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MAXIMIZING MARKET VOLATILITY FOR ENTERPRISE INNOVATIVE CAPABILITIES IN THE MANUFACTURING INDUSTRY

Purpose. The study examines the effect of market volatility on the innovation capabilities of the manufacturing industry. Specifically, it examined: the effect of price instability, unpredictable demand and regulatory stringency on innovation capabilities.
Design/Methodology/Approach. Survey design was adopted for the study. Sampled respondents includes middle-level and top-level staff of the selected manufacturing firm. The participants were administered a structured questionnaire. PLS-SEM had been employed to evaluate the collected data.
Findings. The findings revealed that unpredictable demand has the highest impact on innovation capability, followed by price instability, and regulatory stringency. It was revealed that market volatility is significantly vital for innovation capabilities in Nigeria manufacturing industry.
Originality. This study introduces an original framework that reconceptualizes market volatility not as a disruptive force to be mitigated, but as a dynamic resource for cultivating enterprise innovative capabilities in the manufacturing industry. By reframing volatility as a catalyst for adaptive experimentation, the research departs from conventional risk-avoidance models and proposes a novel approach where uncertainty becomes a structured driver of creativity, resilience, and competitive differentiation.
Keywords: market volatility, innovative capabilities, price instability, unpredictable demand, regulatory stringency.

Introduction

The manufacturing sector in Nigeria is subject to an operating economic environment with immense challenges and opportunities in which effects of technological shifts of market conditions and the intensity of innovativeness also play important roles in determining the performance of firms. Shortage of infrastructures, inter-policy inconsistency and economic pressures of the world have been criticizing the sector affecting its sustainability, leading to its competitiveness and they are seen as causes of why it needs to adopt adaptive strategies in order to survive (Adegboyo & Sarwar, 2025). These realities demand a high sense of how firms can rise despite the uncertainty adding to the economy, along with the potential of technology innovations to enhance productivity (Li et al., 2022). The creation of the manufacturing industry is an important component in diversifying the economy, specifically considering the historical reliance of Nigeria on oil since the nation is vulnerable to the changing aspects of the international market (Nana et al., 2021).

Innovation within the manufacturing sector in Nigeria is an idea that is increasingly becoming important as the firms strive to gain resiliency with the manifesting economic fears and globalisation. The process of shifting towards modern technologies, digital devices, automation, etc., will also allow manufacturers to become more effective in terms of their performance and the quality of their products despite the unstable state of affairs in the marketplace (Nnaemeka et al., 2024). The technological progress requires SMEs (small and moderate-sized businesses) with become prevalent in the sector alongside contributing to high employment and economic growth to the sector (Abidemi, 2024). Inadequate financial access, a lack of infrastructure, and deficiency in the introduction of technology tends to limit the sector's capabilities to innovate (Wang et al., 2022).

Economic fluctuation influences Nigeria substantially through fluctuations in oil prices, fluctuation in the policy unpredictability and viability that influences its long-run development of manufacturing in order to sustain its growth and

competitiveness. These factors pose a challenging scenario, as corporations must trim down as fast as they can to keep their market share alive and in operation (Chen et al., 2024). Adoption of new business practices such as digitization and improved processes offers an avenue that manufacturers can manage to endure the adverse effects of the market turmoil (Adegboyo & Sarwar, 2025). Keeping SMEs as an example, the partners that collaborate with the digital technologies affirm that they become more stable and efficient (Zhao et al., 2023).

Unpredictable prices are one of the biggest threats to the opportunities to develop innovations in the Nigerian manufacturing industry due to uncertainty in cost structures and investment planning. Unstable input costs because of the changing exchange rates and prices of oil can elevate the costs of production and leave less money to support research and development (Moheb-Alizadeh and Handfield, 2018). As an example, SMEs have to participate in very costly materials which makes them incapable of investing in new technologies (Wong et al., 2019). Such uncertainty reduces innovation projects that are long-term because its firms are focused on the short-term survival, they are not focused on strategic development (Nnaemeka et al., 2024).

The innovation capability in the Nigeria manufacturing industry is also hampered by unpredictable demand which alters the production planning and revenue forecast. The unpredictable customer traffic which can be correlated with economic uncertainty imposes burden on the companies in terms of sales forecasting and resource allocation to innovation (Nana et al., 2021). When the market does not always demand new products or processes, SMEs would have trouble providing arguments in favor of investing in such initiatives (Li et al., 2022). This uncertainty restricts the possibility of firms to extend the operations or embrace improved technologies to promote development (Chen et al., 2024).

Innovation capabilities within the manufacturing sector in Nigeria are another obstacle to innovation capabilities posed by the regulatory stringency that ensures that very complicated regulations that pose strain to the resources are imposed. Aggressive regulation laws, which are sometimes selectively applied rather than all the time, are becoming expensive to run its operation and can hamper innovation efforts (Wong et al., 2019). As one instance, SMEs find it harder to go through bureaucratic procedures of issuing licensing, as it is holding back technology adoption (Ajide & Otekunrin, 2024). Regulatory structures are also not always consistent, which adds to uncertainty and does not attract firms that want to develop innovative projects (Adegboyo & Sarwar, 2025). Therefore, the objectives of the study include: to determine the effect of price instability on innovation capabilities, to investigate the influence of unpredictable demand on innovation capabilities, and to examine the influence of regulatory stringency on innovation capabilities.

Literature review

Concept of Market Volatility

Market volatility can be defined as the rapid and unforeseeable changes in a price, exchange rates, or economic measure, which presents a uncertain predictability to the companies within the manufacturing industry in Nigeria. Such changes interfere with the planning of production and cost management of firms (Huang et al., 2012). Volatility in Nigeria is frequently changes facilitated by outward shocks, for instance the changes in worldwide prices for oil, which influence costs of inputs and the profitability. It causes the attitude of risk-aversion because manufacturers experience brevity of foresight when it comes to predicting market conditions (Okuneye & Oluwo, 2023). The idea theaters a perilous part in the realization of the economic predicaments surrounding Nigerian manufacturing sector. Volatility is a determinant of strategic decision making and stability of operations (Oyadeyi, 2025).

The wider range of market volatility is the totality of economic uncertainties which are discouraging business integrity and investment in Nigeria. Changing exchange rates and commodity prices impose more operational costs, especially to SMEs that depend on imported commodities (Mesagan et al., 2021). This poses difficulty in having regular schedules of production patterns. Consumer purchasing power is also influenced by volatility, and such phenomena result in demand fluctuation that is difficult to predict (Abolghasemi et al., 2020). It requires dynamic response to counter risks and generate growth. The idea reflects the necessity of policies to level the economic conditions in Nigeria (Okuneye & Oluwo, 2023).

Concept of Innovation Capabilities

The term innovation capabilities are the capacity of firms in Nigeria and the manufacturing industry to generate new products, processes or any technology that will lead to improvement in competitiveness. Such

capabilities allow the firms to become more efficient and respond to the needs of the market despite limited resources (Otache, 2024). SMEs, the sector leaders, are dependent on innovation to play off employment and growth. Their actions are often troubled by the lack of access to the high-level technologies (Shuaib & He, 2021). To ensure the competitiveness of its manufacturing, innovation is crucial to Nigeria. It establishes a base of the industrial development in the nearest future (Sulaimon, et al., 2024).

As an idea, the innovation capabilities incorporate organizational learning, technological adoption and the collaboration with external partners to come up with market solutions. In Nigeria, limited funding and poor infrastructure limit innovation capacities of firms in the country (Shuaib & He, 2021). In order to become innovative and productive, the supportive ecosystem is required. The capabilities assist firms to overcome the troubles in the economy and comply with the worldwide standards (Otache, 2024). They perform an essential character in refining the eminence of the products and the competence in their operation. The resilience of the manufacturing sector of Nigeria relies on innovation abilities (Sulaimon, et al., 2024).

Effect of Market Volatility on Innovation Capabilities

Market volatility is a major obstacle to innovation within the manufacturing sector of Nigeria because it introduces uncertainty in the financial aspect and curbed the investment in innovation. The unpredictable input prices and exchange rates limit the finances that can be utilized in innovations, especially among SMEs (Okpalaoka et al., 2022). Corporations use the short-term prosperity of the firms rather than the long-term innovation in the development. Volatility destroys supply chains, limiting the supply of materials to manufacture new products (Adesina (Zhi et al., 2024). It kills competitiveness and technology. The effect of market volatility requires an adaptive innovation approach (Sulaimon, et al., 2024).

Also, unpredictability by volatility in the market compromises innovation ability as demand becomes unpredictable, thus making it hard to plan and allocate resources to the firm. Economic volatility limits the potential of the consumers to spend, impacting on the revenue forecast and investments in the area of innovation (Shuaib & He, 2021). The lack of consistency in the cash flows of SMEs poses a problem of adopting new technologies. The volatility also does not promote working together with partners because the companies are concerned with reducing risks (Otache, 2024). Innovation needs to be maintained by the use of flexible production systems. This substance brings out the necessity of stabilizing policies to facilitate innovation (Shuaib & He, 2021).

Effect of Price Instability on Innovation Capabilities

Uncertainty as a result of price instability is paralyzing in that it dramatically affects the ability of firms to innovate. This volatility makes long-term financial planning quite difficult as it is incredibly hard to predict which returns an investment into research and development will imply as they are risky and indeed futuristic (Yulfajar et al., 2025). As a result, companies tend to risk-averse, and resources are redirected to more predictable, (though smaller) projects embracing short term, incremental development. Such a focus of strategy takes radical innovation out of capital and the experiments needed to make technological advancement (Gao et al., 2024). Even the present funding of ambitious initiatives is further limited by the high-risk premiums that investors would charge projects whose cash flows are uncertain in the future. This can always be demonstrated through empirical studies, which reveal that those sectors characterized with persistent price volatility constrained their rates of patenting and slowed their productive growth through invention (Cavalcanti et al., 2014). The final consequence is that price instability could serve as a tax on innovation general, deterring long-term investments, the basis of long-run economic progress and competitive edge. Thus, we propose the first hypothesis as follows:

H_1: *Price instability has a positive influence on innovation capabilities*

Effect of Unpredictable Demand on Innovation Capabilities

The unpredictable demand greatly causes distortion of the market signals posing a strong deterring force to strategic innovation planning and investment. In the instance of firms unable to estimate the market size or customer needs with adequate precision, there is inability to recover the significant sunk costs on new product and service development which makes them cancel or un endpoint research and development (Mañez & Love, 2020). This source of uncertainty compels organizations to operate with reactive strategies, that is, providing prompt and dynamic responses to immediate market changes rather than taking a long-term commitment to conducting underlying

research. The unchanging management concern with operational agility absorbs capital and attention that otherwise might be channeled into more long-term and broader innovation (Franco & Landini, 2022). Such an environment systematically works against breakthrough innovations, which cannot and cannot work in an unstable environment, and that which lacks a clear view of future applications, cannot succeed. The analysis of different industries shows that industries with very unstable demand are associated with inferior overall R&D intensive and are more inclined towards product imitation instead of real novelty (Mai & Lin, 2021). Thus, indecisive demand fosters an environment of responsiveness which gnatts the fundamental abilities needed to attain a lasting innovative advantage.Thus, we propose the second hypothesis as follows:

H_2: *Unpredictable demand has a positive influence on innovation capabilities*

Effect of Regulatory Stringency on Innovation Capabilities

The regulatory stringency has a dualistic effect on the innovation, which may inhibit or stimulate the technological evolution depending on its design and predictability. On the one hand, stringent regulations may induce direct compliance costs that divert finite resources including both financial and management resources out of the innovation investment meditation budgets, thus reducing further investment in innovation especially among small businesses and startups (Wang et al., 2024). When regulations are transparent or constantly shifting, wreaking havoc on the researcher, this effect is magnified further making long-term research commitments discouraged. The regulatory frameworks, on the other hand, which are well-built and stable can indeed spur the innovation by sending out clear market signals as well as assured demand in new ways of doing things, like pollution control or more energy-efficient technologies (Blind et al., 2017). These innovation offsets emerge as push by regulations on firms encourage firms to rethink products and processes in unprecedented ways and methods that eventually lead to improved resource productivity. The net effect is never predetermined and depends on the quality of regulations; the more rigorous are the technological prescripts, the less likely are such prescripts to stimulate positive innovation (Zhang et al., 2021). This way, the relationship is delicate and should have been striking equilibrium between the constraint potency and the ability to strategically influence and bring technological change to the society in directions that are so socially beneficial (He et al., 2020). Thus, we propose the third hypothesis as follows:

H_3: *Regulatory stringency has a positive influence on innovation capabilities*

Theoretical Review

Dynamic Capabilities Theory

The main focus of David J. Teece, Gary Pisano, and Amy Shuen's 1997 Dynamic Capabilities Theory is on businesses' ability to adapt and reallocate their resources in volatile markets, is a properly designed conceptual framework that successfully elaborates on how the manufacturing sector of Nigeria can deal with market volatility and become more innovative in reaction to it (Teece et al., 1997). The theory assumes companies to operate in the potentially uncertain context where organizational learning and managerial-level decisions can enable them to feel and exploit the opportunities (Zabel & O'Brien, 2024). Opponents observe that it lacks concept clarity and the emphasis it draws places undue emphasis on internal processes in the context of its development, which is disproportionate to finite resources available in such places as Nigeria (Helfat & Peteraf, 2009). The innovative use of technologies within the manufacturing industry in Nigeria is contextual given that the theory explains how companies can address the riskiness of dynamism on the exchange rates by being innovative through automation (Schilke et al., 2018). Studies including the ones carried by Wilden and Gudergan, (2014) ensure that dynamic capabilities do enhance technology incorporation in the scenario of unstable markets where technology is going down and up. This theory is most appropriate in Nigeria since it focuses on flexibility that is fundamental to the SME during economic turmoil (Otache, 2024).

Empirical Review

Alghamdi and Agag (2024) conducted recent research that examined the importance of data-driven innovation skills, marketing agility, and market turbulence. Their findings were as follows: Competitive advantage: Using longitudinal and cross-lagged panel data, a longitudinal study of the functions of innovation fueled by data capability, marketing agility, and market turbulence was conducted prior to (T = 677) and after (T+1 = 569) the data. The authors were able to set up evidence-based capabilities of innovation, which make a

significant contribution to the agility of the marketing approach and competitive advantage over time. Market turbulence (a proxy measure on volatility) was also noted to amplify the favorable correlation between a competitive edge and marketing agility, implying that higher innovations in business attain the capability to succeed better in turbulent markets. The study finds that agility should be used to support data-driven innovation as one method of keeping up with turbulent environments.

Marking orientation, technological opportunity, and new product innovation performance, as conducted by Qu and Mardani (2023), is a hierarchically conducted (i.e., on 350 Chinese high-tech firms calculated) multiple-regression study, to investigate the moderating role of volatility in the market on the activities driven by innovation and absorptive capacity. Indeed, the outcomes of their research indicate that innovation led actions produce a positive performance of innovation of new products but when there are the fluctuant situations in the market, the factor of innovation to absorptive capacity is moderated negatively. This means the companies cannot afford to exploit the risk of innovation in breakaway markets in cases they are unable to internalize these insights sufficiently to convert them into practice. One of the final conclusions made by the authors is that the companies should develop efficient systems of knowledge tuning in order to sustain their performance of innovation in response to market fluctuations.

Salisu, Demirer, and Gupta (2024) introduced a macro-level perspective in the article, Title Technological Shocks and Stock Market Volatility Over a Century, in the context of mixed-sampling data (MIDAS) structure and annual data regarding patent data using more than 140 years past data. In their empirical analysis, they have found that technology shock- proxy to innovation- the effects of technological shocks have a highly significant predictive power in future volatility in the stock market both in the immediate and future run. Better still, investment portfolios with technology shocks in the volatility forecasts, tend to provide lower volatility returns in the risk-return strategy. The paper finds that the entire ability to innovate in as much as technological changes are concerned has been established as a deep entrenchment in the promotional vagrancies of markets and has been harnessed in boosting the practice of pricing of assets as well as optimizing the portfolios.

Methodology

A descriptive survey design was utilized in the study to give evidence about the research and to describe the research phenomena. In this research the target population involved some selected pharmaceuticals company middle and top-level employees in Nigeria. These individuals can better understand how external factors interfere with the market volatility of their companies. These group of employees were purposively selected due to their insights that can promote additional generalization of the results to the organization with diverse operations and strategic relevance. Purposeful sampling technique was used to achieve a proportional representation of the middle level as well as the top-level staffs of the company. The sample used consisted of 207 employees in the selected companies using Taro Yamane to derive the statistically viable sample in order to enhance representativeness. Data was gathered using a standardized questionnaire. Potential interrater bias was attained with pilot testing and expert screening checking the internal consistency of the instrument was attained through the use of Cronbach Alpha. Data were analyzed with the aid of Structural Equation Modeling (SEM) that assisted in investigating the correlations between the independent and dependent variables and general fitting and path-significance of the model.

Model Specification

In this research report, market volatility is the independent variable and innovation capability is the dependent variable. The following model will be utilized since the report will make use of structural equation modeling (SEM) (Figure 1):

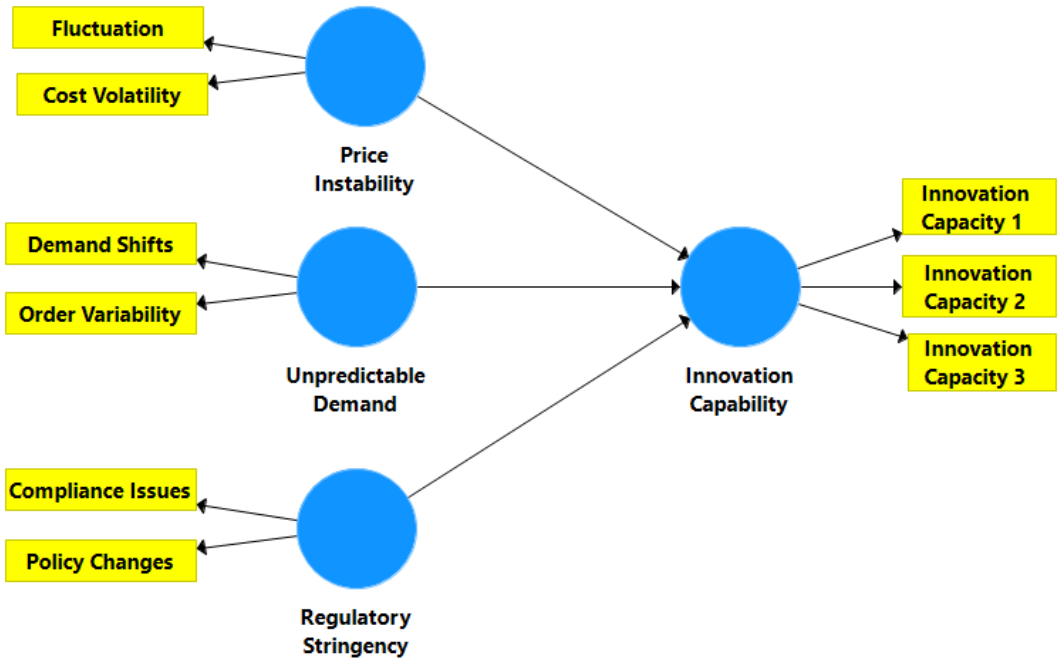
Econometric Model:

$$IC = f(\text{Price Instability } [F + CV] + \text{Unpredictable Demand } [DS + OV] + \text{Regulatory Stringency } [CI + PC])$$

where:

IC= Innovation Capabilities
F = Fluctuation
CV = Cost Volatility
DS = Demand Shifts
OV = Order Variability
CI = Compliance Issues
PC = Policy Changes

Figure 1
Market Volatility and Innovation Capability Conceptual Model



Source: Own's Elaboration, (2026)

Results and discussion

Response Rate

The data needed for this investigation was gathered using a questionnaire. A total of 192 responses has been captured, which is 92.7% of the expected sample size. To meet the expected sample size, fifteen replies are required. Thus, the actual responses make up the data used in this study.

Descriptive Analysis of Responses and Normality test

Table 1
Descriptive Analysis and Normality Test

	Mean	Standard Deviation	Excess Kurtosis	Skewness	Number of Observations Used
Regulatory stringency 1	3.361	1.207	-0.742	-0.406	192.000
Regulatory stringency 2	3.529	1.242	-0.710	-0.582	192.000
Unpredictable demand 1	3.403	1.318	-0.899	-0.464	192.000
Unpredictable demand 2	3.622	1.223	-0.655	-0.603	192.000
Price instability 1	3.387	1.278	-0.949	-0.413	192.000
Price instability 2	3.235	1.281	-1.111	-0.158	192.000
Innovation Capacity 1	3.303	1.400	-1.129	-0.384	192.000
Innovation Capacity 2	3.765	1.248	-0.631	-0.718	192.000
Innovation Capacity 3	3.891	1.333	-0.439	-0.931	192.000

Note. SmartPLS Output, 2026

Table 1 shows the average and standard deviations of the indicators or variables utilized during the investigation, which were derived from the research's survey. The research examined innovative capability and market volatility. Numerous indications were assessed, each of which shed light on a different aspect of the two constructs. The average scores, standard deviations, and the quantity of data used for each indicator provide valuable information and significant implications for scholars and practitioners alike. The generally favorable mean score (above 3) for the quizzes indicates that respondents think there is a substantial correlation between market volatility and innovation capacity. The relatively small standard deviation of each case indicates that the responses vary slightly from the mean. These descriptive results demonstrate the various ways in which market volatility impacts potential. These demonstrate the importance of innovation capabilities through successful market volatility.

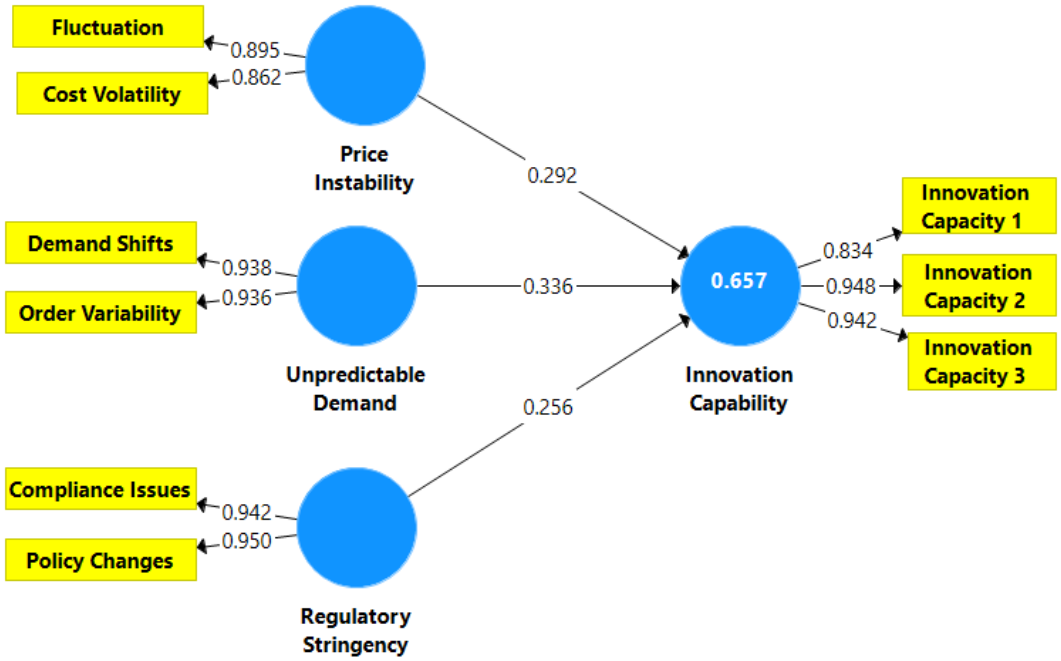
The number of observations is in excess of 100, indicating that an absolute skewness value of +1.0 or less is necessary for the data to be regarded as normal, according to the distribution's normality results. Furthermore, kurtosis should have an absolute value of ±3.0 for a usual peakedness because any value below that might be concerning and dangerous. The kurtosis findings also came under the ±3.0 absolute value, and the normality results showed that all the variables were below the ±1.0 total value threshold. All of the data submitted for the research are regularly distributed, according to the results of the normality test, and may be used for further analysis and deduction. This implies that the variables employed to measure market volatility are successful in establishing the causal link between market volatility and innovation potential, have a moderate mean with minimal deviation from the mean, and are generally distributed.

Assessment of Measurement Model

To assess the effect of market volatility on innovation capacity, the variables used to measure market volatility are price instability, unpredictable demand, and regulatory stringency against innovation capacity.

Figure 2

A path model of market volatility and innovation capacity



Note. SmartPLS Output, 2026

The structural model evaluated the impact of market volatility on innovation capacity, as seen in Figure 2. Three independent variables–price volatility, unpredictable demand, and regulatory strictness–and one dependent variable–innovation capacity– are incorporated into the model. Based on the configuration of the model findings, innovation ability is significantly enhanced by each of the three independent factors. Accordingly, market instability is beneficial to companies as it may foster more creativity. Each of the independent elements significantly affects innovation ability, as demonstrated by the particular impacts. This suggests that organizations should work on generating market volatility to improve innovation capability.

Table 2
Construct Reliability and Validity

	Cronbach's Alpha	Composite Reliability	Average Variance Extracted (AVE)
Regulatory stringency	0.884	0.945	0.896
Unpredictable demand	0.862	0.935	0.878
Price instability	0.706	0.871	0.772
Innovation Capacity	0.895	0.935	0.827

Note. SmartPLS Output, 2026

Table 2 displays significant statistical measures related to the construct reliability and validity of the four latent variables used in this study. These parameters help assess how well these variables capture the core concepts they are intended to represent. The two primary metrics used to evaluate construct dependability are Cronbach's Alpha and Composite Dependability. By measuring how closely each item is connected to every other item, Cronbach's Alpha evaluates the internal consistency of a latent variable. The four latent variables' internal consistency scores are above 0.7, indicating good quality. These values imply that everything across each parameter are trustworthy indicators of the connected structures since they are significantly higher than the generally recognized cutoff criterion of 0.7. Another construct reliability metric that considers internal consistency as well as the connections between the elements and the latent variable is called composite reliability. With all values above 0.7, every variable in the current study exhibits strong composite dependability, offering a more reliable reliability metric. The elevated values of the latent variables indicate that they are reliable indicators of the constructs they represent. The Average Variance Extracted (AVE), which assesses the convergent validity of each latent variable, is also included in the table. Convergent validity is the extent to which items in a variable measure approximately the same basic concept and are related to one another. Every AVE value in the table exceeds the recommended threshold of 0.5. This demonstrates that, when considered together, the items of each latent variable measure the relevant constructs effectively and are convergent. The results suggest that the latent variables in the present investigation have excellent construct validity and reliability. These variables' great composite reliability, considerable internal consistency, and good convergent validity all support the selection of them as reliable and valid measures in the course of the investigation.

Table 3
Discriminant Validity

	Regulatory stringency	Unpredictable demand	Price instability	Innovation Capacity
Regulatory stringency	0.946			
Unpredictable demand	0.777	0.937		
Price instability	0.759	0.748	0.879	
Innovation Capacity	0.739	0.753	0.738	0.910

Note. SmartPLS Output, 2026

The results of the discriminant validity analysis in Table 3 provide compelling evidence of discriminant validity within the latent variables–unpredictable demand, price instability, innovation capability, and regulatory stringency. Discriminant validity establishes if these conceptions are distinct and not closely related to one another. Assessing the correlations between these variables reveals that the diagonal values, which show the correlations of each variable with itself, are substantially higher than the off-diagonal values, or the correlations between other variables. By showing that each latent variable has greater connections with independently in comparison to the remaining constructs, this validates the idea that every single latent variable is distinct and assesses a different aspect of the aggregate construct. Innovation capabilities have a better correlation with themselves rather than with price stability, regulatory stringency, and unpredictable demand. Unpredictable demand also has a strong link with itself compared to its relationships with the other components. But the same is true for additional factors in their proper contexts.

These results show that the latent variables in the research we conducted are assessing distinct concepts rather than just different manifestations of an identical fundamental entity. Since the measuring technique effectively separates four essential components–price instabilities, regulatory stringency, innovation capabilities, and unexpected demand–it suggests that it is suitable for the study's goals.

Multicollinearity

This assesses the correlation of the independent variable. Finding out if two independent variables are unrelated and producing equivalent outcomes is the goal. The variance inflation factor (VIF) is used in this study to assess the predicted relationship between the independent variables.

Table 4
Inner VIF Values

	Regulatory stringency	Unpredictable demand	Price instability	Innovation Capacity
Regulatory stringency				3.087
Unpredictable demand				2.964
Price instability				2.772
Innovation Capacity				

Note. SmartPLS Output, 2026

Table 4 displays the VIF values for the latent variables related to innovation ability. Regulatory stringency, price instability, and unpredictable demand results in VIF values which fall substantially beneath the 10, and this can be beneficial because it suggests that these factors latent variables are not displaying noteworthy multicollinearity. In simpler terms, none of those factors are drastically related to one another, so multicollinearity will not pose a major issue when these factors are accounted for in the current investigation.

Test of Hypothesis

Table 5 shows the coefficient of determination (R^2), a statistic employed to evaluate the degree to which a model predicts data. The model's R-squared score of 0.657 indicates that the independent or latent components incorporated into the model account for around 65.7% of the variability seen in the dependent variable (innovation capabilities). This implies that the spotted variances in the innovative capabilities are captured and explained by the model. 0.655 is the adjusted R-squared value. As a consequence, the extent of fit of the model is assessed more thoroughly. It seems implausible that the addition of the independent variables to the model would result in excess estimation or undue intricacy because the modified R-squared value is nearly identical to the traditional R-squared value. This suggests that despite of taking into consideration any concerns connected to model intricacy, the explanation capacity of the model continues to be robust. Incorporating extra latent variables seems unlikely to impair the model's performance, and the R-squared and modified R-squared values show that the innovation capability model describes innovation capacity variability quite well.

Table 5
Coefficient of Determination Score

	R Square	R Square Adjusted
Innovation Capacity	0.657	0.655

Note. SmartPLS Output, 2026

Table 6
Assessment of the Effect Size (f^2)

	Regulatory stringency	Unpredictable demand	Price instability	Innovation Capacity
Regulatory stringency				0.062
Unpredictable demand				0.111
Price instability				0.090
Innovation Capacity				

Note. SmartPLS Output, 2026

The effect size, also referred to as the f-square, is a statistical research metric that quantifies the degree to which independent factors impact a dependent variable. The impact of several latent factors on the latent factor of innovation ability is assessed in this study, along with the effect size of those variables. All of the independent variables had values greater than 0.02, which is considered to be a small impact size. Since all of the factors together have a major impact on the potential for innovation, it follows that they all bear the hallmark of middle-tier effects. In other words, a change or fluctuation in any of the factors might indicate a modest amount of diversity in capability for innovation. This implies that the identified variables does not only influence innovative capability but also have significant impact on the conceptual issue.

Table 7
Bootstrapping Results Showing Path Coefficient for Structural Model

	Original Sample (O)	Sample Mean (M)	Standard Deviation (STDEV)	T Statistics (|O/STDEV|)	P Values
Regulatory stringency ->Innovation Capacity	0.256	0.252	0.053	4.814	0.000
Unpredictable demand ->Innovation Capacity	0.336	0.339	0.056	5.951	0.000
Price instability ->Innovation Capacity	0.292	0.293	0.055	5.292	0.000

Note. SmartPLS Output, 2026

Analysis in the table 7 revealed that market volatility metrics are significantly related to innovation capacity. These outcomes show that the aspects of market variances with regulatory stringency, unstable prices, and erratic demand have substantive effects on the innovation capacity. An examination of the direction taken by regulatory stringency, price instability and non-predictive demand towards the innovation capacity are statistically optimal. The t-statistics for all the indicators were all greater than 1.96 and p-values below the conventional level of significance of 0.05. This implies that market volatility metrics such as regulatory stringency in the pharmaceutical companies as a result of the nature of their product to human survival as life does not have duplicate which forces the companies to be innovative. Also, price instability in terms of raw materials needed for production activities affects their productivity efficiency which compel the firms in the pharmaceuticals to be more innovative in

ensuring that material are sources at a reasonable price to avoid intermittent in production. Besides, unpredictable demand where the enterprise get unexpected order for their products above their capacity force the enterprise to embrace innovative capacity to handle unforeseen demand developing strategies to curtail surge in demand. Therefore, market volatility is influenced by price volatility, regulatory stringency, and unpredictable demand, all of which have a significant impact on innovation capabilities.

Discussion of Findings

Market volatility metrics (price instability, unpredictable demand, and regulatory stringency) influenced the capabilities of innovation. This implies that firms need to maximise market volatility to their advantage most especially innovative capability. Price fluctuations in raw materials and energy costs force firms to adopt cost-optimization strategies such as lean manufacturing, predictive analytics, and alternative sourcing. Enterprises that integrate real-time monitoring systems and AI-driven forecasting can transform price volatility into opportunities for product redesign and process efficiency. Also, price instability encourages risk-sharing partnerships and supply chain diversification, strengthening resilience and innovation. Besides, Demand volatility drives firms to adopt modular production systems and mass customization, enabling rapid response to shifting consumer preferences. Enterprises leverage digital twins, IoT, and demand sensing tools to anticipate market shifts and innovate in product design and delivery models. While firms that embrace demand unpredictability as a learning mechanism develop stronger customer-centric innovations and adaptive business models. However, Stringent regulations on sustainability, emissions, and labor practices push firms toward green manufacturing, circular economy models, and ethical innovation. Regulatory volatility fosters institutional learning, encouraging enterprises to embed compliance into their innovation strategies. Firms that proactively align with evolving regulations gain first-mover advantages, positioning themselves as industry leaders in sustainable innovation. Thus, market volatility influences innovative capability. This finding is in line with the studies of Alghamdi and Agag (2024); Qu and Mardani (2023), which revealed that the control of market volatility boosts efficiency operationalities and builds consumer trust in an emerging market. In such a way, market volatility requires a coordinated mode of driving innovation capability. This explains the importance of having organizations which have strong frameworks capable of adjusting to changes in the market thus fostering innovation culture. Also, a business can also invest in analytics and forecasting tools to encourage them to deal with uncertainty, which means even more power to overcome difficulties.

Conclusion

The study establishes that market volatility is not merely a disruptive force but a strategic enabler of innovation in manufacturing enterprises. By reframing volatility metrics–Price Instability, Unpredictable Demand, and Regulatory Stringency–as catalysts rather than constraints, firms can cultivate dynamic capabilities that enhance resilience, adaptability, and competitiveness. The identified market volatility metrics were not barriers but accelerators of enterprise innovative capabilities. Manufacturing firms that embrace volatility through flexibility, digital integration, and sustainability-driven innovation can transform uncertainty into long-term competitiveness. Price Instability compels enterprises to adopt cost-optimization, predictive analytics, and diversified sourcing strategies, which in turn stimulate process and product innovation. Unpredictable Demand drives operational flexibility, modular production, and customer-centric innovation, enabling firms to thrive in uncertain consumer markets. Regulatory Stringency accelerates sustainable innovation, embedding compliance into enterprise strategy and positioning firms as leaders in ethical and green manufacturing. Therefore, these volatility metrics foster antifragile systems that grow stronger under uncertainty, transforming volatility into a strategic asset for enterprise innovation. Based on the findings, the study recommends:

i. Enterprises should embed volatility indicators into strategic planning and R&D frameworks, ensuring that fluctuations in price, demand, and regulation are continuously monitored and leveraged for innovation.

ii. Adoption of digital transformation investment is critical for real-time responsiveness to volatility. These technologies enable predictive modeling, adaptive production, and innovation in product design.

iii. Regulatory stringency should be embraced as a driver of green innovation, circular economy practices, and ethical manufacturing. Proactive compliance can yield competitive advantages and reputational capital.

Conflicts of Interest

The author declares no conflict of interest.

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