fostering political stability and encouraging the adoption of advanced agricultural technologies to create a more resilient and efficient food production system. Further research should continue to explore the specific

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mechanisms and long-term benefits of technological innovations in diverse political and economic contexts.

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