



Review Article

Nuclear-Related Sanctions and Adaptive Political Economy in Iran: Mechanism Tracing of Endogenous Equilibrium Formation

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ARTICLE INFO

Article history:

Date of submission: 06 December 2025

Date of revise: 23 July 2026

Date of acceptance: 07 August 2026

JEL Classification:

F51, F59, P16, O17.

Keywords:

Iran; nuclear-related sanctions;
adaptive political economy;
mechanism tracing;
institutional adaptation;
endogenous equilibrium.

ABSTRACT

This paper examines how nuclear-related sanctions have shaped an adaptive political economy in Iran. While existing research has documented the macroeconomic, welfare, and financial consequences of sanctions and assessed their coercive effectiveness, less attention has been paid to the mechanisms through which sanctions-generated pressure is absorbed, redistributed, and reorganized within the target economy. Addressing this gap, the paper develops an endogenous-equilibrium perspective that treats sanctions as forces reshaping domestic institutions, firm behavior, household adjustment, and transnational commercial networks. The study employs theory-guided structured comparison and mechanism tracing across three episodes: the 2006–2013 multilateral sanctions regime, the 2015–2016 JCPOA implementation period, and the post-2018 maximum-pressure campaign. It triangulates macroeconomic, welfare, firm-level, financial-market, trade, and labor-market evidence. The analysis identifies four interrelated mechanisms: macroeconomic contraction, reallocation of access to scarce resources, institutional adaptation, and sanctions-induced uncertainty. The findings show that sanctions imposed severe costs, including output losses, weaker investment, exchange-rate instability, erosion of the middle class, and greater labor-market vulnerability. Yet these costs were distributed unevenly. Scarcity increased the value of access to finance, foreign exchange, imports, institutional coordination, and external commercial networks. Better-connected firms adapted through liquidity management, supply-chain restructuring, alternative payments, and trade rerouting, whereas less-connected firms and households bore disproportionate costs. The paper concludes that repeated sanctions generated a constrained and unequal adaptive equilibrium in which external pressure became embedded in domestic institutions, business strategies, and expectations. It contributes to sanctions research by showing that long-term outcomes depend not only on pressure intensity but also on the mechanisms through which pressure is mediated and sustained.

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DOI: <https://doi.org/10.48308/jep.2026.242798.1255>



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1. Introduction

Nuclear-related sanctions have been among the most consequential external constraints on Iran's economy over the past two decades. They have restricted oil exports, payments, finance, imported inputs, technology, transport, and foreign investment, producing output losses, inflation, exchange-rate instability, declining investment, deteriorating welfare, and uncertainty. Yet their long-term consequences cannot be understood from economic severity alone. Pressure is transmitted through institutions, firms, households, financial markets, and transnational commercial networks, which respond strategically.

Recent scholarship increasingly treats sanctions not as homogeneous external shocks but as interactive political-economic systems in which sender states, target institutions, private actors, and third-country intermediaries adjust to changing incentives, risks, and expectations (Gutmann et al., 2025). In Iran, sanctions have altered both external access and domestic structures through which scarcity is allocated, exchange organized, and risks managed.

The empirical literature is incomplete. One strand documents macroeconomic and welfare effects, including output contraction, inflation, currency depreciation, inequality, poverty, and weaker household welfare (Ezzati, 2016; Farzanegan & Hayo, 2019; Kokabisaghi, 2018). A second analyzes sanctions as coercive statecraft, emphasizing design, enforcement, coordination, bargaining, and credible relief (Bapat & Kwon, 2015; Bapat & Morgan, 2009; Drezner, 1999; Hufbauer et al., 2007). A third highlights Iran's institutional resilience, hybrid governance, informal networks, welfare structures, and adaptive capacity under sustained pressure (Alizadeh, 2000; Harris, 2017; Maloney, 2015).

These literatures leave an analytical gap. Studies of economic consequences focus on aggregate losses, while work on coercive effectiveness evaluates whether sanctions alter target-state behavior. Neither explains fully how sanctions-generated pressure is absorbed, redistributed, and reorganized within

the target economy. Limited work integrates macroeconomic contraction, resource reallocation, firm adjustment, financial expectations, trade deflection, and labor-market responses within a unified political-economy framework.

This paper addresses that gap by examining nuclear-related sanctions as adaptive political-economic transformation. It asks how sanctions generate constrained adaptation within Iran's political economy and how these processes reshape the transmission, distribution, and persistence of external pressure. The paper does not estimate the average causal effect of sanctions on Iran's nuclear policy or assume that adaptation alone explains the persistence of the nuclear dispute. Rather, it investigates how sanctions become embedded in structures governing economic activity, institutional coordination, and commercial exchange.

The paper develops the concept of an endogenous equilibrium of constrained adaptation. It is endogenous because it emerges from domestic institutional, firm, household, and commercial-network responses to sustained restrictions. It is constrained because these responses neither eliminate welfare losses nor restore normal conditions. Rather, they keep selected economic and institutional channels active under scarcity, uncertainty, and limited international access, while shifting greater costs toward households, workers, smaller firms, and sectors with weaker financial or institutional capacity.

The analysis focuses on four interrelated mechanisms. First, macroeconomic contraction creates scarcity in foreign exchange, imported inputs, trade finance, investment, and employment. Second, scarcity reallocates access to resources among firms, households, and institutionally embedded actors. Third, institutional adaptation consolidates responses through foreign-exchange allocation, import access, public coordination, alternative payments, and logistics arrangements. Fourth, sanctions-induced uncertainty shapes expectations about exchange rates, credit, trade access, and diplomatic relief, influencing investment, liquidity management, firm valuation, and household decisions. Firm heterogeneity, trade deflection, and labor-market adjustment are transmission and feedback channels.

Sanctions effects are highly heterogeneous. They spread beyond targeted entities through export restrictions, imported-input costs, logistics barriers, exchange-rate volatility, financial constraints, and supply-chain disruption. In some cases, non-connected firms bear larger aggregate losses than politically connected firms, suggesting that sanctions are broad-based shocks rather than narrowly calibrated instruments of elite pressure (Shamsi, 2023). Financial-market evidence further shows that sanctions-related news and prospects of diplomatic relief affect firm valuations and expectations, particularly among politically connected firms (Draca et al., 2023; Ghasseminejad & Jahan-Parvar, 2020).

External adjustment also matters. Sanctions can trigger rerouting through third countries, alternative suppliers, payment intermediaries, re-export hubs, and new logistics arrangements. Trade deflection may preserve part of international exchange while raising transaction costs, reducing export margins, extending transport routes, and increasing dependence on intermediaries. Sanctions thus reshape the geography and terms of trade rather than simply reducing trade volumes proportionally (Haidar, 2017; Jena et al., 2024; Petrevski, 2025).

The empirical analysis compares three episodes: the 2006–2013 multilateral sanctions regime, the 2015–2016 JCPOA implementation period, and the post-2018 maximum-pressure campaign. They differ in sanctions intensity, credibility of relief, international coordination, and accumulated adaptation. The first captures acute constraints and initial adaptation; the JCPOA period tests whether partial relief reversed these arrangements and restored expectations of normalization; and the post-2018 period assesses renewed pressure on an economy shaped by earlier adaptations.

The paper contributes in three ways. First, it advances a mechanism-based account linking macroeconomic contraction to resource reallocation, institutional adaptation, uncertainty, and external network adjustment. Second, it integrates macroeconomic counterfactual, welfare, firm-level, financial-market, trade, and labor-market evidence. Third, it offers a path-

dependent interpretation of sanctions, emphasizing that repeated episodes affect an economy transformed by earlier restrictions and responses. The remainder presents the methodology, theoretical framework, empirical evidence, and implications for sanctions and coercive economic statecraft.

2. Theoretical Foundations of Endogenous Sanctions Equilibrium

In this study, the term equilibrium does not refer to a formal market-clearing outcome, a Nash equilibrium, or a stable solution derived from an explicit economic model.

In this study, equilibrium does not denote a market-clearing outcome, a Nash equilibrium, or a stable solution derived from an explicit formal model. It refers to a recurrent configuration of institutional, firm-level, household, and network-based responses to sustained restrictions. It emerges when foreign-exchange allocation, alternative payments, trade rerouting, liquidity preservation, supply-chain adjustment, and labour reallocation become routinized and shape the later transmission of sanctions pressure. Equilibrium implies neither efficiency, welfare improvement, political stability, nor the disappearance of conflict. It describes persistent adaptation under constraint, with substantial and uneven costs across firms, households, sectors, and social groups; it is a political-economy description, not a claim about optimality or formal balance.

This framework treats sanctions as constrained adaptation rather than a uniform shock. Restrictions limit access to markets, finance, technology, and foreign exchange, but their effects are filtered through institutions, organizational capabilities, distributional structures, and commercial networks. Macroeconomic contraction generates scarcity; scarcity reshapes resource access; and repeated responses become embedded in routines, strategies, and expectations. The equilibrium is endogenous because it is produced through domestic responses to continuing pressure. It is constrained and unequal because it neither eliminates welfare losses nor restores normal conditions, though it can preserve selected channels of production, exchange, and coordination.

2.1. Macroeconomic Contraction, Distributional Reallocation, and Institutional Consolidation

Sanctions initially constrain export revenues, foreign exchange, international payments, imported inputs, finance, and investment. In Iran, these restrictions have been associated with output contraction, inflationary pressure, currency depreciation, and heightened volatility in economic expectations (Ezzati, 2016; Laudati & Pesaran, 2023). Yet contraction is not a socially uniform reduction in economic capacity. It creates scarcity in strategically important resources and changes the relative value of access to foreign exchange, import channels, credit, transport, procurement, and commercial information.

Scarcity consequently produces distributional reallocation. Actors differ in their ability to obtain administratively allocated foreign exchange, secure public-sector coordination, access alternative finance, or mobilize domestic and external commercial networks. The relevant divide is not simply between politically connected and non-connected firms: adjustment depends on institutional embeddedness, financial and technological capacity, organizational experience, and trade-related networks. Sanctions can therefore impose broad costs while creating differentiated opportunities. Iranian firm-level evidence shows dispersed exposure and adjustment, while survival is conditioned by planning capacity, finance, technology, resources, and business networks (Cheratian, Goltabar, & Farzanegan, 2022; Shamsi, 2023).

Institutional adaptation develops through efforts to manage scarcity. Foreign-exchange allocation, import licensing, public procurement, transport coordination, payment arrangements, and alternative commercial channels become more consequential when conventional market mechanisms and international financial links are disrupted. Such measures may begin as emergency responses but repeated sanctions can turn them into routines through which institutions, firms, intermediaries, and households organize exchange. Institutional adaptation thus includes formal policy change and the consolidation of administrative, semi-formal, and commercial arrangements that sustain activity under restriction.

This process does not make sanctions harmless. Adaptive institutions redistribute and manage scarcity rather than remove the costs of reduced investment, restricted technological access, deteriorating welfare, and weaker long-term growth. Informal and semi-formal channels are not universally available: their usefulness depends on capital, foreign currency, institutional protection, and commercial connections, and they may reproduce unequal access to opportunity (Farzanegan & Hayo, 2019). Institutional consolidation consequently stabilizes selected adjustment channels while deepening segmentation between actors able to access adaptive resources and those more directly exposed to disruption. The implication is path dependence: later sanctions are imposed on an economy whose allocation structures, routines, and commercial practices have been reshaped by earlier pressure. Contraction therefore initiates a cumulative process through which subsequent sanctions are transmitted, absorbed, and politically mediated.

2.2. Macro–Meso–Micro Formation of the Adaptive Equilibrium

Sanctions do not operate through a single-level causal process. They generate a structured interaction among macro-level pressures, meso-level institutional and distributive transformations, and micro-level behavioural responses. This layered framework links external coercion to a self-reproducing political-economic configuration.

At the macro level, sanctions act as an exogenous constraint on access to markets, financial systems, and strategic technologies. They heighten uncertainty, raise transaction costs, and reshape aggregate expectations. However, macro pressure alone does not determine outcomes because firms and institutions do not respond uniformly to external shocks (Stępień & Truskolaski, 2025, pp. 120–121). At the meso level, contraction is translated into selective access to foreign exchange, import channels, and state-mediated resources. This redistribution changes incentives across actors and sectors. Firms can respond through compliance, circumvention, or withdrawal, according to their evaluation of sanctions exposure and associated costs and

benefits (Stępień & Truskolaski, 2025, pp. 121–122). Their embedding in routines and governance practices helps stabilize a constrained order.

At the micro level, heterogeneous capabilities shape the form of adjustment. Firms with stronger strategic agility and international experience are more able to diversify markets, reconfigure supply chains, or relocate activities; less capable firms are more likely to withdraw or reduce costs (Stępień & Truskolaski, 2025, pp. 123–124). Their interaction is recursive: macro pressure triggers meso-level redistribution, which reshapes incentives and enables differentiated micro adaptation; these responses aggregate upward and reinforce the meso structure. External coercion becomes a structuring force rather than a transient shock. Rising sanctions intensity thus need not produce proportionate political or economic breakdown. Equilibrium is the institutionalization of adaptive responses under sustained pressure.

2.3. Firm-Level Strategic Mediation of Sanctions Effects

Firm behaviour is a central transmission channel because firms are active agents, not passive recipients of sanctions. They shape the ultimate incidence of external pressure through heterogeneous adjustment strategies. Stępień and Weber (2019, pp. 131–133) show that systematic differences in firms' responses significantly condition aggregate outcomes; sanctions effects are therefore filtered through firm-level decisions rather than transmitted uniformly across the economy.

Firms select among compliance, avoidance, and defiance strategies, reflecting different degrees of engagement with or withdrawal from the sanctioned environment. These choices are shaped by resource endowments, international exposure, and institutional embeddedness (Stępień and Weber, 2019, pp. 135–136). Firms with stronger market embeddedness and higher sunk costs are more likely to defy sanctions than to exit (Stępień and Weber, 2019, pp. 140–141). Resource dependence produces a non-linear distribution of responses across firms (Stępień and Weber, 2019, p. 142), while administrative and institutional constraints can discourage active engagement

and reinforce conservative adjustment (Stępień and Weber, 2019, pp. 145–146). Firm heterogeneity consequently helps determine how macroeconomic pressure is distributed, how long it persists, and which activities survive.

2.4. Financial Expectations, Elite Exposure, and Sanctions Bluntness

Sanctions also operate through expectations about future restrictions, market access, exchange-rate conditions, and the credibility of diplomatic relief. Financial markets are particularly informative because they incorporate assessments of future profitability, financing conditions, and political risk. In Iran, sanctions-related news affects firm valuations, and announcements associated with relief can generate substantial positive market responses (Ghasseminejad & Jahan-Parvar, 2020). Sanctions thus affect behaviour through realized restrictions and expectations concerning their durability, reversibility, and commercial consequences.

This channel bears directly on elite exposure. Firms associated with influential actors may respond strongly to diplomatic developments and prospects of relief (Draca et al., 2023). Yet this finding does not demonstrate precise political coercion. Losses and uncertainty also spread across non-targeted firms, suppliers, workers, consumers, and sectors linked by trade, finance, logistics, and imported inputs. The question is whether costs are sufficiently concentrated on actors able to influence the disputed policy and create a durable incentive for change.

Available evidence suggests that concentration is incomplete. Financial-market reactions show that politically connected firms are not insulated, whereas firm-level evidence indicates broad spillovers beyond formally targeted or politically linked entities (Draca et al., 2023; Shamsi, 2023). Sanctions thus function both as signals to particular actors and as economy-wide shocks diffusing costs through interconnected production and financial networks. This bluntness weakens the premise that elite losses translate mechanically into political concession.

Expectations also reinforce adaptation. Anticipating recurring restrictions, unstable exchange rates, or reversible relief, firms may preserve liquidity, reduce leverage, postpone irreversible investment, limit hiring, diversify suppliers, and prioritize resilience over expansion. Individually rational responses can collectively reduce investment, slow productivity growth, and entrench defensive organization. The JCPOA period is instructive: positive responses to diplomacy did not necessarily restore durable expectations of normalization when relief remained politically contingent and reversible (Ghasseminejad & Jahan-Parvar, 2020; Laudati & Pesaran, 2023). Financial expectations are a feedback mechanism, converting anticipated coercion into current decisions while uneven costs limit political pressure.

2.5. External Network Adjustment: Trade Deflection

Sanctions also operate through external adjustment channels, including trade diversion and rerouting through third-party economies. Bilateral restrictions do not necessarily cause proportional reductions in overall trade; targeted economies can reroute flows through third countries, changing the geography of exchange without fully eliminating external access (Stępień & Truskolaski, 2025, pp. 118–121). Third-party economies are active nodes in a networked adjustment system. Trade deflection can attenuate contraction but increase transaction costs, reliance on intermediaries, and heterogeneity in adjustment. Sanctions are thus network-disrupting interventions, not purely bilateral coercive instruments.

2.6. Labour Migration as a Labour-Market Adjustment Channel

Labour migration is a household-level response to sanctions-induced contraction and uncertainty. Declining wages, employment insecurity, and macroeconomic volatility can make migration an adjustment strategy within constrained opportunity structures rather than an exogenous demographic process. It reallocates labour across space and sectors, altering the distribution of human capital and the structure of labour markets over time.

Unlike firm adaptation, which works through production and commercial decisions, migration reflects household optimisation under constraint. It links macroeconomic shocks to demographic and spatial reallocation and is consistent with a mechanism-based account of heterogeneous responses rather than uniform contraction (Ezzati, 2016; Kokabisaghi, 2018; Laudati & Pesaran, 2023; Mohammadshahi et al., 2025). By increasing uncertainty regarding future income streams and institutional stability, sanctions can also shape intertemporal household decisions and reinforce outward mobility pressures (Laudati & Pesaran, 2023).

2.7. Integrated Equilibrium Proposition

The mechanisms interact. Contraction initiates scarcity and reallocation; institutional consolidation embeds adjustment; financial expectations amplify elite and non-elite responses; trade deflection reroutes flows; and labour migration reallocates costs across employment forms, sectors, and borders. Together they generate recurrent constrained adaptation, reproduced through routines, firm strategies, household adjustment, and external networks, while imposing welfare losses, unequal access, and uncertainty.

The framework distinguishes core mechanisms from transmission and feedback channels. The core mechanisms are macroeconomic contraction, distributional reallocation of access to scarce resources, institutional adaptation, and sanctions-induced uncertainty. Firm heterogeneity, trade deflection, and labour-market adjustment are not independent mechanisms; they modify the incidence, distribution, and persistence of core processes. Firm heterogeneity determines who can absorb scarcity; trade deflection alters external transmission; and labour-market adjustment redistributes social costs. The equilibrium is produced by the four core mechanisms, while these channels shape how unevenly it is experienced and reproduced.

3. Methodology

This study employs theory-guided structured comparison and mechanism tracing to examine how nuclear-related sanctions have shaped an adaptive

political economy in Iran. It neither estimates the average causal effect of sanctions on Iran's nuclear policy nor treats domestic adaptation as the sole explanation for the persistence of the nuclear dispute. Instead, it examines how sanctions-generated pressure is transmitted, redistributed, and reorganized through domestic institutions, firms, households, and transnational commercial networks. The guiding question is: through what observable processes do sanctions produce constrained adaptation rather than uniform economic dislocation or a linear political outcome?

Sanctions are complex political-economic interventions, not discrete homogeneous shocks. Their effects depend on formal restrictions and on responses by state institutions, firms, households, financial markets, and third-country intermediaries. Recent scholarship emphasizes this interactive character, in which senders, targets, and transnational actors adjust to changing constraints, incentives, and expectations (Gutmann et al., 2025). Mechanism tracing is therefore appropriate for identifying temporally sequenced, interacting processes where aggregate outcomes may arise through multiple pathways and inference depends on observable implications of theoretically specified mechanisms (Beach & Pedersen, 2019; Bennett & Checkel, 2015).

The design compares three historically connected but analytically distinct episodes: the 2006–2013 multilateral sanctions regime, the 2015–2016 JCPOA implementation period, and the post-2018 maximum-pressure campaign. They vary in sanctions intensity and composition, credibility of prospective relief, international coordination, and accumulated adaptation. The first captures severe multilateral oil, banking, and trade restrictions; the JCPOA period tests whether partial relief reversed earlier arrangements and restored expectations of normalization; and the post-2018 episode assesses renewed pressure on an economy already experienced in alternative payments, trade rerouting, supply-chain adjustment, and financial precaution.

The unit of analysis is the sanctions episode: a temporally bounded but historically connected configuration of external restrictions, domestic institutional arrangements, and adaptive responses. This permits analysis of path dependence because later sanctions were imposed on an economy reshaped by

earlier episodes rather than an unchanged institutional and commercial structure (George & Bennett, 2005). The comparison assesses both recurrent mechanisms and changes in their operation as prior adjustment accumulated.

The analysis traces four interrelated mechanisms: macroeconomic contraction; reallocation of access to scarce resources across firms, households, and institutionally embedded actors; institutional adaptation through foreign-exchange allocation, import access, public coordination, transport arrangements, and alternative payments; and sanctions-induced uncertainty regarding exchange rates, credit, trade access, and diplomatic relief. Firm heterogeneity, trade deflection, and labor-market adjustment are treated as transmission and feedback channels through which these mechanisms are filtered, reinforced, or redistributed.

Evidence is selected using four criteria. Priority is given to Iran-specific research directly addressing economic, institutional, firm-level, trade, or labor-market effects of nuclear-related sanctions. The analysis favors transparent empirical strategies, including counterfactual estimation, firm-level surveys, event studies, structural trade analysis, and labor-market modeling. Evidence must relate to one or more of the three episodes; comparative and cross-country studies are used only to clarify broader mechanisms where Iran-specific evidence is limited. This is not a systematic literature review, but a transparent strategy for theory-guided selection and triangulation. The aim is process-oriented and bounded: not definitive causal identification of political effects, but an explanation of how repeated sanctions became embedded in an adaptive and unequal political-economic configuration, where substantial welfare losses coexisted with the preservation and reorganization of selected channels of production, exchange, and institutional coordination.

4. Empirical Validation Strategy and Evidentiary Benchmarks

This section traces the Section 3 mechanisms across sanctions episodes using macroeconomic, firm-level, institutional, financial, trade, and labour-market evidence.

4.1 Macroeconomic Contraction and Transmission Heterogeneity

Nuclear-related sanctions generated an uneven macroeconomic shock. The 2011–2013 escalation combined oil, banking, payment, and secondary sanctions, reducing export earnings, constraining foreign-exchange repatriation, raising import costs, and impairing trade finance. GDP growth fell to approximately –7.44 percent in 2012 (Ezzati, 2016, p. 463). Counterfactual evidence synthesized by Farzanegan and Batmanghelidj (2023, pp. 201, 207) indicates that GDP was about 12 percent below its synthetic benchmark in the first year after the 2012 shock, 17 percent below it by 2014, and 19 percent below the counterfactual by 2015; the effects persisted for roughly two years after the 2016 easing.

The JCPOA produced only partial recovery because continuing United States measures, secondary-sanctions risk, and doubts about durability limited foreign re-engagement. The post-2018 maximum-pressure campaign consequently affected an economy already weakened and structurally altered by the preceding episode (Farzanegan & Habibi, 2025, p. 3). Comparative evidence finds stronger negative growth effects from United States-led trade and financial sanctions (Petrevski, 2025, pp. 18–19).

Costs were socially heterogeneous: around 10 percent of households entered poverty during sanctions years, while no more than 6 percent escaped it. Rural, young, low-educated, private-sector, lower-income, and middle-income households were especially exposed; public-sector and highly educated households faced lower risks (Farzanegan & Batmanghelidj, 2023, p. 207). Welfare losses averaged 15 percent, were almost twice as large in rural areas, and coincided with a 40–50 percent decline in real government revenues (Gharibnavaz & Waschik, 2018, as cited in Farzanegan & Batmanghelidj, 2023, p. 207). Synthetic-control estimates show an average annual middle-class decline of 17 percentage points between 2012 and 2019; the more conservative synthetic difference-in-differences estimate is 12 percentage points, with a 28-percentage-point counterfactual gap by 2019 (Farzanegan & Habibi, 2025, pp. 1, 10). Sanctions therefore redistributed insecurity as well as reducing output.

4.2 Sectoral and Firm-Level Transmission

Exposure depended on international integration, supply-chain dependence, resources, and capability. Shamsi's (2023) measure is text-based, capturing sanctions-related concern in listed-company disclosures rather than realized losses across the entire economy; its results should therefore be interpreted accordingly. Within that scope, concern peaked after the 2018 United States withdrawal from the JCPOA and was about 20 percent higher than COVID-19 concern. Engineering, technical testing, electronics, and other internationally integrated industries reported greater exposure than recreation, sports, and entertainment (Shamsi, 2023, pp. 2–4).

Reported concerns centred on export restrictions (25.8 percent), import costs (18.4 percent), logistics (16.6 percent), and finance (11.0 percent) (Shamsi, 2023, p. 31). This indicates combined disruption rather than financial exclusion alone. Among 840 listed companies, direct targeting, ownership links, Revolutionary Guard affiliation, and Setad affiliation did not significantly predict the measured exposure (Shamsi, 2023, pp. 19–20). The average firm lost roughly 800 billion rials after adverse sanctions news. Aggregate losses were approximately 32,000 billion rials for politically connected firms and 161,000 billion rials for non-connected firms; each dollar lost by connected firms was associated with about five dollars of losses among non-connected firms (Shamsi, 2023, pp. 23–24). Sanctions were thus broad shocks, not precise instruments of elite coercion.

Adaptation was conditional on capabilities. Evidence from 486 Iranian MSMEs associates survival with planning, finance, technology, export orientation, business networks, consulting, selected cost reductions, and IT investment; reducing production or freezing wages reduced survival prospects (Cheratian, Goltabar, & Farzanegan, 2022, pp. 1–3). Among 480 MSMEs, supply-chain diversification improved persistence only with full external-finance access: the interaction coefficient was 1.449, compared with –1.285 for diversification without external finance (Goltabar, Cheratian, & Najafi, 2025, p. 12). Financial-market evidence shows two-week cumulative

abnormal returns of –5.4 percent for directly sanctioned firms and –7.3 percent for first-time designations. Relief events produced average positive abnormal returns of 14.19 percent, reaching 16.85 percent after the November 2013 breakthrough and 18.44 percent on JCPOA implementation day (Ghasseminejad & Jahan-Parvar, 2020, pp. 27, 30). Sanctions thus favoured surviving firms with finance, networks, and adaptive capacity.

4.3 Institutional Adaptation and Strategic State Responses

Institutional adaptation is visible in rules governing foreign exchange, imports, trade finance, transport, and public support. Oil and financial sanctions after 2011 reduced export receipts and impeded repatriation, increasing reliance on administratively allocated foreign exchange. The black-market dollar premium rose from 2.53 percent in 2010 to 112.55 percent in 2012, via 23.77 percent in 2011 (Farzanegan & Batmanghelidj, 2023, pp. 204–205). Access to official exchange rates therefore became a valuable privilege.

The allocation structure was distributive: exchange-rate differentials encouraged mis-invoicing, smuggling, and rent-seeking among recipients of subsidized currency while raising costs for actors reliant on market rates (Farzanegan & Batmanghelidj, 2023, p. 205). Firms reported concerns over restricted transfers, central-bank exchange rates, shipping arrangements, imported inputs, and tariffs; they used alternative transfer channels and negotiated with public entities to sustain exports and logistics (Shamsi, 2023, pp. 29–31). The channels were foreign exchange, trade finance, shipping, import access, and logistics, rather than explicit subsidies. The distribution of reported concerns—25.8 percent export restrictions, 18.4 percent import costs, 16.6 percent logistics, and 11.0 percent financial restrictions—was broadly stable from 2016 to 2022, suggesting that sanctions had become a persistent operating condition (Shamsi, 2023, p. 31).

Informality was not a universal escape route. The 2012–2013 sanctions reduced shadow-economy growth by roughly 30 percentage points more than

formal-economy growth, whereas partial relief in 2016–2017 was associated with a 13.6-percentage-point increase in shadow-economy growth (Farzanegan & Batmanghelidj, 2023, pp. 205–206, 215). Informal networks remained adaptive but depended on capital, currency, and connections. Institutional adaptation therefore managed scarcity and stabilized selected channels without removing welfare losses or the uneven burden on firms and households.

4.4 Sanctions-Induced Uncertainty and Expectation Formation

Sanctions affected Iran through restrictions and expectations about escalation, exchange rates, inputs, and relief credibility. Laudati and Pesaran's newspaper-based index links rising sanctions intensity to lower oil-export revenues and output growth, a depreciated rial, and higher inflation (Laudati & Pesaran, 2023, pp. 278–281). Anticipated depreciation, inflation, and import disruption shortened planning horizons before every restriction was realized.

The post-2018 episode illustrates it. GDP per capita fell by around 12 percent in 2018–2019, inflation rose from 9.6 percent to above 40 percent, annual oil-export losses approached \$80 billion, and the rial lost roughly 80 percent of its value against the dollar (Fardoust, 2020, as cited in Zareei et al., 2024, p. 6). Firms faced uncertainty over credit, foreign currency, inputs, and export markets. Event studies show that first-time designations generated returns of –8 percent for Guard-linked firms and –5.3 percent for deep-state-linked firms, versus –2 percent for the wider sample (Ghasseminejad & Jahan-Parvar, 2020, pp. 16–17). Relief events generated average abnormal returns of 14.19 percent, including 16.85 percent after the November 2013 breakthrough and 18.44 percent on implementation day; however, the July 2015 JCPOA agreement event yielded –4.09 percent, indicating that markets assessed the credibility and enforceability of relief rather than announcements alone (Ghasseminejad & Jahan-Parvar, 2020, p. 30).

Direct sanctions reduced leverage and increased cash holdings among sanctioned firms, reflecting liquidity preservation under uncertain access to

finance and trade (Ghasseminejad & Jahan-Parvar, 2020, pp. 34–35). More exposed firms later reported lower sales, investment, and hiring, while better-resourced firms could preserve liquidity, postpone irreversible investment, or diversify suppliers (Shamsi, 2023, pp. 1–4). Uncertainty prolonged effects, reinforced defensive strategies, and encouraged decisions based on recurrent coercion even during partial relief.

4.5 External and Network Adjustment

External networks rerouted pressure, preserving partial access to exchange but raising costs and favouring firms with stronger networks. Haidar's study of 35,953 Iranian non-oil exporters finds that about two-thirds of sanctions-disrupted exports were redirected to non-sanctioning countries rather than disappearing. Exporters often reduced prices to enter or retain alternative markets, mitigating volume losses at the cost of profitability and weaker terms of trade (Haidar, 2017; Farzanegan & Batmanghelidj, 2023, p. 209).

Haidar provides direct Iran-specific evidence. Jena et al. (2024) provide cross-country structural-gravity evidence that sanctions reduce direct bilateral trade and encourage third-country diversion. This is not direct Iranian evidence, but is consistent with Haidar's finding. Firm evidence shows the operational burden: export restrictions, import costs, logistics, and finance accounted respectively for 25.8, 18.4, 16.6, and 11.0 percent of sanctions-related concerns (Shamsi, 2023, p. 31). Alternative transfers, shipping negotiations, and efforts to maintain export volumes were available mainly to firms with international experience, foreign-exchange access, logistics links, and institutional support.

Trade deflection was constrained partial reintegration, not normalization: it replaced direct links with longer routes, intermediaries, higher insurance and transport costs, delayed payments, and greater exchange-rate risk. It moderated contraction while reinforcing unequal adaptive capacity.

4.6 Labour Migration and Labour-Market Adjustment

Sanctions reshaped labour markets through lower wages, weaker employment prospects, vulnerable trade-dependent sectors, and incentives for outward migration. Migration has other causes, but restrictions altered expected income, stability, and returns to domestic work. Zareei, Falahi, Wadensjö, and Sadati report that severe sanctions coincided with an approximately 80 percent rial depreciation and a 141 percent rise in emigration. Their model identifies sanctions on non-oil exports as most consequential because these sectors are connected to manufacturing, services, agriculture, and labour-intensive supply chains. A non-oil-export shock increased the desire to emigrate by about 4 percent, reduced employment by around 5 percent, and lowered real wages by about 2 percent; such sanctions accounted for 86.81 percent of variation in migration incentives, while intermediate-input restrictions added pressure through production constraints and inflation (Zareei et al., 2024, pp. 12–13).

Effects varied. The 2012 sanctions reduced employment-growth rates in manufacturing by 16.4 percent, especially in import-dependent industries (Moghaddasi Kelishomi & Nisticò, 2022, as cited in Farzanegan & Batmanghelidj, 2023, pp. 215–216), and female employment was more adversely affected in capital-intensive and import-dependent industries. Some import-competing activities expanded as depreciation improved domestic competitiveness. Between 2012 and 2019, real income per capita, investment, imports, and industrial value added declined, while self-employment increased by 3.4 percentage points and vulnerable employment by 2.7 percentage points (Farzanegan & Habibi, 2025, p. 17). The four-percent effect is potential migration pressure among roughly 24 million workers, not annual departures of one million. Adjustment thus occurred through migration and movement toward more precarious domestic work, without removing underlying welfare losses.

4.7 Integrated Empirical Synthesis

The evidence shows interacting processes. Contraction created scarcity in foreign exchange, imported inputs, trade finance, investment, and employment. Scarcity increased the value of administratively allocated resources, financial capacity, institutional coordination, and commercial networks. Actors responded through foreign-exchange allocation, alternative payments, logistics coordination, import access, and formal and semi-formal practices.

Uncertainty reinforced these processes by shaping expectations about restrictions, exchange rates, credit, trade access, and relief. Firms with organizational capability, finance, international experience, and networks were better able to preserve activity through liquidity management, supplier diversification, and trade rerouting. Firms and households with weaker access to such resources faced more direct import disruption, investment losses, employment insecurity, and declining real income. Trade deflection and labour-market adjustment further redistributed effects across markets, sectors, employment forms, and households.

The evidence supports a constrained adaptive equilibrium, not complete insulation or uniform dislocation. Sanctions imposed substantial welfare and investment costs, but institutional arrangements, firm heterogeneity, trade deflection, financial precaution, and labour-market reallocation altered their incidence and transmission. These processes neither removed sanctions damage nor establish a direct causal link between aggregate economic pressure and nuclear-policy outcomes. They show why output loss, inflation, depreciation, and trade disruption alone cannot establish whether pressure is concentrated on politically relevant actors or translated into effective political leverage. The following tables and episode-level analysis assess these processes across the 2006–2013 regime, the 2015–2016 JCPOA period, and the post-2018 maximum-pressure campaign.

Table 1a. Comparative Empirical Synthesis: 2006–2013 Multilateral Sanctions Regime

Dimension	Summary
Sanctions episode	• 2006–2013 multilateral sanctions regime • Major escalation after 2011
Stated coercive objective	• Constrain nuclear activities • Induce compliance with international demands • Apply coordinated oil, trade, and financial pressure
Diplomatic inflection point	• Intensified negotiations in 2013 • Joint Plan of Action, November 2013
Expected transmission pathway	• Oil-revenue and foreign-exchange losses • Rising costs for economically relevant actors • Stronger incentives for negotiation and policy adjustment
Observed adaptive processes and evidence	• Severe output losses and foreign-exchange scarcity • Sharp widening of the official--market exchange-rate gap • Greater value of access to subsidized foreign exchange, import channels, and state coordination • Roughly two-thirds of disrupted non-oil exports redirected to non-sanctioning markets • Trade partly preserved, but at lower prices and higher transaction costs • Evidence: Farzanegan and Batmanghelidj (2023); Haidar (2017)
Economic and diplomatic outcome	• Acute economic deterioration and unequal adjustment costs • Negotiations intensified and an interim agreement was reached • Adaptive institutional and commercial arrangements remained in place
Key contextual factors and alternative explanations	• Domestic political transition after 2013 • Multilateral diplomatic bargaining • Oil-price developments • Domestic foreign-exchange and fiscal policies • Regional-security conditions

Note. This table synthesizes the first sanctions episode by distinguishing the intended pressure pathway from the observed adaptive processes and relevant contextual factors.

Source: Author's compilation based on the studies cited in Section 4.

Table 1b. Comparative Empirical Synthesis: 2015–2016 JCPOA Implementation Period

Dimension	Summary
Sanctions episode	• 2015-2016 JCPOA implementation period • Partial sanctions relief
Stated coercive objective	• Exchange verified nuclear limits for sanctions relief • Restore incentives for continued implementation • Facilitate economic normalization
Diplomatic inflection point	• JCPOA conclusion, July 2015 • Implementation Day, January 2016
Expected transmission pathway	• Credible relief would restore trade, investment, and finance • Economic normalization would reinforce incentives to maintain the agreement
Observed adaptive processes and evidence	• Strong positive market reactions to relief-related announcements • Abnormal returns of 16.85% after the November 2013 breakthrough • Abnormal returns of 18.44% on Implementation Day • Commercial and banking re-engagement remained incomplete • Secondary-sanctions risk and uncertainty persisted • Firms and banks maintained cautious strategies • Evidence: Ghasseminejad and Jahan-Parvar (2020)
Economic and diplomatic outcome	• Partial economic recovery • Temporary implementation of nuclear commitments • Incomplete economic normalization • Relief remained politically reversible
Key contextual factors and alternative explanations	• Continuing United States restrictions • Banking-sector de-risking • Legal and compliance uncertainty • Domestic policy constraints • Global energy-market conditions

Note. This table synthesizes the JCPOA implementation period as a contrast case of partial sanctions relief, incomplete normalization, and persistent uncertainty.

Source: Author's compilation based on the studies cited in Section 4.

Table 1c. Comparative Empirical Synthesis: Post-2018 Maximum-Pressure Campaign

Dimension	Summary
Sanctions episode	• Post-2018 maximum-pressure campaign • Reimposed oil, financial, and secondary sanctions
Stated coercive objective	• Compel renewed negotiations • Seek stronger or more durable nuclear constraints • Intensify economic pressure on Iran
Diplomatic inflection point	• United States withdrawal from the JCPOA • Reimposition of sanctions • Iran's subsequent reduction of nuclear commitments
Expected transmission pathway	• Renewed economic costs would increase bargaining pressure • Greater pressure was expected on strategically relevant actors
Observed adaptive processes and evidence	• Broad exposure through export restrictions, import costs, logistics barriers, financial constraints, and currency instability • Exposure extended beyond politically connected firms • Non-connected firms bore larger aggregate losses • Better-resourced firms used liquidity preservation, supply-chain diversification, alternative payments, and trade rerouting • Evidence: Shamsi (2023); Cheratian, Goltabar, and Farzanegan (2022)
Economic and diplomatic outcome	• Continued economic deterioration • Selective firm-level and network-based adaptation • Trade deflection and greater labor-market vulnerability • No durable renegotiated settlement
Key contextual factors and alternative explanations	• Oil-price volatility • Regional conflict and security developments • Domestic fiscal and monetary policies • Changes in international diplomatic coordination • Strategic calculations beyond economic pressure alone

Note. This table synthesizes the post-2018 maximum-pressure campaign, emphasizing the interaction between renewed external pressure, accumulated adaptive capacity, and contextual factors.

Source: Author's compilation based on the studies cited in Section 4.

4.8 Episode-Level Process Tracing and Alternative Explanations

This subsection assesses whether the temporal sequence across three sanctions episodes is consistent with the proposed argument. It does not attribute diplomatic or nuclear-policy developments to sanctions alone. Rather, it asks whether sanctions-generated pressure was followed by scarcity, redistribution, institutional adjustment, expectation formation, and external-network adaptation, and whether they accumulated over time.

The 2006–2013 multilateral sanctions episode marks the initial formation of the adaptive configuration. Escalating oil, banking, and trade restrictions after 2011 reduced export earnings, impeded foreign-exchange repatriation, raised import costs, and weakened trade finance. The consequences were contraction, currency instability, inflation, and welfare losses. Yet the shock produced a differentiated allocation environment rather than uniform collapse. The widening gap between official and market exchange rates increased the value of access to subsidized foreign exchange, import channels, public coordination, and commercial information. Part of disrupted non-oil exports was rerouted through non-sanctioning countries, albeit at lower prices and higher transaction costs (Farzanegan & Batmanghelidj, 2023; Haidar, 2017).

Diplomatic developments in 2013, including the Joint Plan of Action, followed intensified pressure, but this sequence does not prove that sanctions alone produced negotiations. Domestic political change, multilateral diplomatic coordination, oil-price conditions, fiscal and exchange-rate policies, and regional-security developments also shaped the bargaining environment. More cautiously, sanctions intensified constraints while generating arrangements through which costs were distributed and managed. The first episode therefore established severe pressure and foundations for later adaptation.

The 2015–2016 JCPOA implementation period provides a contrast case. If sanctions operated only through contemporaneous material restrictions, partial relief should have rapidly restored investment, commercial relations, and expectations of normalization. Instead, recovery was partial and

uncertainty persisted. Affected firms recorded substantial positive abnormal returns after the November 2013 breakthrough and Implementation Day in January 2016, but market reactions varied and the July 2015 agreement did not produce an equally positive response. Firms and investors thus assessed the credibility, timing, enforceability, and commercial consequences of relief, rather than formal announcement alone (Ghasseminejad & Jahan-Parvar, 2020).

Formal relief did not immediately reverse institutional routines, risk perceptions, damaged commercial relations, or precautionary strategies developed under earlier sanctions. Continuing United States restrictions, secondary-sanctions exposure, banking-sector de-risking, domestic policy constraints, and uncertainty over the agreement's durability limited re-engagement. The U.S. withdrawal in 2018 confirmed that such caution was not irrational. This shows that suspending restrictions does not automatically unwind prior adaptive structures.

The post-2018 maximum-pressure campaign illustrates cumulative and path-dependent adjustment. Renewed sanctions confronted an economy already experienced in alternative payments, supply-chain adjustment, trade rerouting, foreign-exchange management, and financial precaution. This experience did not eliminate costs but altered their incidence. Sanctions concerns intensified after the U.S. withdrawal and were associated with export restrictions, import costs, logistics barriers, financial constraints, and exchange-rate uncertainty. Firms with greater resources, organizational capacity, international experience, and business networks were better positioned to preserve activity through liquidity management, supplier diversification, and alternative commercial arrangements (Cheratian, Goltabar, & Farzanegan, 2022; Shamsi, 2023).

Outcomes after 2018 should not be attributed mechanically to sanctions. COVID-19, oil-price volatility, regional-security developments, domestic fiscal and monetary policies, and diplomatic coordination also mattered. Nevertheless, the evidence is consistent with renewed sanctions interacting with prior adaptive structures. Trade deflection, selective firm survival,

financial precaution, vulnerable employment, and stronger migration incentives became components of adjustment, further segmenting opportunities between actors with access to protection, finance, and networks and those directly exposed to restrictions.

Taken together, the episodes reveal a recurrent sequence. The first generated acute scarcity and initiated adaptation; the JCPOA period showed that partial relief did not fully reverse these arrangements or restore durable expectations of normalization; and the post-2018 episode activated and reinforced accumulated mechanisms. This does not show that sanctions have no diplomatic effect or that adaptation alone determines the nuclear dispute. It does show that sanctions increasingly operated through institutional routines, selective firm capabilities, external networks, and expectation-based behavior. Repeated sanctions therefore confronted not an unchanged target economy but structures reshaped by earlier restrictions and responses. The relevant issue is not only the scale of costs, but how they are allocated, mediated, and transformed over time. Tables 1a–1c summarize these episode-specific processes, economic and diplomatic developments, and alternative explanations.

5. Conclusion: Adaptive Political Economy and Endogenous Equilibrium Formation

This study examined how nuclear-related sanctions shaped an adaptive political economy in Iran. Rather than treating sanctions as uniform external shocks, it traced how pressure was transmitted, redistributed, and reorganized through institutions, firms, households, and transnational networks. Repeated sanctions produced neither economic insulation nor a linear progression from deterioration to political concession. They generated constrained, unequal adaptation in which welfare losses coexisted with preservation of selected channels of production, exchange, finance, and coordination.

Across episodes, sanctions imposed persistent costs. The escalation after 2011 curtailed oil revenues, international payments, imported inputs, and trade finance, contributing to contraction, currency instability, weaker

investment, and welfare decline. These effects did not disappear during the JCPOA period, while post-2018 maximum pressure affected an economy already altered by earlier restrictions. Each episode thus interacted with structures reshaped by previous pressure.

Contraction was not distributed uniformly. Scarcity in foreign exchange, imports, trade finance, transport, and credit increased the value of access to administratively allocated resources, institutional coordination, and commercial networks. The widening gap between official and market exchange rates illustrates this transformation. Sanctions changed not only aggregate capacity but also the distribution of strategic resources. Firms, households, and sectors with weak finances, limited institutional embeddedness, or heavy import dependence faced more direct exposure, whereas actors with better access to finance, foreign exchange, public coordination, and external networks could better preserve activity.

Institutional adaptation reinforced this process. Repeated restrictions elevated foreign-exchange allocation, import access, alternative payments, logistics coordination, and trade-related administration. These arrangements did not make sanctions harmless or restore investment, productivity, real incomes, or labour-market conditions; they enabled activity under constraint. Temporary responses became routinized, consolidating an adaptive institutional environment.

Firm-level evidence indicates that adaptation was selective. Sanctions affected firms through export restrictions, import costs, logistics, finance, and exchange-rate conditions. Capacity to respond depended on resources, technology, finance, export orientation, networks, and institutional connections. Better-positioned firms could preserve liquidity, diversify suppliers, alter commercial arrangements, or redirect activity to alternative markets. Less capable firms were more likely to reduce production, postpone investment, freeze employment, or exit. Sanctions thus favoured firms able to finance adaptation while shifting greater costs to smaller enterprises, workers, and households.

External networks displayed a similar pattern. Trade deflection allowed exporters and importers to retain part of their activity through third-country routes, payment intermediaries, alternative suppliers, and re-export hubs. Yet it required longer routes, higher insurance and transport costs, delayed payments, lower margins, and greater reliance on intermediaries. External adjustment was constrained partial reintegration, not normalization. It moderated disruption while reinforcing differences between firms with international networks and those more exposed to import restrictions and lost markets.

Sanctions-induced uncertainty was another component. Financial-market and corporate evidence indicates that firms and investors responded not only to realised restrictions but also to anticipated escalation, exchange-rate instability, access to credit and inputs, and the credibility of relief. During the JCPOA period, relief announcements generated positive market responses, yet re-engagement remained incomplete because relief appeared reversible. The subsequent U.S. withdrawal confirmed that caution was not irrational. Firms therefore preserved liquidity, reduced leverage, delayed irreversible investment, and shortened planning horizons.

Labour-market adjustment completed the process. Sanctions weakened real wages, reduced prospects in import-dependent and trade-linked sectors, increased vulnerable and self-employment, and strengthened incentives for outward migration. This was not uniform collapse: some import-competing sectors expanded as depreciation improved domestic competitiveness. Overall, sanctions reallocated labour across sectors, employment forms, and national borders, with consequences for household security and human capital.

Taken together, the findings support an endogenous equilibrium of constrained adaptation. It emerges from institutional, firm, household, and commercial-network responses to sustained restrictions; remains associated with lower welfare, weaker investment, unequal resource access, and persistent uncertainty; and is cumulative because repeated sanctions interact with prior adaptations, routines, and commercial practices. The outcome is not welfare-enhancing stability, but a recurrent configuration that redistributes pressure while preserving selected activity and imposing severe costs elsewhere.

Sanctions should therefore be assessed not only by their economic severity but also by the structures through which their effects are transmitted. Output losses, currency depreciation, or trade disruption cannot alone reveal whether pressure is concentrated on politically relevant actors or capable of changing strategic calculations. The key question is how sanctions reshape resource access, institutional coordination, incentives, expectations, and transnational networks. In Iran, these processes limited the conversion of economic costs into concentrated political pressure while producing a more segmented and adaptive order.

This study does not claim that adaptation neutralized sanctions or that domestic political economy alone explains the nuclear dispute's persistence. It shows that sanctions became embedded in the economy they sought to constrain. Their effects were substantial but filtered through unequal institutional, organizational, and network-based responses. Understanding this process is essential to explaining their long-term consequences and developing a more disaggregated account of coercive economic statecraft.

Funding

This study received no financial support from any organization.

Authors' contributions

All authors had contribution in preparing this paper.

Conflicts of interest

The authors declare no conflict of interest.

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