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The Effect of Economic Complexity on Entrepreneurship Density in Iran: The Role of Government Size

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ABSTRACT

The pursuit of stable and robust economic growth has consistently been a cornerstone of economic policy objectives. In this pursuit, economic complexity has emerged as paramount driver, significantly fostering innovation, promoting economic diversification, and yielding substantial long-term productivity gains. This study undertakes a rigorous examination of the impact of economic complexity on entrepreneurship density within the specific context of Iran's oil-dependent economy, an environment notably characterized by extensive governmental intervention in revenue allocation processes. Employing a sophisticated Time-Varying Parameter Vector Autoregression with Stochastic Volatility (TVP-VAR-SV) model, this research meticulously analyzes the intricate dynamic interdependencies among the core variables across different time horizons. The empirical findings compellingly indicate that economic complexity, while initially inducing a contractionary short-term effect on entrepreneurship density, subsequently catalyzes a sustained expansionary phase in the longer term. Moreover, the analysis quantifies a positive contribution of economic complexity to GDP growth, estimating it at a 0.25% increase. The nuanced impact of government size on entrepreneurship density is observed to manifest initially as a slight negative influence. However, this effect progressively attenuates over time, eventually transitioning into a positive and significant impact on the economy. Consequently, this study strongly recommends that policymakers strategically prioritize substantial investments in technological advancement, critical infrastructure development, and comprehensive educational reforms. Such strategic priorities are essential to fully harness the profound long-term benefits of economic complexity for fostering entrepreneurship, while simultaneously endeavoring to mitigate the potentially disruptive short-term costs associated with structural adjustments.

KEYWORDS: Economic Complexity, Economic Growth, Entrepreneurship Density, Government Size, Time-Varying Parameters.

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1. Introduction

A paramount objective for policymakers and economic planners is the attainment of high and sustainable economic growth, recognized for its contributions to economic welfare, reduction of poverty and unemployment, enhancement of income distribution, stimulation of investment, and stabilization of inflation. While foundational economic growth theories primarily identified labor and physical capital as key drivers, contemporary theories increasingly emphasize knowledge-based economies, innovation, and knowledge itself as primary catalysts for growth and development, surpassing traditional factors. Economic complexity exhibits a positive correlation with elevated income levels and overall economic expansion. Nations possessing more intricate economic structures typically host more advanced and competitive industrial sectors (Zhu and Li, 2017). However, a relatively underexplored dimension within the existing literature pertains to the influence of economic complexity on an economy's internal dynamics, specifically entrepreneurship density. This exploration is particularly needed within a nonlinear framework and when accounting for the moderating influence of governmental policies. This study endeavors to bridge this gap by meticulously investigating the nonlinear relationship between economic complexity and entrepreneurship density, concurrently analyzing the potential moderating effects of government policies. To achieve this, the research leverages empirical data and contemporary statistical evidence to foster a more precise and realistic comprehension of the underlying mechanisms through which economic complexity impacts entrepreneurship.

The economic complexity paradigm can be conceptualized as a measure of a nation's technological sophistication, derived from the diversity of its manufactured goods (Inoua, 2023). This perspective underscores the knowledge and skills intrinsically embedded within an economy's production processes. The Economic Complexity Index (ECI) serves as a quantitative methodology for assessing the scope of productive knowledge and capabilities within an economy. Its foundation rests on the premise that a country's productive knowledge base is discernible through the composition of its exports. The index quantifies a nation's productive structure by employing the principles of diversity and ubiquity (Adegboyega et al., 2024). It is widely regarded as a potent predictor of economic growth, implying that heightened economic complexity correlates with superior economic returns and diminished production volatility (Tecchella et al., 2018). The production of more complex goods inherently involves more stringent process constraints, exemplified by the automotive industry, where vehicle manufacturing necessitates specialized aerodynamic engineering. Economies characterized by greater complexity in their production and export landscapes generally exhibit superior performance and possess a greater capacity to alleviate income disparities between affluent and less affluent nations (Gala et al., 2018).

In the pursuit of growth characterized by minimal volatility, a critical consideration is its effect on entrepreneurship. Consequently, the central inquiry crystallizes as: How does economic complexity shape entrepreneurial activity?

Advancements in economic complexity signify a diffusion of knowledge, the assimilation of novel technologies, and the generation of new employment opportunities, all of which contribute to augmenting a nation's product capabilities and quality. Recent scholarly inquiries suggest that the nexus between economic complexity and entrepreneurship density conforms to an inverted U-shaped trajectory. This implies that while initial increments in complexity stimulate entrepreneurial endeavors up to a certain threshold, subsequent increases in complexity may potentially impede entrepreneurial activities (Nguyen et al., 2021). The ramifications of the ECI are contingent upon the prevailing level of economic development within a specific country. Notably, it has been observed to diminish entrepreneurship density—quantified by the number of new business registrations—in high-income economies, while simultaneously augmenting it in low- and middle-income economies. Therefore, governmental intervention aimed at elevating the degree of economic complexity within national economies can serve as a catalyst for entrepreneurial activities (Nguyen et al., 2021). Economies endowed with robust property rights (particularly intellectual property rights, given that economic complexity stems from activities driven by novel ideas), an incorrupt judicial system, and effective contract enforcement mechanisms that circumscribe the government's capacity for wealth redistribution via taxation and regulation, tend to foster greater engagement of inventive individuals in productive entrepreneurial pursuits (Sobel, 2015).

While entrepreneurship appears to flourish amidst high economic complexity, an investigation into the specific factors acting as moderating variables—capable of either reinforcing or attenuating this relationship—is essential. In major oil-exporting nations, such as Iran, a pronounced dependence on oil revenues for public budget consolidation presents a unique characteristic that significantly influences this dynamic. Due to the substantial share of oil in public finances, governmental employment generation initiatives, including the establishment of new industries and the expansion of state organizations, are predominantly reliant on these incomes. Concurrently, the private sector also derives considerable benefits from oil revenues through mechanisms such as access to state-owned banking facilities, governmental financial support, and the utilization of public infrastructure. Within this context, state institutions, serving as the primary conduits for oil revenues, attain significant scale, rendering fiscal policies and government expenditures critical elements. These state-driven factors possess the potential to substantially moderate the interplay between economic complexity and entrepreneurial activities. Theoretically, this oil dependency could diminish the entrepreneurial opportunities arising from economic complexity—for instance, through reduced incentives for innovation or inefficient resource allocation—while also altering the pathways through which entrepreneurship manifests. Consequently, oil plays a pivotal role, not only as the principal source financing public employment but also as a key determinant influencing private sector job creation and its relationship with economic complexity via fiscal and governmental policies. Furthermore, adverse economic circumstances can compel certain individuals to exit the conventional labor force and transition into entrepreneurial ventures (Shiller, 2017).

Most existing studies have solely focused on the impact of economic complexity on entrepreneurship. However, this research takes a different approach by examining the moderating role of government size in this relationship. We propose an integrated framework that connects economic complexity, government size, and entrepreneurial density. In this view, economic complexity reflects an economy's capacity for innovation and production. Government size is seen as a system of institutional capabilities that shape the business environment. Finally, entrepreneurial density indicates the scale and quality of entrepreneurial activities. This approach allows us to look beyond simple one-way relationships and better understand how these three factors interact in the Iranian economy.

This study uses quarterly data from 2001:1 to 2021:4 to fill gaps in the current literature. Our research makes two main contributions:

The Moderating Effect of Government Size: We investigate how different aspects of government size can change the strength and direction of the relationship between economic complexity and entrepreneurship.

Using the TVP-VAR-SV Model: To analyze these relationships as they change over time, we use the Time-Varying Parameters Vector Autoregression with Stochastic Volatility (TVP-VAR-SV) method. This model is useful because it accounts for the fact that economic relationships in Iran change during different periods—such as during structural reforms or periods of sanctions. Traditional static methods cannot capture these dynamic shifts as effectively as this model.

By combining these elements, we provide a clear framework that links institutional quality, economic complexity, and entrepreneurship. This study offers a realistic and dynamic view of the Iranian economy, which is essential for supporting sustainable economic development. The paper is structured in five sections. Following the introduction, Section Two reviews theoretical frameworks and the literature on empirical studies relevant to the present topic. Section Three analyzes research methods and estimation models. Section Four presents the findings of the estimation models. Finally, Section Five discusses the results and provides policy recommendations.

2. Theoretical Foundations and Research Background

The term "entrepreneurship" originates from the French verb entreprendre, meaning "to undertake." According to Webster's Collegiate Dictionary, an entrepreneur is an individual who organizes, manages, and assumes the risks associated with an economic activity. Entrepreneurship is widely recognized as a critical catalyst for economic progress, driving growth, intensifying market competition, enhancing individual enterprises through technological innovation, and generating employment, value, and societal welfare (Gutterman, 2020).

The study of entrepreneurship by economists dates back to the 16th century, with various schools of thought offering distinct perspectives. Within the Classical School (18th and 19th centuries), figures like Adam Smith and Jean-Baptiste Say defined entrepreneurship as the process

of allocating economic resources towards profitable opportunities. In this view, the entrepreneur was characterized as an individual assuming the risks inherent in economic activities (Hébert, 1988). The Neoclassical School (late 19th and early 20th centuries), particularly through Alfred Marshall, considered entrepreneurship as a distinct factor of production, alongside capital, labor, and land. Marshall described the entrepreneur as the agent responsible for selecting the optimal combination of these production factors (Marshall, 1890). Joseph Schumpeter, a prominent figure of the Austrian School (early 20th century), conceptualized entrepreneurship as a dynamic process of discovering and exploiting opportunities, where the entrepreneur navigates uncertainty and capitalizes on market price discrepancies (Schumpeter, 1934). The Behavioral School (mid-20th century), notably represented by David McClelland, defines entrepreneurship through specific behavioral patterns such as creativity, innovation, and risk-taking, emphasizing the personality traits and cognitive processes of entrepreneurs (McClelland, 1961). In the Organizational School (late 20th century), William Baumol posited entrepreneurship as an intra-organizational process focused on value creation via innovation and the effective utilization of organizational resources (Baumol, 1993). The Resource-Based School (late 20th and early 21st centuries), spearheaded by Jay Barney and Brian Barney, defines entrepreneurship as the strategic process of leveraging and combining scarce resources to create and capitalize on new opportunities, with a focus on the individual and organizational resource base (Barney, 1991). Finally, the Network School (early 21st century), developed by Howard Aldrich, views entrepreneurship as a process facilitated by social and economic networks, wherein entrepreneurs utilize their relationships to access critical resources and opportunities (Aldrich and Ruef, 2006).

In a related development, Hidalgo and Hausmann (2009) introduced a methodology for assessing an economy's knowledge stock and productive capabilities, positing that a nation's productive knowledge is discernible from its product composition. Utilizing international trade data, this method determines the Economic Complexity Index (ECI), which quantifies a country's productive structure through measures of diversity and uniqueness. Economic complexity demonstrates a significant positive correlation with economic development. In less developed economies, the presence of economic dynamism and complexity can serve as a powerful impetus for entrepreneurial activities and the establishment of new ventures (Piras, 2023). A complex economy inherently promotes research and development (R&D) and the adoption of advanced technologies, thereby creating fertile ground for entrepreneurial endeavors (Mahmudin, 2024). Consequently, economic complexity acts as a catalyst for accelerating business growth and increasing the density of entrepreneurship (Balland et al., 2020). Complex economic systems, characterized by intricate networks of interactions and adaptive processes, foster an environment conducive to entrepreneurial endeavors. Within such dynamic settings, entrepreneurs are necessitated to exhibit considerable flexibility and engage in continuous adaptation to align with evolving conditions and emergent opportunities (Arthur, 2009). Economies possessing higher complexity in their production processes typically benefit from more robust infrastructure, which consequently diminishes barriers to market entry (Popkova et al., 2023).

According to The Knowledge Spillover Theory of Entrepreneurship posits that the diffusion of knowledge and information throughout an economy serves as a critical catalyst for new venture creation. Such spillovers are instrumental in facilitating the identification of novel opportunities and mitigating the information asymmetry faced by potential entrepreneurs. Consequently, they contribute to the reduction of entry barriers, thereby fostering a higher density of startup firms. The Economic Complexity Index (ECI) is instrumental in enhancing economic resilience and sustainability, thereby cultivating a more secure milieu for entrepreneurs, characterized by an expansion of opportunities and a diminution of inherent risks (Hartmann et al., 2017). Furthermore, economies demonstrating greater complexity tend to allocate more substantial resources toward research and development (R&D), which, in turn, catalyzes the establishment and growth of innovative enterprises, ultimately fostering a higher density of entrepreneurial activity (Mealy et al., 2019).

The conceptualization of government size is a subject of divergent interpretations across various economic schools of thought. Classical economic paradigms generally espouse a philosophy of minimal governmental intervention, positing that markets achieve optimal efficiency with limited interference, thereby facilitating the most effective allocation of resources. Within this framework, an expansive government is frequently perceived as a potential impediment to economic progress, primarily due to the imposition of stringent regulations and burdensome taxation (Merza, 2023; Siddiqui, 2023). Conversely, the Keynesian school champions active governmental engagement, particularly during periods of economic contraction. Proponents of this perspective contend that governmental expenditure and fiscal policies are indispensable for attenuating economic shocks and invigorating aggregate demand (Mutoni, 2024). Marxist analyses, meanwhile, regard government intervention as imperative for ameliorating the intrinsic instabilities and pervasive inequalities endemic to capitalist systems, arguing that its absence inevitably precipitates crises and social injustices (Siddiqui, 2023). The Neoclassical public choice theory critically examines both maximalist and minimalist governmental roles, suggesting that the optimal size of government should be determined by a careful calibration of the benefits derived from public goods against the inefficiencies inherent in large bureaucratic structures (Tariq et al., 2024). Contemporary discourse frequently advocates for a balanced approach, acknowledging both the efficacy of market mechanisms and the potential benefits of strategic government intervention. This integrated perspective posits that judicious governmental action can significantly contribute to technological advancement, environmental sustainability, and macroeconomic stability (Sadeh et al., 2020).

Entrepreneurial activities exhibit considerable variation across diverse national contexts and historical epochs (Ma & Yao, 2022). In developing economies, the qualitative and quantitative dimensions of entrepreneurship are profoundly shaped by a constellation of institutional factors, notably including the prevailing size and scope of government (Chowdhury et al., 2019). An enlarged government, if characterized by excessive accessibility or profound inefficiency, may precipitate governance failures. Such failures can engender a more intricate and challenging

business environment, thereby introducing undue risks for entrepreneurs and potentially suppressing entrepreneurial dynamism (Audretsch et al., 2022).

A substantial public sector might resort to financing its expenditures through mechanisms such as elevated taxation, increased public borrowing, or monetary expansion. However, these measures can exert deleterious effects on the economy, manifesting as inflationary pressures and a depreciation of the national currency. Conversely, an undersized or absent governmental role may constrain economic growth, as the state might be unable to adequately provide essential public goods. Financial capital remains a critical and foundational element for entrepreneurship; the unavailability of adequate funding for investment can constitute a primary impediment to the inception of entrepreneurial ventures (Sendra-Pons et al., 2022). By optimizing its core functions, government can significantly bolster the capabilities of a skilled and trained workforce, enhance labor productivity, and foster the progression of knowledge-based development. This strategic role is pivotal in elevating the global competitiveness of technology-intensive goods and services.

Investigating the impact of startup regulations and the quality of organizational frameworks on new business formation across 119 economies, Tsoukis et al. (2019) reported that the creation of new businesses is markedly diminished in nations characterized by excessive entry barriers. Specifically, their findings indicated that each incremental step required to initiate a new business correlates with a reduction in entrepreneurial activity ranging from 3 to 7 percent.

Empirical studies also provide evidence supporting this theoretical framework. For example, Alawi et al. (2022) examined the extent to which innovation influences the overall early-stage entrepreneurial activities in generating employment in Oman. Using data from the 2020 Global Entrepreneurship Monitor (GEM) and applying structural equation modeling (SEM), their findings indicate that innovation among nascent and new entrepreneurs significantly affects the level of job creation in the country. Similarly, Nguyen et al. (2021) investigated the relationship between economic complexity and entrepreneurial density across 53 economies. Using panel data covering the period 2006–2016 and applying the Granger causality approach, the authors found strong evidence of Granger causality running from economic complexity to entrepreneurial density. However, the reverse causal relationship was not supported. Ajide et al. (2022) investigated the impact of economic complexity on entrepreneurship in selected African countries. Employing panel data from 2006 to 2017 and utilizing a dynamic panel data approach with a consistent covariance estimator, their findings indicate that economic complexity positively influences entrepreneurship in Africa. Wei (2022) examined the role of regional governments and opportunity-based entrepreneurship within underdeveloped institutional environments, adopting an entrepreneurial ecosystem perspective. Utilizing provincial-level data from China spanning 1993–2013 and employing panel data methods, the results demonstrated that the primary function of regional governments in providing public and social services leads to the growth of opportunity-based entrepreneurship in the region. Salami et al. (2023) investigated the influence of government policy on entrepreneurial growth in Asaba, Delta State, Nigeria, using a questionnaire-based approach. The study concludes that government policy shapes the institutional environment wherein entrepreneurial decision-making occurs. Consequently, government policy is crucial for

entrepreneurship. Barros (2024) investigated the relationship between financial complexity, economic complexity, and government size. This research utilized cross-country panel data and a two-way fixed effects regression. The findings indicated that at smaller (larger) government scales, an increase in financial complexity is associated with greater (lesser) economic complexity.

Despite these valuable contributions, A substantial body of scholarly literature has investigated key determinants of entrepreneurial development, prominently featuring economic complexity. However, the intricate and often overlooked interplay among economic complexity, entrepreneurial density, and government size—particularly within emerging and resource-dependent economies—remains a relatively unexplored domain. Acknowledging this critical research gap, the present study aims to elucidate the complex and moderating role of government size in the relationship between economic complexity and the emergence of entrepreneurial density. We posit that disregarding government size, which plays a pivotal role in economies like Iran's, leads to an incomplete understanding of entrepreneurial processes. Consequently, the primary contribution of this research lies in offering a comprehensive analytical and empirical framework that examines these three-way relationships, thereby providing novel insights for policymakers and researchers on how to navigate entrepreneurial development in challenging economic landscapes.

3. Research Methodology

This study adopts an applied research approach, with data collection based on library and documentary research methods. The period under review spans from 2001-2021 on a quarterly basis. This study employs the ratio of total government expenditure to GDP as a proxy for government size due to its comprehensive reflection of the state's economic activity and its direct implications for resource allocation and market competition within Iran's institutional context. The data required for this research were extracted from statistics and reports available on the World Bank website, For the entrepreneurial density variable, we utilized data from permits issued by the Central Bank, which are reported on a quarterly basis.

and information related to the Economic Complexity Index (ECI) was obtained from the Atlas of Economic Complexity, affiliated with MIT.

In this research, structural shocks are identified within the TVP-VAR-SV framework to enable the analysis of economic shocks with appropriate time-varying properties. This identification is based on assumptions regarding the contemporaneous relationships among variables, allowing for the dynamic tracking of structural shock effects on other variables with time-varying coefficients. This approach, while preserving the model's ability to adapt to time dynamics, coefficients, and heteroskedasticity, facilitates the analysis of structurally interpretable economic relationships over time.

Vector Autoregression (VAR) is a foundational econometric tool with extensive applications in econometric analyses. Among these, the TVP-VAR with stochastic volatility, proposed by Primiceri (2005), is widely used for analyzing macroeconomic issues. The TVP-VAR model allows for the computation of time-varying coefficients within the VAR framework (Khazri et al.,

1397). Based on the SVAR model and by integrating suitable econometric approaches, the TVP-SVAR-SV approach permits the time-varying nature of structural shock transmission mechanisms and variances (Nakajima, 2011). The SV-SVAR-TVP model includes dynamic VAR coefficients and an error covariance matrix, enabling a better explanation of time-varying relationships among variables across different time horizons and specific time points. Furthermore, this method prevents information loss due to sample period selection, thereby preserving the completeness of the sample information (Anand & Paul, 2021). Stochastic volatility plays a significant role in TVP-VAR models. Although initially proposed by Black (1976) and pursued in advancements in financial econometrics, recent macroeconomic analyses increasingly incorporate stochastic volatility. In numerous instances, the data-generating process of economic variables appears to exhibit both stochastic volatility shocks and coefficient drift.

In this section, the basic estimation method for the TVP-VAR-SV model is presented. The TVP regression model is as follows:

$$y_t = \acute{x}_t\beta + \acute{z}_t a_t + \varepsilon_t. \quad \varepsilon_t \sim N(0.\sigma_t^2) \qquad t = 1 \dots \dots .. N \qquad \text{(-1}$$

Time-Varying Coefficients:

$$a_{t+1} = a_t + u_t. \qquad u_t \sim N(0.\Sigma) \qquad t = 1 \dots \dots .. N \qquad (3\text{-}2)$$

Stochastic Volatility:

$$\sigma_t^2 = \gamma \exp(h_t) \qquad (3\text{-}3)$$

$$h_{t+1} = \emptyset h_t + \delta_t. \qquad \delta_t \sim N\left(0.\sigma_\delta^2\right) \qquad (3\text{-}4)$$

Where y_t is a scalar response variable, x_t and z_t respectively are $p \times 1$ and $k \times 1$. β represents a $k \times 1$ vector of fixed coefficients, a_t is a $p \times 1$ vector of time-varying coefficients, and h_t denotes stochastic volatility. It is assumed that:

$$a_0 = 0. \qquad u_0 \sim N(0.\sum_0). \qquad \gamma > 0. \quad h_0 = 0. \qquad (3\text{-}5)$$

In equation (3-1), it should be noted that the covariance is divided into two components: one related to time-varying coefficients (a_t) and the other associated with fixed coefficients (β). Additionally, the impact of $x_t$is assumed to be constant over time, whereas the effect on the time-varying variable is considered. The time-varying coefficients follow a first-order random walk process, which allows for both permanent and temporary changes in the coefficients.

Furthermore, coefficients with drift are emphasized to account for nonlinear behaviors, such as structural breaks or gradual changes. Consequently, there is a possibility that the time-varying coefficients may exhibit spurious movements in addition to genuine ones. In other words, if the relationship between yt and zt is unclear or ambiguous, there is a risk of overfitting the data when using time-varying coefficients. Therefore, to avoid such a situation, it may be preferable to assume the stationarity of the time-varying coefficients over time. The regression disturbance term ε_t is assumed to have time-varying variance σ_t^2 and follow a normal distribution. The logarithm of volatility ($h_t = log\, {\sigma_t^2}/{\gamma}$), as formulated in Equation (3-4), follows a first-order autoregressive process (AR (1)). Similar to the discussion on the assumption of time-varying coefficients, the modeling of the logarithm of volatility can also be considered in both stationary and non-stationary forms. Furthermore, it is assumed that $|\varphi| < 1$. However, if $\varphi = 1$, the logarithm of volatility follows a random walk process. The initial condition is based on a stationary distribution, such as $\delta_t \sim N\left(0.\frac{\sigma_\delta^2}{1-\sigma_\delta^2}\right)$.

To estimate the model parameters using this method, the following equation is considered:

$$y_t = X_t\beta_t + A_t^{-1}\sum_t \varepsilon_t \tag{3-6}$$

$$\begin{matrix}\beta_{t+1} = \beta_t + u_{\beta t} \\ \alpha_{t+1} = \alpha_t + u_{\alpha t}. \\ h_{t+1} = h_t + u_{ht}\end{matrix} \begin{pmatrix}\varepsilon_t \\ u_{\beta t} \\ u_{\alpha t} \\ u_{ht}\end{pmatrix} \sim N\left[0 \quad \begin{bmatrix} I & 0 & 0 & 0 \\ 0 & \Sigma_\beta & 0 & 0 \\ 0 & 0 & \Sigma_\alpha & 0 \\ 0 & 0 & 0 & \Sigma_h \end{bmatrix}\right] \tag{3-7}$$

The parameters $\alpha_{s+1} \sim N(\mu_{\alpha_0}.\Sigma_{\alpha_0})$, $\beta_{s+1} \sim N(\mu_{\beta_0}.\Sigma_{\beta_0})$, $h_{s+1} \sim N\left(\mu_{h_0}.\Sigma_{h_0}\right)$ are assumed to follow a random walk process, as outlined in Model (3-7). To estimate the parameters, the Bayesian Markov Chain Monte Carlo (MCMC) method is employed. This approach facilitates the inference of model parameters by generating samples from their posterior distributions.

4. Finding

Table1 presents the results of the calculations using the MCMC algorithm, including posterior means, standard deviations, and 95% confidence intervals.

Table1. Results from Estimating the Parameters of the TVP-VAR Model

Parameter	Mean	Stdev	95%L	95%U
sb_1	0.02	0	0.03	0.01
sb_2	0.02	0	0.03	0.01
sa_1	0.09	0.03	0.01	0.04
sh_1	0.75	0.12	1.04	0.56
sh_2	0.88	0.11	1.13	0.67

Source: Research finding.

In Figure1, the variables are assumed to be stationary, and the optimal lag length of 1 is selected based on the Akaike Information Criterion (AIC). To compute the posterior distribution estimates, 400 samples (M = 400) are drawn.

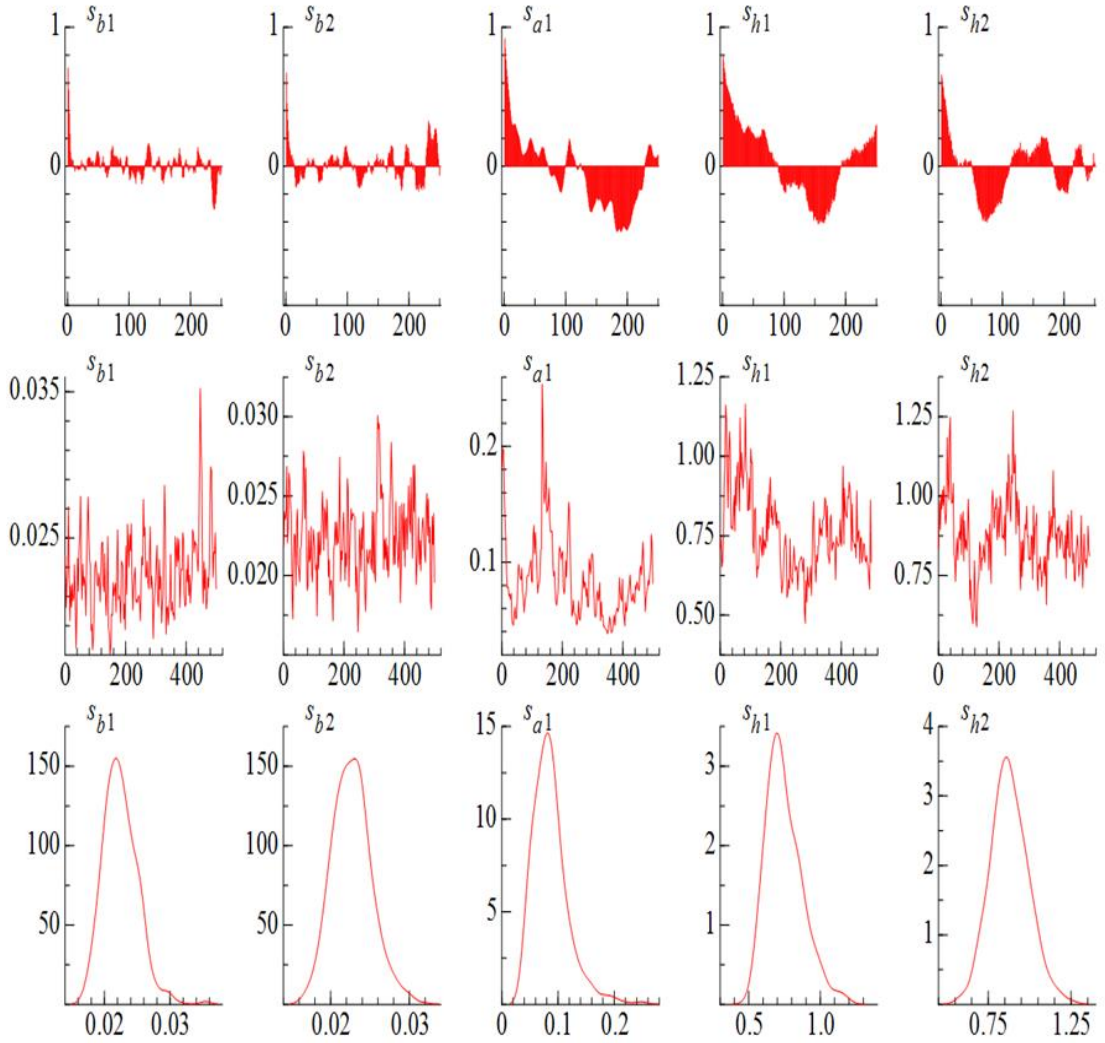

Figure1. (First row) Autocorrelation (Second row) Sample Path (Third row) Posterior Density

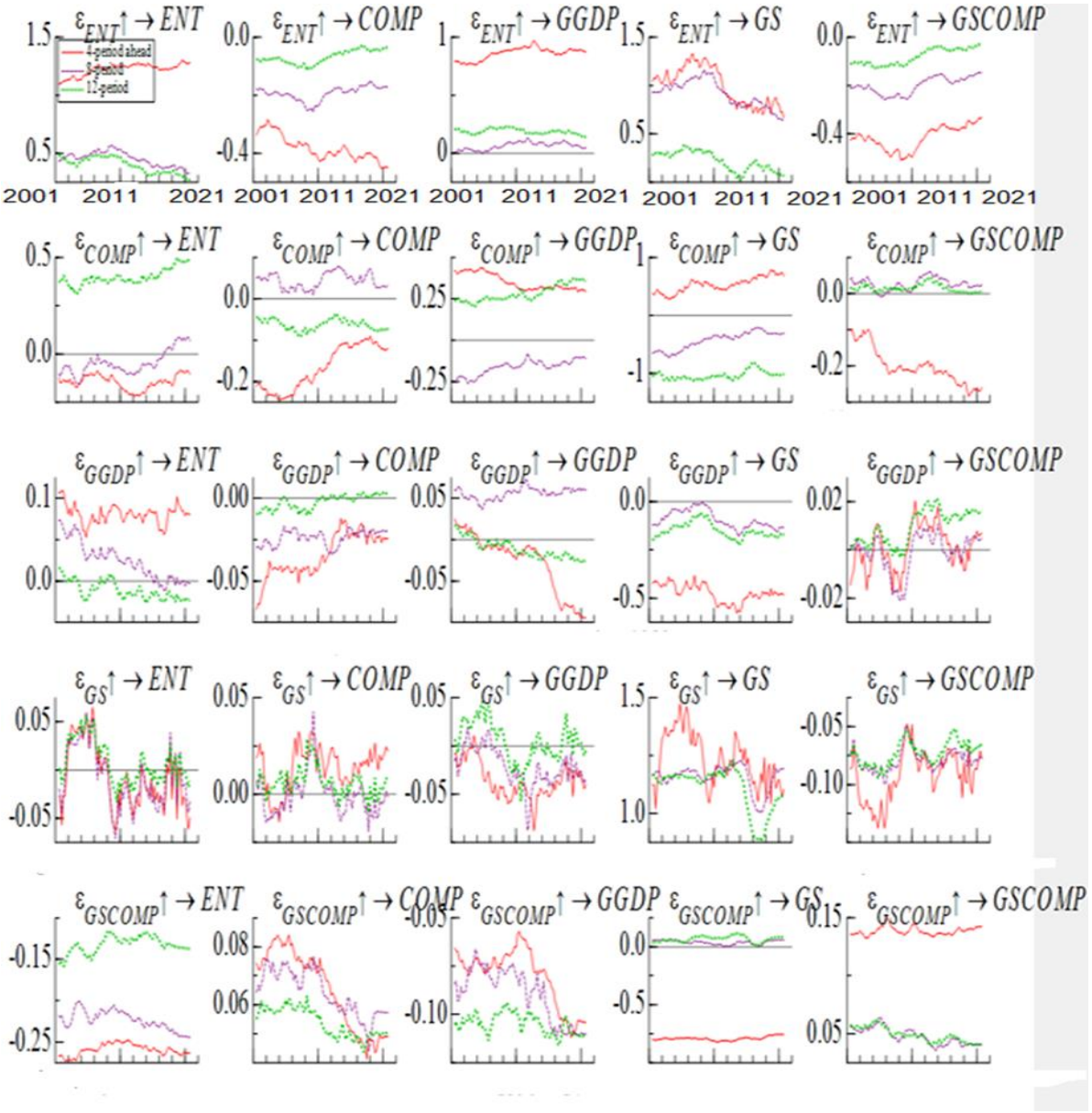

Figure2: Results from the TVP-VAR-SV Mode

The impulse response functions provide critical insights into the dynamic behavior of the system's variables following a one-standard-deviation shock. In this section, the dynamic responses of ENT, COMP, GS, GSCOMP, and GGDP are examined based on structural decomposition across three time horizons: 4, 8, and 12 periods. According to Figure2, a positive shock to entrepreneurship density initially leads to a decrease in economic complexity. This short-term decline can be attributed to the rapid entry of entrepreneurs who may lack the specialized skills necessary to contribute to complex economic activities. However, over time, less competitive entrepreneurs exit the market, while skilled and innovative entrepreneurs remain, leading to a gradual increase and stabilization of economic complexity.

Regarding government size, a rise in entrepreneurship density exerts a consistently positive, albeit modest, impact across all periods. This indicates that promoting entrepreneurship may slightly expand the public sector, likely through increased governmental support and infrastructure development aimed at enhancing economic competitiveness. Similarly, a positive shock to entrepreneurship density stimulates GDP growth, especially in the short term. However, the interaction term between government size and economic complexity initially declines following an entrepreneurship shock, suggesting some early-stage inefficiencies in aligning public sector expansion with complex economic development.

A positive shock to economic complexity, conversely, reduces entrepreneurship density in the short run. This could reflect heightened uncertainty or transitional challenges that discourage new business formation. Nonetheless, in the long term, economic complexity fosters a supportive environment for entrepreneurship, resulting in a sustained increase in entrepreneurship density. Furthermore, economic complexity contributes positively to GDP growth, with long-term effects estimated at a 0.25% increase. Notably, while economic complexity initially expands government size in the short term, over time, the effect reverses, and government size contracts, stabilizing around an equilibrium level more conducive to private sector activity and sustained economic growth.

In the short term, economic complexity negatively affects the interaction term between government size and economic complexity. However, this relationship stabilizes in the long run, suggesting an eventual balance between government intervention and complex economic structures.

Turning to GDP growth, a 1% increase in GDP leads to a 0.1% rise in entrepreneurship density in the short run, with the effect stabilizing over time. GDP growth also positively affects economic complexity initially, with the impact persisting into subsequent periods. Interestingly, a short-term increase in GDP growth reduces government size; however, this contraction lessens over time and eventually stabilizes at a balanced level. Additionally, while GDP growth initially reduces the interaction term between government size and economic complexity, in the long run it increases it, with a 1% rise in GDP growth resulting in a 20% increase in this interaction term.

The impulse response analysis of government size on entrepreneurship density reveals that, over certain periods, the initially negative effects diminish and even turn positive. This suggests that under specific conditions—such as strategic public investments in infrastructure and support services—a larger government size can enhance entrepreneurial activity.

Moreover, an increase in government size positively affects economic complexity, particularly in the early stages. This positive association reflects the government's role in strengthening economic structures, fostering specialized skills, and facilitating more intricate economic interactions. Although some fluctuations are observed, the overall effect remains prominently positive across significant time spans.

In contrast, the short-term impact of larger government size on GDP growth is negative, but this adverse effect diminishes over time and eventually shifts towards a positive contribution. Both in the short and long run, however, government size exerts a reducing effect on the interaction term between government size and economic complexity.

Finally, the impulse response analysis of the interaction term between government size and economic complexity indicates that it reduces entrepreneurship density, particularly in the long run. While an increase in this interaction term promotes economic complexity, it simultaneously exerts a negative effect on GDP growth. Additionally, although the interaction term temporarily influences government size in the short term by reducing it, its impact disappears over the long run, leading to no significant change. The observed fluctuations in Impulse Response Functions (IRFs) across different time horizons reflect the critical role of time-varying uncertainty in the Iranian economy. Such uncertainties can decelerate the dynamics of adjustments and influence the direction and magnitude of variables' responses to policy or other shocks. A closer examination of the figures, as presented in the detailed analysis, clearly illustrates these variations in the responses of variables such as Entrepreneurship (ENT) and Economic Complexity (COMP) in Iran. Furthermore, the analysis of transmission mechanisms reveals that the effects of shocks are transmitted through various channels, including changes in investment, innovation, and the expectations of entrepreneurs and economic actors within Iran. For instance, positive shocks to Economic Complexity (COMP) demonstrate long-term positive effects on Entrepreneurship Density (ENT) in Iran. This is likely attributable to the creation of a more conducive environment for startups and innovative ventures when faced with these complexities.

Robustness Check: To ensure the robustness of the primary TVP-VAR-SV model findings, a sensitivity analysis was conducted using a standard Vector Autoregression (VAR) model. The results of this check indicate that the key relationships identified in the original model are stable and do not change significantly when the model's assumptions, such as constant parameters and error variances, are altered. Comprehensive details of this analysis, including the impulse response functions derived from the standard VAR model, are provided in the Appendix

5. Conclusion and Recommendations

This study investigated the intricate relationship between economic complexity, state size, and entrepreneurial density, with a specific focus on Iran as a case study within a resource-dependent economy. Our key findings reveal that economic complexity presents a double-edged sword in the short term; while it holds significant potential for fostering entrepreneurship and economic growth in the long run, its transition phase is accompanied by notable challenges.

Key Findings:

Dichotomous Impact of Economic Complexity on Entrepreneurship: Economic complexity initially leads to a temporary decrease in entrepreneurial density. This phenomenon can be attributed to initial structural adjustment costs, labor displacement from traditional sectors to new knowledge-intensive ones, and potential crowding-out mechanisms where state resources or early-

stage investments might temporarily marginalize the private sector. However, post-transition, economic complexity substantially contributes to the expansion of entrepreneurship in the long term.

Sustainable Contribution to GDP Growth: Economic complexity plays a positive role in Gross Domestic Product (GDP) growth, contributing approximately 0.25%. While seemingly modest at first glance, this figure represents a more stable and diversified growth driver compared to the volatility often characterizing oil revenue in resource-dependent economies. This underscores its strategic importance for mitigating oil dependency and building long-term economic resilience.

The Moderating Role of State Size: The size of the state significantly influences the relationship between economic complexity and entrepreneurship. In the short term, a larger state apparatus tends to reduce entrepreneurial density (approx. -0.05 effect), reflecting challenges in resource management and potential competition with the private sector. However, this negative effect diminishes over time, and the state's role can ultimately shift from substitutive to complementary.

Policy Recommendations: Based on the above findings, a set of policy recommendations for governments, particularly in resource-dependent economies, are proposed:

Proactive Management of the Transition Phase: Policymakers must acknowledge and actively manage the short-term challenges associated with increasing economic complexity. This involves implementing supportive measures such as targeted training and retraining programs for the workforce to facilitate transitions to new occupations, providing financial incentives and credit facilities for nascent ventures in complex industries, and developing robust support networks for entrepreneurs to mitigate initial adverse effects and smooth the transition.

Strategic Investment in Complexity Drivers: Governments should strategically focus on investments that bolster the long-term effects of economic complexity. This includes prioritizing research and development (R&D) in advanced sectors such as artificial intelligence, biotechnology, and clean energy; developing critical digital infrastructure (e.g., high-speed internet and data centers) alongside modern physical infrastructure (e.g., smart transportation and logistics hubs); and undertaking fundamental reforms in the education system to cultivate 21st-century skills, including critical thinking, problem-solving, and digital literacy across all educational levels. This approach reframes the state's role from a mere implementer to an active facilitator and enabler of innovation and entrepreneurship.

Reforming State Size and Efficiency: Policy should aim at enhancing the efficiency of the public sector and orienting it towards supporting, rather than competing with, the private sector. This can be achieved through streamlining administrative processes, reducing bureaucratic hurdles, and ensuring the delivery of high-quality, efficient public services. The state should actively stimulate entrepreneurial growth by providing targeted incentives, facilitating access to capital and technical knowledge, and fostering a conducive business environment.

Generalizability and Regional Considerations: While this study is based on the case of Iran, its findings possess considerable generalizability to other resource-dependent economies. These nations often grapple with similar challenges related to economic diversification, natural resource revenue management, and the role of the public sector. However, the successful implementation

of these policy recommendations is highly contingent upon institutional quality (e.g., transparency, rule of law, bureaucratic efficiency), the level of human capital development, labor market flexibility, and the specific national strategies adopted by each country. Therefore, it is recommended that policymakers in similar economies adapt and localize this framework, considering their unique national characteristics.

In conclusion, this study underscores the imperative of a holistic approach to economic policymaking, wherein the pursuit of economic complexity must be synergized with public sector reforms. This ensures that complexity serves as fertile ground for entrepreneurial flourishing and the attainment of sustainable development.

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Authenticity of the texts, honesty and fidelity has been observed.

CONFLICT OF INTEREST

Author/s confirmed no conflict of interest.