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Interpreting Production Pressures in Iranian Manufacturing Through a Multilevel Resilience Framework

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Abstract

This article interprets production-related pressures in Iranian manufacturing through a multilevel resilience framework encompassing firm-level conditions, sectoral variation, and macro-institutional constraints. Drawing on secondary data from official statistical sources and manufacturing Purchasing Managers' Index (PMI) indicators, the study adopts a descriptive and diagnostic approach rather than a causal one. The evidence indicates that recent manufacturing conditions in Iran have been characterized by rising input prices, weak raw-material inventories, liquidity constraints, foreign-exchange pressures, regulatory instability, and energy-related disruptions. Sectoral evidence further points to uneven industrial conditions, with PMI outcomes varying across industries. These differences may be associated with variation in supply-chain structure, import dependence, and exposure to infrastructural stress, although the available data do not permit direct testing of such relationships. At the macro level, the findings suggest the coexistence of fiscal pressure, short-term financing patterns, and unstable institutional and energy conditions that shape the broader environment in which industrial production takes place. Taken together, these patterns may be interpreted as more consistent with survival-oriented adjustment than with clearly demonstrated strategic resilience. The article therefore offers a conceptually informed and descriptively grounded interpretation of industrial resilience as a multilevel phenomenon, while recognizing the limits of the available evidence for establishing causal effects or cross-level interactions.

Keywords: Supply chain resilience; Institutional constraints; Post-conflict economic recovery

چکیده

این مقاله فشارهای ناظر بر تولید در بخش صنعت ایران را در قالب چارچوبی چندسطحی از «تاب‌آوری»، شامل شرایط بنگاهی، تفاوت‌های بخشی و تنگناهای نهادی-کلان تبیین می‌کند. این مطالعه با اتکا به داده‌های ثانویه آماری رسمی و شاخص مدیران خرید بخش صنعت، رویکردی توصیفی-تشخیصی را برای تحلیل وضع موجود به کار می‌گیرد. شواهد حاکی از آن است که محیط تولید صنعتی در سال‌های اخیر متأثر از جهش قیمت نهاده‌ها، تحلیل موجودی مواد اولیه، مضیقه نقدینگی، تنش‌های ارزی، بی‌ثباتی مقرراتی و ناترازی حامل‌های انرژی بوده است. در سطح بخشی، نوسانات نامتوازن شامخ نشان‌دهنده ناهمگونی عملکرد صنایع مختلف است؛ ناهمگونی‌هایی که احتمالاً از تفاوت در ساختار زنجیره تأمین، عمق وابستگی به واردات و شدت آسیب‌پذیری در برابر شوک‌های زیرساختی نشأت می‌گیرد. در سطح کلان نیز تلاقی فشارهای مالی، الگوهای تأمین مالی کوتاه‌مدت و ناپایداری‌های نهادی و انرژی، بستر فعالیت صنعتی را به‌شدت تحدید کرده است. جمع‌بندی این متغیرها نشان می‌دهد که واکنش کنونی صنعت ایران بیش از آنکه تجلی «تاب‌آوری راهبردی» باشد، بازتابی از رفتارهای انطباقیِ «بقامحور» در برابر شوک‌هاست. در نهایت، این مقاله تفسیری مفهومی و متکی بر شواهد از تاب‌آوری صنعتی به مثابه پدیده‌ای چندسطحی ارائه می‌دهد، هرچند بر محدودیت‌های داده‌ای در اثبات روابط علّی میان‌سطحی تأکید می‌ورزد.

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1. Introduction

In recent years, production resilience has gained increasing prominence in operations management, industrial policy, and crisis studies. The growing frequency of economic, political, and environmental disruptions has intensified attention to the conditions under which production systems can sustain continuity under stress. Within this literature, resilience is generally defined as the capacity to absorb disruption, adapt to shifting conditions, and maintain an acceptable level of operational continuity when faced with external shocks (Christopher & Peck, 2004; Sheffi & Rice, 2005). From this perspective, resilience is significant not only for firm performance but also for the stability of value chains and the preservation of productive capacity under uncertainty.

This article distinguishes production resilience from two related but distinct concepts: "production continuity," which refers to the maintenance of core production activities during disruption, and "strategic resilience," which denotes longer-term capacities for restructuring, renewal, and capability building beyond immediate survival. Accordingly, the continuation of production under crisis conditions should not be automatically interpreted as evidence of developed strategic resilience. In many cases, continuity may instead reflect short-term coping or survival-oriented adjustments. This distinction is particularly relevant to Iranian manufacturing, where production operates under the combined pressure of structural and recurrent disruptions, including exchange-rate volatility, regulatory instability, restricted access to imported inputs and technology, liquidity pressures, and recurring energy-related disruptions.

In such a context, the persistence of production does not necessarily indicate robust strategic adaptation; it may instead reflect constrained efforts to maintain minimum operational viability under stress. Existing research suggests that firms may reduce vulnerability through supplier diversification, strategic inventory management, and greater process flexibility. However, the effectiveness of these responses is often limited when broader supply-chain, sectoral, and institutional conditions remain unsupportive (Pettit et al., 2010). Therefore, production resilience should not be treated as an exclusively firm-level attribute. Rather, it is more appropriately understood as being conditioned by the interaction between organizational capacities and the wider environment in which production systems are embedded.

A further issue concerns the propagation of disruption across production networks. Research on resilience and supply-chain disruption indicates that shocks may extend beyond individual firms through supplier linkages, infrastructural dependencies, and institutional bottlenecks. This perspective is consistent with a multilevel understanding of production resilience, in which firm capabilities, network relations, and macro-institutional conditions jointly shape the durability of production systems. However, analytically integrated treatments of these levels in the context of Iranian manufacturing remain limited. Accordingly, this article develops a conceptual and interpretive framework for examining

production-related pressures in Iranian manufacturing from a multilevel perspective. Rather than adopting either a purely firm-centered or a purely policy-centered view, this study considers how organizational conditions, sectoral variation, and institutional constraints relate to production continuity under persistent stress. The objective is to provide a structured, evidence-informed interpretation of manufacturing pressures through the lens of multilevel resilience rather than to test causal interactions directly.

This study contributes to the literature on industrial resilience in three distinct ways. First, it develops an analytically integrated framework that bridges the gap between firm-level operational realities and broader macro-institutional constraints. By synthesizing these levels, the article delineates the complex dynamics that shape industrial activity in high-uncertainty environments, moving beyond siloed analyses of either individual firm strategy or aggregate economic policy. Second, it reframes resilience not as a static, inherent outcome, but as a multilevel, context-dependent process. This perspective is particularly pertinent for understanding how firms in economies subject to structural shocks prioritize survival-oriented adjustments over long-term strategic renewal. Finally, the research provides a diagnostic tool for researchers and policymakers alike. By employing a structured interpretation of available industrial indicators, such as the Manufacturing Purchasing Managers' Index (PMI) and official statistics, this study translates fragmented descriptive data into a coherent narrative of industrial pressures. Consequently, the framework serves not as a definitive causal model, but as a robust platform for evidence-informed discourse in industrial policy, offering a nuanced lens through which to interpret production continuity in the face of persistent volatility.

2. Theoretical Foundations and Literature Review

Resilience has emerged as a central concept in the analysis of production systems operating under unstable, high-risk, and crisis-prone conditions. While initially rooted in engineering, ecology, and crisis studies (Gunderson & Holling, 2002; Hollnagel et al., 2006), the term has gained prominence in operations management, supply chain management, and industrial economics. Across these disciplines, resilience is consistently understood as a system's capacity to withstand disruption, maintain core functions, adapt to environmental shifts, and recover after a shock (Ponomarov & Holcomb, 2009; Sheffi & Rice, 2005). Given that these fields emphasize different dimensions of the phenomenon, an integrated approach, viewing production resilience as a multidimensional and multilevel construct, is essential for meaningful analysis.

In operations management, resilience is characterized by a system's ability to sustain acceptable performance levels during internal or external disturbances and to recover within a reasonable timeframe (Craighead et al., 2007; Ivanov et al., 2017). Attention is directed toward process design, capacity planning, and resource allocation to mitigate the

likelihood of severe interruption. From this perspective, resilience encompasses the entire cycle of disruption: preparedness before an event, adaptive adjustment during the crisis, and the reconfiguration of resources afterward (Fiksel, 2003; Kleindorfer & Saad, 2005). A resilient firm is thus one that balances operational efficiency with responsiveness, preserving continuity through durable organizational arrangements (Chowdhury & Quaddus, 2017)

a. Resilience framework

Within the supply chain literature, resilience is framed as a networked capacity whereby firms anticipate, absorb, and contain disruptions across interconnected relationships (Christopher & Peck, 2004; Scholten & Schilder, 2015). Research in this domain emphasizes that firm-level outcomes are often inseparable from broader supply-chain conditions; disruptions frequently propagate through supplier linkages, transportation networks, and information flows (Blackhurst et al., 2005; Scheibe & Blackhurst, 2018). Consequently, resilience is viewed not merely as an intra-organizational capability, but as a relational attribute where collaboration, visibility, and flexibility serve as critical components for returning a system to a stable state (Brandon-Jones et al., 2014; Pettit et al., 2013).

In industrial economics, the concept is closely associated with the stability of production structures and the preservation of competitive capacity (Martin & Sunley, 2015; Simmie & Martin, 2010). Analysis in this field focuses on how systemic shocks, such as trade restrictions, exchange-rate volatility, and policy instability, affect cost structures, scale of production, and firm continuity (Boschma, 2015; Bristow & Healy, 2014). Resilience is often discussed in terms of survival capacity, input substitution, and the role of industrial policy in mitigating vulnerability (Aiginger, 2014; Rodrik, 2008). In contexts characterized by persistent economic pressure, research suggests that structural instability may incentivize short-term, survival-oriented responses rather than long-term strategic restructuring (Lall, 2001; Martin, 2012).

Finally, the crisis management literature highlights capacities for prevention, response, and recovery (Pearson & Clair, 1998; Roux-Dufort, 2007). In this tradition, crisis is treated as a persistent feature of the organizational environment rather than an exceptional event (Boin & van Eeten, 2013; Mitroff, 2005). Resilience is therefore linked to scenario planning, business continuity arrangements, and post-incident learning (Burnard & Bhamra, 2011; Lampel et al., 2006). A resilient organization is one that effectively limits the severity of disruption and converts crisis experience into a basis for strengthening future capabilities (Carmeli & Markman, 2011; Weick & Sutcliffe, 2007).

A synthesis of these perspectives suggests that, despite varying analytical emphases, resilience converges around four recurring dimensions: shock absorption, continuity of core performance, adaptation to changing conditions, and recovery (Bhamra et al., 2011; Hohenstein et al., 2015; Kamalahmadi & Parast, 2016). While operations management focuses on internal processes, supply chain management on network relationships,

industrial economics on structural policy conditions, and crisis management on contingency and learning, these distinctions are complementary. For the purposes of this study, this convergence indicates that production resilience in an unstable economic setting is more accurately interpreted as a multidimensional, multilevel phenomenon than as a single measurable attribute (Ali et al., 2017; Pettit et al., 2010).

b. Conceptual Pillars of the Multilevel Framework

To operationalize this understanding, the analysis draws on five core concepts that recur throughout the resilience literature:

1. **Flexibility:** The ability of a system to modify resources, processes, or plans without severe deterioration in performance. This capability enables firms to move away from rigid operating patterns under uncertainty and preserve alternative pathways for production and procurement.
2. **Agility:** The capacity for rapid and effective response to environmental change. While flexibility provides the potential for change, agility emphasizes the speed of detection, decision-making, and execution, allowing for the timely mobilization of resources.
3. **Redundancy:** The existence of alternative capacities, such as safety stock, backup infrastructure, or multiple suppliers, that remain available under disruptive conditions. Durable resilience often depends on "intelligent redundancy," calibrated to the risk profile and the specific costs of failure.
4. **Business Continuity:** The structured set of plans and arrangements aimed at maintaining vital functions during crisis. By identifying critical activities and establishing recovery procedures, business continuity reduces reliance on improvised or unsystematic reactions during periods of instability.
5. **Organizational Learning:** The foundational capacity to reflect on past disruptions and adapt future practices. Resilience is not merely a matter of resistance; it requires institutional memory and iterative improvement, providing a bridge between short-term continuity and long-term strategic capability

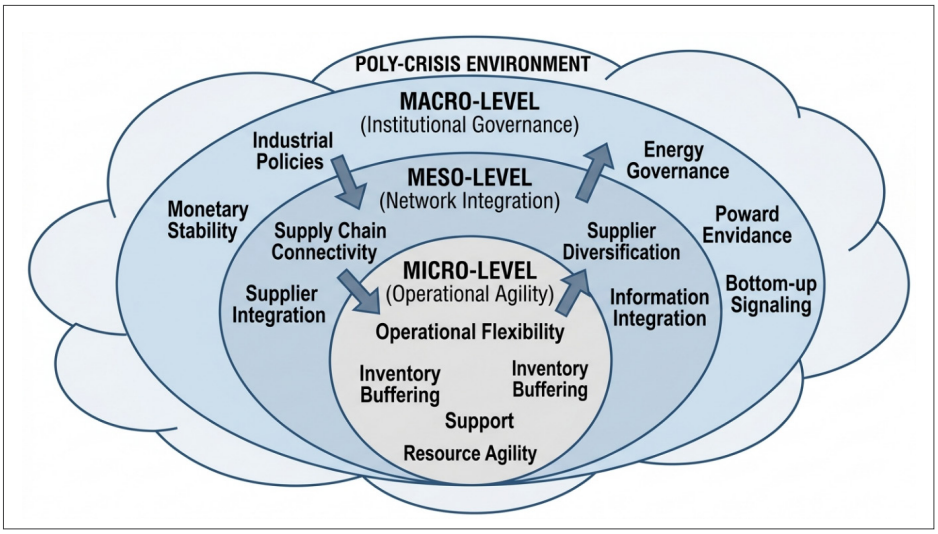

Figure [1]. Multi-level Production Resilience Model

3. Review of Domestic and International Studies

The literature on production resilience and supply chain resilience has expanded considerably across operations management, industrial policy, risk management, and crisis studies. A common thread in this body of work is the recognition that economic, political, technological, and environmental disruptions are not necessarily exceptional or temporary, but may constitute persistent features of the contemporary business environment. As a result, firms and production networks are increasingly expected to maintain continuity, adapt to disruption, and recover under conditions of uncertainty, while still facing the constraints of cost efficiency and competitiveness.

a. Foreign Literature Review

International scholarship has made a substantial contribution to the conceptualization and operationalization of supply chain resilience. Christopher and Peck (2004) were among the early scholars to present supply chain resilience as a strategic capability for dealing with disruption. Their work suggests that globally extended supply chains, especially those shaped by lean production, cost minimization, and extensive outsourcing, may be more exposed to external shocks. They argue that resilience requires the integration of risk management, inter-organizational collaboration, information visibility, and flexibility. This line of research shifted attention from resilience as a general managerial ideal toward resilience as a design principle embedded in supply chain architecture.

Sheffi and Rice (2005) further developed this perspective by examining resilience at both

the firm and supply chain levels. Their work implies that organizational resilience cannot be fully understood without reference to the broader network in which the firm operates. They highlight mechanisms such as alternative sourcing, reserve capacity, operational flexibility, and collaboration with partners as important ways of reducing vulnerability to disruption. In this view, resilience is not merely a reactive response after crisis, but also a form of preparedness that may reduce the scale and duration of operational interruption.

A major contribution to this literature was made by Pettit et al. (2010), who offered one of the most widely cited frameworks for assessing supply chain resilience. Their model links resilience capabilities to vulnerabilities arising from disruption, complexity, and resource constraints. In their framework, capabilities such as flexibility, capacity, efficiency, visibility, collaboration, and adaptability may help reduce exposure to disruption or improve the ability to respond to it (Pettit et al., 2013). This contribution is particularly important because it treats resilience not only as a conceptual construct, but as a multidimensional attribute that can be assessed and managed through operational choices.

More recent studies have drawn attention to the networked nature of disruption. Habibi et al. (2023), for example, suggest that supply chain shocks may propagate across connected actors rather than remain confined to a single firm or node. Their work underscores the importance of network structure, interdependence, and transmission effects in resilience analysis (Ivanov, 2020; Scheibe & Blackhurst, 2018). This perspective is especially relevant for settings in which firms depend on a limited number of suppliers, logistics corridors, or critical inputs, since disruption in one segment may be associated with wider production instability.

Other international studies have examined the behavior of firms under sanctions, crisis conditions, and socio-economic shocks (Ahn & Ludema, 2020; Dizaji & van Bergeijk, 2013; Evenett & Fritz, 2021). Across this literature, disruption is often treated as a structural condition that may shape firm behavior, supply chain organization, and industrial strategy. Financial restrictions, trade barriers, technology access problems, and higher transaction costs are frequently discussed as factors that may erode resilience and encourage firms to rely on coping strategies such as supplier substitution, input localization, and network reconfiguration (Gereffi et al., 2022; Khorana et al., 2021). However, the effectiveness of such strategies appears to vary considerably depending on sectoral structure, institutional support, and the duration of the shock.

b. Iran-Focused Studies

In the Iranian context, Vizvбri and Shakeri (2016) provide an important reference point for understanding how sanctions affect supply chain management. Their study suggests that sanctions are associated with heightened supply-chain risk, particularly through financial instability, exchange-rate volatility, fluctuations in raw material prices, and constrained access to resources. This finding is significant because it points to the interaction of financial, commercial, and institutional constraints in shaping firm vulnerability, rather than attributing fragility to internal management inefficiencies alone.

At the firm level, Cheratian et al. (2022) examined the survival strategies of Iranian firms under sanctions. Their findings indicate that many small and medium-sized enterprises (SMEs) have relied on cost-cutting, adjustments in sales patterns, operational modifications, and informal networks to remain active. While these responses are critical for short-term survival, they do not necessarily indicate durable resilience, as they are predominantly reactive and rarely strengthen long-term production capacity or strategic competitiveness.

Sector-specific studies also provide corroborating empirical evidence. Bastani et al. (2021), for instance, examined resilience in Iran's pharmaceutical supply chain under persistent political and economic pressure. Their findings suggest that sectoral resilience can be strengthened through targeted support for domestic production, enhanced coordination among value-chain actors, modernized information systems, and institutional support. Although their analysis focused on the pharmaceutical industry, these implications readily extend to other manufacturing sectors, particularly capital goods and heavy industries, where imported intermediate inputs, regulatory coordination, and logistical stability are critical.

Recent Iranian scholarship has also addressed supply chain redesign under the compounded conditions of sanctions and external market disruptions. Nikian et al. (2022), for example, evaluated resilient and sustainable closed-loop supply chain configurations under systemic shocks. Their work demonstrates that resilience-oriented decisions are tightly bound to network redesign, multi-echelon resource allocation, and the balancing of economic viability with recovery capacity. Taken together, this stream of domestic research reinforces the core premise that production resilience in Iran cannot be reduced to isolated firm-level coping mechanisms; rather, it must be addressed as a network-wide and institutionally mediated phenomenon.

c. Synthesis and Research Gap

A defining feature of the extant empirical literature on Iranian industrial resilience is structural fragmentation. Many studies concentrate on a single manufacturing sub-sector, an isolated shock category, or a single analytical level of resilience. While these works offer granular insights into specific vulnerabilities and short-term coping mechanisms, they rarely synthesize firm-level dynamic capabilities, supply-chain network architectures, and overarching institutional constraints into an integrated framework. Consequently, the literature generates context-bound observations that remain difficult to generalize across heterogeneous industrial sectors or translate into systemic industrial policy instruments (Pettit et al., 2019; Sheffi & Rice, 2005).

To establish an integrative baseline, the literature can be categorized into three distinct analytical streams:

1. **Internal Firm Capabilities:** Studies focusing on endogenous operational parameters, including production flexibility, agile capacity planning, strategic redundancy, inventory buffering, and organizational learning (Golicic et al., 2020; Hohenstein et al., 2015).
2. **Supply Chain and Network Relations:** Studies examining inter-organizational dynamics, such as multi-tier supplier collaboration, multi-sourcing strategies,

buyer–supplier dependency, and the propagation of disruption across complex networks (Habibi et al., 2023; Scheibe & Blackhurst, 2018).

3. **Institutional and Macroeconomic Environment:** Studies addressing structural constraints, including international economic sanctions, foreign exchange volatility, capital market frictions, regulatory uncertainty, and state industrial interventions (Cheratian et al., 2022; Vizvбri & Shakeri, 2016).

The fundamental research gap identified in this study is the marked absence of an indigenous, multilevel analytical framework that bridges these three streams within Iran's unique institutional and operational landscape. Prevailing global resilience frameworks provide robust conceptual tools, yet they were predominantly calibrated for advanced industrial economies characterized by institutional stability, deep financial markets, and highly predictable logistical corridors (Ivanov, 2020; Pettit et al., 2010). Conversely, Iran-focused studies have documented the acute pressures of geopolitical shocks and macroeconomic volatility, but have largely failed to consolidate these insights into a unified, multilevel operational model.

Accordingly, this study addresses the empirical and theoretical divide by conceptualizing production resilience in Iran as an interdependent, multilevel construct rather than an isolated managerial mandate or a purely top-down policy outcome. In operational reality, shop-floor decisions regarding safety stock, supplier contracts, and production schedules are continuously constrained by foreign-exchange allocation rules, trade barriers, and credit rationing. Conversely, state-level industrial policies that overlook operational realities and network-level interdependencies inevitably yield sub-optimal results. This article therefore proposes a context-sensitive, multilevel framework to evaluate and reinforce production resilience in Iranian manufacturing under chronic structural crisis conditions.

Table 1. Summary of Literature Review

Research Axis	Main Focus	Representative Sources	Limitations for the Present Study
Supply Chain Resilience	Flexibility, agility, collaboration, visibility, and risk management in responding to disruption	Christopher & Peck (2004); Sheffi & Rice (2005); Pettit et al. (2010)	Limited attention to sanction-related constraints and the institutional conditions of the Iranian economy
Network Disruption Propagation	Network-based transmission of disruptions and interdependencies across supply chain actors	Habibi et al. (2023)	Greater emphasis on network effects than on the policy and industrial context of Iran

Research Axis	Main Focus	Representative Sources	Limitations for the Present Study
Firms Under Sanctions	Survival strategies, vulnerability reduction, and adaptation under financial and trade constraints	Vizvári & Shakeri (2016); Cheratian et al. (2022)	Stronger focus on survival under sanctions than on a broader multilevel conception of resilience
Specific Industries in Iran	Resilience challenges in pharmaceuticals, medical equipment, and selected industrial supply chains	Bastani et al. (2021); Nikian et al. (2022)	Findings are often sector-specific and may not be fully generalizable to the wider manufacturing sector
Research Gap	Development of a native, multilevel framework for analyzing production resilience in Iran	Present study	Requires analytical integration of firm, supply chain, industry, and state levels

4. Proposed Conceptual Framework: A Multi-level Resilience Model

To conceptualize and interpret production-related pressures in Iranian manufacturing, this study proposes an integrated multilevel framework for analyzing resilience under persistent structural instability. Rather than conceptualizing resilience solely as an internal firm-level dynamic capability, the framework treats it as a context-dependent condition emergent from the systemic interactions across three analytically distinct tiers: the micro level (firm-specific operations), the meso level (inter-firm networks and sectoral dynamics), and the macro level (institutional and macroeconomic conditions). In this formulation, resilience does not reside within a single unit of analysis; rather, it serves as an interpretive architecture to organize how operational shocks, network dependencies, and macro-institutional constraints converge across industrial sectors.

Methodologically, this framework serves as an interpretive and diagnostic structure rather than an empirically validated causal-path model. The empirical baseline utilized in this study, derived from manufacturing Purchasing Managers' Index (PMI) data and official state statistical releases, allows for the identification of broader structural patterns and operational strains across sub-sectors. However, it does not support econometric testing of cross-level causation, micro-level feedback mechanisms, or the internal organizational routines through which dynamic resilience capabilities are institutionalized (Ivanov, 2020; Pettit et al., 2019). Consequently, this framework is operationalized to map and categorize observed industrial pressures across micro, meso, and macro domains.

Micro Level: Operational Adjustment and Buffering Capabilities

At the micro level, the analytical focus centers on the internal shop-floor conditions under which individual enterprises attempt to maintain manufacturing continuity during disruptions. Extant literature characterizes firm-level resilience through mechanisms such as production flexibility, input substitution, dynamic inventory buffering, multi-skilling of labor, and production-line reconfiguration (Hohenstein et al., 2015; Sheffi & Rice, 2005).

These operational buffers allow enterprises to absorb immediate high-frequency shocks and maintain baseline output.

Within the empirical scope of this study, however, these micro-level dynamics must be interpreted with methodological caution. Aggregate PMI sub-indices and macroeconomic production statistics provide proxy indicators of operational stress, such as raw material inventory depletion, surging input costs, and decelerating order books, rather than direct observations of internal managerial capabilities or dynamic adaptation strategies (Cheratian et al., 2022). Consequently, the micro-level tier within this framework designates the functional domain where operational adjustments and tactical buffering occur, retaining an inferential interpretation grounded in descriptive empirical evidence.

Meso Level: Network Dependencies and Sectoral Heterogeneity

The meso level expands the analytical boundary beyond single organizations to encompass the industrial networks, value-chain architectures, and sectoral ecosystems within which manufacturing occurs. Resilience literature associates this meso-tier with multi-tier supplier visibility, inter-firm collaboration, geographical diversification, and network redundancy (Habibi et al., 2023; Pettit et al., 2010; Scheibe & Blackhurst, 2018). These structural parameters determine whether supply-chain shocks are localized, absorbed, or amplified across broader industrial ecosystems through bullwhip and ripple effects.

In this study, cross-sectoral divergences observed in PMI outputs and production indexes serve as descriptive evidence of asymmetric exposure to shocks, rather than direct metrics of inter-firm relational governance. The data highlight distinct sectoral vulnerabilities, including differential exposure to import dependencies, energy grid curtailments, and localized logistics bottlenecks. The meso level thus functions as an analytical layer for interpreting structural asymmetries and inter-firm dependencies across sub-sectors without asserting unverified causal claims regarding shock propagation pathways.

Macro Level: Institutional and Policy Constraints

The macro level captures the structural and institutional matrix governing manufacturing activity. This includes foreign-exchange allocation regimes, capital access frictions, trade barriers, regulatory unpredictability, logistics infrastructure reliability, and industrial energy supply stability. Within the context of Iranian industrial policy under sanctions, these factors represent pervasive structural conditions that dictate operational feasibility rather than secondary background variables (Ahn & Ludema, 2020; Dizaji & van Bergeijk, 2013; Vizvбri & Shakeri, 2016).

Nevertheless, the aggregate empirical indicators employed here do not permit exact econometric attribution of single policy interventions to specific manufacturing performance variances. Instead, macro-level indicators are utilized descriptively to establish the boundary conditions of resource allocation and regulatory friction within which industrial enterprises operate. The macro tier thereby establishes the institutional baseline required to contextualize

micro-level operational buffering and meso-level supply network strains.

d. Cross-Level Relations and Interpretive Use of the Framework The central proposition of the framework is that production resilience is more plausibly interpreted as a multilevel and relational phenomenon than as a fixed attribute located exclusively at the firm, network, or institutional level. In conditions of overlapping economic, infrastructural, and regulatory pressure, continuity in production may depend not only on internal firm responses, but also on the structure of supply relationships and the stability of the broader policy environment. However, the present study does not test these cross-level relations empirically. Neither the PMI nor the accompanying statistical evidence can establish feedback loops, directional causation, or the relative weight of micro-, meso-, and macro-level influences. For this reason, the framework should be read as a structured interpretive device that helps situate descriptive evidence within a broader analytical architecture. It is intended to support more disciplined interpretation of manufacturing pressures, while avoiding unsupported claims about causal interaction or fully demonstrated resilience. Figure 1 presents this multilevel framework and illustrates the analytical relationship among firm-level adjustment, network dependencies, and institutional conditions under persistent stress.

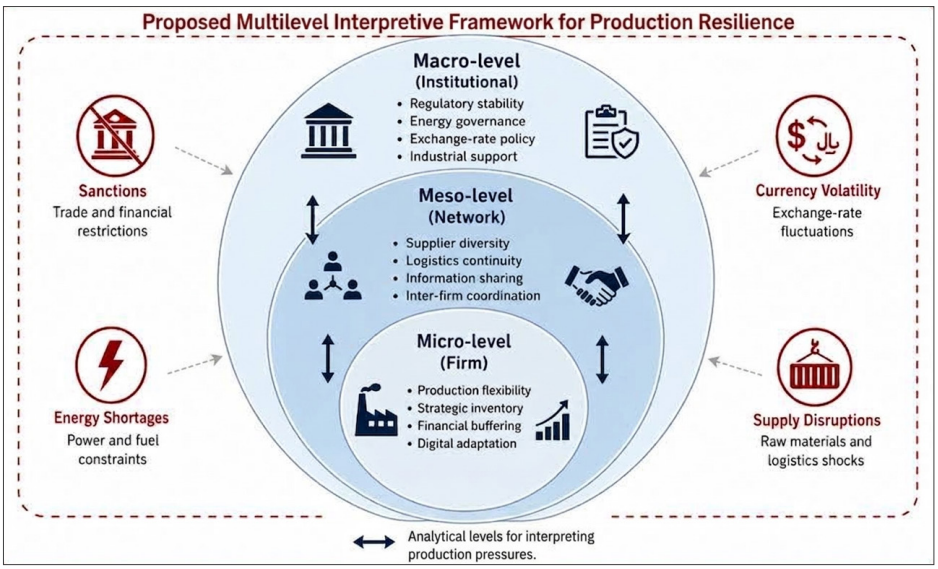

Figure 1. Proposed multilevel interpretive framework linking firm-level adjustment, network dependencies, and macro-institutional conditions in Iranian manufacturing

The figure should be understood as a conceptual map for organizing interpretation, rather than as a validated representation of causal mechanisms.

5. Methodology

This study employs a qualitative-interpretive research design supported by secondary descriptive statistical evidence. The primary analytical objective is neither to quantify production resilience as a single unidimensional observable variable nor to formally test causal relationships through structural econometric modeling. Instead, the study utilizes resilience as an interpretive lens to examine documented production conditions, supply-network vulnerabilities, and macro-institutional pressures operating across the Iranian manufacturing sector under chronic structural instability (Bhamra et al., 2011; Ivanov, 2021).

By adopting this interpretive approach, the study evaluates descriptive data streams, predominantly Purchasing Managers' Index (PMI) indicators and official sector-level statistical releases, to map systemic operational strains across industrial tiers (Pettit et al., 2019). This methodological choice acknowledges that while aggregate secondary data may not capture internal dynamic capabilities or micro-level managerial choices directly, it offers rigorous empirical indicators of operational stress, resource constraints, and cross-sectoral asymmetries under sustained economic disruption (Cheratian et al., 2022; Vizvбri & Shakeri, 2016).

5.1. Research Design and Conceptual Framework

The methodological architecture integrates two distinct analytical components: a conceptual synthesis of the industrial resilience literature and a secondary descriptive analysis of sectoral indicators. The conceptual dimension provides the structural organizing framework, operationalizing three analytical tiers, the micro (firm-level operations), meso (supply network and value-chain relations), and macro (institutional and policy environment) levels, to systematically categorize and interpret the empirical data streams (Hohenstein et al., 2015; Pettit et al., 2010).

Within this methodological setup, these three levels are deployed as analytical categories for structured diagnostic interpretation rather than as empirically verified, deterministic causal tiers. This integrative structure allows the study to bridge high-frequency descriptive indicators with theoretical constructs of operational resilience, supply network vulnerability, and institutional friction without overextending empirical inferences beyond the explanatory power of aggregate secondary data (Bhamra et al., 2011; Ivanov, 2021).

5.2. Data Sources and Scope

The empirical analysis relies exclusively on secondary data, primarily the manufacturing Purchasing Managers' Index (PMI) and official industrial statistics. These materials are treated as officially published records; no primary data collection, such as interviews or firm-level surveys, was conducted. The principal sources include:

- **Manufacturing PMI Reports:** Monthly indices published by the Iran Chamber of Commerce, Industries, Mines and Agriculture (ICCIMA, 2024).
- **Official Statistics:** Sectoral data on financing, energy costs, and production volume released by the Statistical Centre of Iran (SCI, 2024) and relevant industrial

authorities.

5.3. Interpretive Use of PMI Indicators

PMI indicators are used cautiously and in accordance with standard reporting conventions (Institute for Supply Management [ISM], 2023). A value below 50 signifies contraction relative to the previous month, while a value above 50 indicates expansion. Within this study, however, PMI values are not treated as direct measures of "resilience" or "fragility" (Bhamra et al., 2011). Instead, sub-indices, including raw material prices, inventory levels, and supplier delivery times, are interpreted as reported proxies for operational pressure (Pettit et al., 2019). Their meaning is understood to be situated within the original survey's methodology, weighting procedures, and seasonal adjustments (Iran Chamber of Commerce, Industries, Mines and Agriculture [ICCIMA], 2024).

5.4. Analytical Procedure

The study proceeds in three stages:

1. **Thematic Synthesis:** Reviewing resilience literature to identify dimensions relevant to production continuity under disruption.
2. **Descriptive Mapping:** Examining selected official statistics and PMI trends to identify prominent pressures affecting Iranian manufacturing.
3. **Multilevel Interpretation:** Synthesizing observed statistical patterns through the proposed micro-meso-macro framework to generate a conceptually informed reading of production conditions.

5.5. Methodological Limitations

The study acknowledges several constraints inherent in its design:

- **Operationalization:** Resilience is not directly measured; the analysis focuses on observable pressures and reported conditions that may be associated with resilience.
- **Causality:** Due to the descriptive nature of the secondary evidence, the study does not establish causal mechanisms or demonstrate empirical interaction across analytical levels.
- **Data Reliability:** The analysis is contingent upon the sampling procedures, classification rules, and reporting practices of the original data-producing institutions.

Accordingly, the findings are presented as a structured descriptive interpretation rather than a confirmatory test of a resilience model.

6. Descriptive Analysis of Reported Production Conditions

This section presents a descriptive overview of selected statistical evidence published by official and sectoral reference bodies, with particular attention to manufacturing PMI indicators for May 2026 (Ordibehesht 1405). Its purpose is to document reported production-

related conditions and to organize those observations within the article's micro/meso/macro framework. The section does not treat the reported indicators as direct measures of production resilience. Rather, it identifies patterns that may be relevant to the interpretation of production continuity and industrial adjustment under stress (Iran Chamber of Commerce, Industries, Mines and Agriculture [ICCIMA], 2026a). To enhance transparency, each numerical indicator discussed in this section should be linked in the final manuscript to its precise institutional source, report title, publication date, and table or figure number.

6.1. Micro-Level Reported Operating Conditions

The May 2026 manufacturing PMI reported a seasonally adjusted headline value of 45.3, which in standard PMI interpretation indicates contraction relative to the benchmark level of 50 (ICCIMA, 2026a). This reading suggests that surveyed manufacturing activity remained in contractionary territory during the reference month. It does not, by itself, identify the causes of that contraction. Several sub-indices provide additional descriptive information about reported operating conditions. The raw-material purchase-price index was reported at 92.4, indicating a high incidence of reported increases in input purchase prices within the PMI survey framework (ICCIMA, 2026a). The raw-material inventory index stood at 36.3, which is consistent with relatively weak inventory conditions as reported by surveyed firms (ICCIMA, 2026a). The energy-consumption index was 49.5, while the sales index was 41.5; both remained below the neutral threshold of 50 (ICCIMA, 2026a). Taken together, these indicators describe a difficult reported operating environment characterized by contractionary survey readings, elevated input-price pressures, weak inventory conditions, and subdued sales. These observations may be relevant to the analysis of production continuity at the firm level. However, the available data do not permit direct causal inference, nor do they directly measure firm resilience.

6.2. Meso-Level Sectoral PMI Patterns

The sectoral PMI data indicate that reported manufacturing conditions varied across industries during the same period. Some sectors recorded readings above 50. For example, rubber and plastics reported 60.2, and wood, paper, and furniture reported 51.5. Other sectors remained below 50, including apparel and leather at 41.1. Sectoral sub-indices also show noticeable variation. In the automotive sector, for example, the raw-material inventory index was reported at 28.6, suggesting relatively weak inventory conditions in that sector. Similar differences appear across other industries in relation to input prices, inventories, and output-related indicators. At the descriptive level, these results point to heterogeneity in reported industrial conditions rather than a uniform manufacturing pattern. The data do not identify why these differences occur. They may be associated with variation in input dependence, supply-chain structure, foreign-exchange exposure, market conditions, technical production requirements, or energy intensity, but these mechanisms are not directly tested in this article. For that reason, the sectoral evidence is used here to document variation, not to establish explanatory hierarchy.

6.3. Macro-Level Institutional and Financial Context

Additional official statistics provide descriptive evidence on broader production-related conditions beyond the PMI survey. One reported pattern concerns the relationship between industry's economic weight and its direct tax burden. According to the cited official statistics, industry accounts for approximately 19.2 percent of GDP while contributing about 32 percent of direct tax revenues (Iranian National Tax Administration [INTA], 2026; Statistical Centre of Iran [SCI], 2026). This comparison may be read as suggesting a relatively heavy fiscal burden on industry, although the statistic alone does not establish its precise effect on firm behavior, investment, or output. A second pattern concerns the structure of industrial finance. Official data indicate that working-capital financing accounted for 87.7 percent of total industrial financing in the reported period (Central Bank of the Islamic Republic of Iran [CBI], 2026). This suggests a financing profile concentrated on short-term operating needs. However, this figure does not directly reveal how firms allocated funds internally, nor does it by itself demonstrate underinvestment in modernization. It nevertheless provides descriptive evidence consistent with a short-term financing orientation. A third pattern concerns regulatory and infrastructural conditions reported by sectoral and institutional sources. These include references to regulatory unpredictability, bureaucratic delays, customs frictions, energy cost increases, and recurrent power or fuel constraints (Iran Chamber of Commerce, Industries, Mines and Agriculture [ICCIMA], 2026b). These reported conditions are relevant because they may shape the broader environment within which production decisions are made. Even so, the present article treats them as contextual descriptive evidence rather than as directly quantified determinants of resilience.

6.4. Descriptive Synthesis

The evidence reviewed in this section points to three broad categories of reported pressure. First, financial and price-related pressures are reflected in high reported input-price readings and evidence of strong reliance on working-capital financing. Second, institutional and fiscal pressures are reflected in taxation patterns and reported regulatory frictions. Third, infrastructural pressures are especially visible in energy cost and supply conditions. Within the logic of this article, these categories are organized analytically across the micro, meso, and macro levels. This organization should be understood as an interpretive classification of the observed evidence, not as proof of empirically demonstrated interaction across levels. The main contribution of this section is therefore descriptive: it shows that reported production conditions in Iran appear to involve multiple types of pressure operating at different analytical scales.

7. Discussion

The descriptive evidence presented in Section 6 suggests that manufacturing conditions in Iran may be more meaningfully interpreted through a multilevel perspective than through a narrowly

firm-centered one (Hohenstein et al., 2015; Pettit et al., 2019). This claim should be understood in a limited analytical sense. The article does not empirically validate a multilevel resilience model through causal testing or confirmatory analysis. Rather, it shows that the available descriptive evidence can be organized coherently across firm-level operating conditions, sectoral variation, and the broader institutional context (Cheratian et al., 2022; Ivanov, 2021).

A central implication of this interpretation is conceptual. The data reviewed in this article do not directly measure production resilience (Bhamra et al., 2011). Instead, they describe reported pressures, contractions, asymmetries, and constraints that may be relevant to production continuity and adaptive behavior (Habibi et al., 2023; Sheffi & Rice, 2005). For this reason, resilience is treated here as an analytical construct used to interpret the significance of the observed evidence, rather than as an empirically measured outcome demonstrated by the data.

7.1. Firm-Level Interpretation

At the micro level, the PMI evidence suggests that many firms were operating in a difficult reported environment during the reference period. Elevated input-price readings, weak inventory indicators, soft sales, and sub-50 energy-related readings together point to strained operating conditions (Habibi et al., 2023; Iran Chamber of Commerce, Industries, Mines and Agriculture [ICCIMA], 2026a). These observations are relevant to resilience analysis because they may indicate limited room for maneuver in procurement, scheduling, and liquidity management (Bhamra et al., 2011; Sheffi & Rice, 2005).

At the same time, caution is necessary. The data do not show how individual firms responded internally, which firms adapted more effectively than others, or which managerial practices were most consequential (Pettit et al., 2019; Vizvбri & Shakeri, 2016). Accordingly, the article cannot conclude that firm-level resilience was low in any direct measured sense. A more defensible interpretation is that the observed conditions appear consistent with pressure on production continuity at the firm level (Cheratian et al., 2022).

7.2. Sectoral Interpretation

At the meso level, the sectoral PMI results indicate that reported manufacturing conditions were uneven across industries. This is analytically important because it suggests that industrial conditions were not homogeneous during the reference period. Some sectors reported relatively stronger readings, while others remained well below the contraction threshold (Cheratian et al., 2022; Iran Chamber of Commerce, Industries, Mines and Agriculture [ICCIMA], 2026a).

The article interprets this heterogeneity as relevant to the meso level because sectoral structure and network position may influence how pressures are experienced and managed (Hohenstein et al., 2015; Pettit et al., 2010). However, the present evidence does not directly observe supply-network configuration, inventory strategies across networks, or actual inter-

firm coordination mechanisms (Ivanov, 2021; Sheffi & Rice, 2005). The article therefore stops short of claiming that meso-level mechanisms have been demonstrated empirically. Instead, it argues that sectoral variation makes a meso-level analytical lens useful for interpretation (Bhamra et al., 2011; Habibi et al., 2023).

7.3. Macro-Level Interpretation

At the macro level, the fiscal, financial, regulatory, and energy-related evidence suggests that manufacturing firms operate within a broader institutional environment that may shape production conditions (Farzanegan & Hayo, 2019; North, 1990). Taxation patterns, reliance on working-capital finance, and reported regulatory and infrastructural frictions all appear relevant to the conditions under which industrial activity is sustained under stress (Central Bank of the Islamic Republic of Iran [CBI], 2026; Islamic Parliament Research Center [IPRC], 2025; Vizvбri & Shakeri, 2016).

Here again, the article does not claim that these macro conditions have been causally shown to determine production outcomes. Rather, it argues that the descriptive evidence makes it difficult to interpret firm-level conditions in isolation from the broader institutional setting (Acemoglu et al., 2005; Cheratian et al., 2022). In that limited but important sense, the macro dimension appears analytically significant (Habibi et al., 2023; Scott, 2014).

7.4. Survival-Oriented Adjustment as a Conceptual Reading

One useful interpretive distinction emerging from the evidence is that between survival-oriented adjustment and strategic resilience (Bhamra et al., 2011; Lengnick-Hall et al., 2011). The available data do not directly operationalize either concept. Nonetheless, the descriptive pattern of strong working-capital orientation, difficult input conditions, weak inventories, and unstable infrastructure appears more consistent with short-term continuity management than with clearly observable long-term strategic upgrading (Central Bank of the Islamic Republic of Iran [CBI], 2026; Cheratian et al., 2022; Iran Chamber of Commerce, Industries, Mines and Agriculture [ICCIMA], 2026a; Islamic Parliament Research Center [IPRC], 2025).

This distinction should therefore be presented as a conceptual reading of the evidence rather than as a directly measured conclusion (Pettit et al., 2019; Vizvбri & Shakeri, 2016). It helps clarify why continued production under stress should not automatically be equated with robust resilience in a developmental or strategic sense (Duchek, 2020; Habibi et al., 2023).

7.5. Implication for the Framework

Overall, the framework proposed in this article is useful primarily as an interpretive device for organizing evidence across multiple analytical levels (Bhamra et al., 2011; Pettit et al., 2019). It does not empirically prove that these levels interact in a formally tested way, nor does it establish a hierarchical model of causation (Cheratian et al., 2022; Vizvбri & Shakeri, 2016). What it does show is that the observed descriptive evidence can be read

more coherently when firm-level indicators, sectoral variation, and institutional context are considered together rather than in isolation (Duchek, 2020; Habibi et al., 2023; Scott, 2014).

8. Policy Implications

Because the empirical evidence used in this article is descriptive, the policy implications offered here should be understood as evidence-informed and conditional rather than as directly validated prescriptions. Each implication is linked to a pattern observed in the reported data, but the article does not test the effectiveness of the proposed interventions (Pettit et al., 2019; Vizvбri & Shakeri, 2016).

8.1. Firm-Level Implications

The PMI evidence reports elevated input-price pressure and weak inventory conditions (Iran Chamber of Commerce, Industries, Mines and Agriculture [ICCIMA], 2026a). These patterns suggest that firms may benefit from strengthening procurement monitoring, diversifying suppliers where feasible, and improving contingency planning for critical inputs (Bhamra et al., 2011). The relevance of these implications derives from the reported price and inventory indicators, not from direct evidence that such strategies would be equally effective across all sectors or firms. The sales and financing evidence likewise suggests that tighter working-capital management may become more important under contractionary conditions (ICCIMA, 2026a). Where firms face soft demand, rising input costs, and a concentration of financing in short-term operating facilities, closer coordination among purchasing, production, and cash-flow planning may help reduce exposure to short-term disruption (Cheratian et al., 2022). Finally, sub-50 energy-related readings, together with broader evidence on energy instability, point to the potential importance of firm-level energy contingency planning (ICCIMA, 2026a; Ministry of Energy, 2026). This may include revised production scheduling, backup arrangements where economically feasible, and greater attention to energy efficiency in continuity planning (Habibi et al., 2023).

8.2. Industry-Level Implications

The sectoral PMI evidence indicates uneven reported conditions across industries (ICCIMA, 2026a). This suggests that a uniform industrial support strategy may be less appropriate than sector-sensitive approaches. Sectors with lower PMI readings and weaker inventory conditions may require different forms of coordination and support from those with relatively stronger short-term performance (Hohenstein et al., 2015). The observed heterogeneity also supports the view that sectoral associations, chambers, and coordinating institutions may play a useful role in information sharing and bottleneck reporting. Where sectors are highly exposed to input bottlenecks, collaborative procurement, shared market intelligence, or more structured reporting of supply constraints may also deserve consideration (Ivanov, 2021).

8.3. Macro-Level Implications

The broader financial, fiscal, regulatory, and infrastructural evidence suggests that policy predictability may matter for production continuity (North, 1990). Where firms operate under unstable regulatory, financing, and energy conditions, clearer and more consistent institutional rules may improve planning conditions (Farzanegan & Hayo, 2019). The concentration of industrial finance in working-capital facilities also suggests that policymakers may wish to consider whether the existing financing structure leaves sufficient room for modernization, adaptation, and capability upgrading (Central Bank of the Islamic Republic of Iran [CBI], 2026). The evidence on energy costs and supply instability likewise points to the possible importance of industrial energy governance. More transparent pricing, more reliable supply arrangements, and clearer shortage-management mechanisms may be especially relevant in an environment where energy appears repeatedly in the descriptive evidence as a production-related constraint (Islamic Parliament Research Center [IPRC], 2025).

8.4. Integrated Implication

Taken together, the evidence suggests that production-related pressures are distributed across operational, sectoral, and institutional levels. For that reason, an integrated policy approach may be more appropriate than interventions focused on only one level. This should be read as a policy inference from the structure of the observed evidence, not as a tested claim about optimal policy design (Scott, 2014).

9. Conclusion

This article examined production-related pressures in Iranian manufacturing through a conceptual multilevel framework supported by secondary descriptive evidence (Bhamra et al., 2011; Scott, 2014). Rather than directly measuring production resilience or testing causal relationships, the study used resilience as an interpretive concept for organizing evidence on firm-level operating conditions, sectoral PMI variation, and the broader institutional and infrastructural context (Duchek, 2020; Pettit et al., 2019). The descriptive evidence indicates contractionary manufacturing readings during the reported PMI period, elevated input-price pressure, weak inventory conditions, uneven sectoral performance, strong reliance on working-capital finance, and broader fiscal, regulatory, and energy-related pressures (Central Bank of the Islamic R0; Pettit et al., 2019). The descriptive evidence indicates contractionary manufacturing readings during the reported PMI period, elevated input-price pressure, weak inventory conditions, uneven sectoral performance, strong reliance on working-capital finance, and broader fiscal, regulatory, and energy-related pressures (Central Bank of the Islamic Republic of Iran [CBI], 2026; Iran Chamber of Commerce, Industries, Mines and Agriculture [ICCIMA], 2026a; showing that these observed pressures can be interpreted through a micro/meso/macro framework in a way that highlights the layered character of

industrial conditions (Cheratian et al., 2022; Habibi et al., 2023). This should not be read as an empirical validation of cross-level interaction. Rather, it is a structured interpretive approach that helps relate firm-level indicators to sectoral variation and broader institutional context (Hohenstein et al., 2015; North, 1990). A further interpretive implication is that continued production under stress may, in some cases, be more appropriately understood as survival-oriented adjustment rather than as demonstrated strategic resilience (Lengnick-Hall et al., 2011). In the present article, this distinction remains conceptual and inferential. It therefore requires more direct examination in future research through firm-level surveys, comparative case studies, or longitudinal analysis (Ivanov, 2021).

The study also has clear limitations. It relies on secondary data, does not directly operationalize resilience through a validated indicator, and does not establish causal effects (Sheffi & Rice, 2005). In addition, the explanatory value of the analysis depends on the quality, scope, and transparency of the original data sources (Farzanegan & Hayo, 2019). Future research could strengthen the framework by incorporating firm-level evidence, clearer operational indicators, and more systematic comparison across sectors and time periods (Ministry of Energy, 2026).

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