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## Blockchain for Economic Diversification: Measuring Public Investment and Financial Sector Innovation in the GCC

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### Abstract

*The GCC economies have taken strategic initiatives to incorporate blockchain technology to introduce more innovation in finance and to reduce their dependence on oil. This paper presents the empirical analysis of the impact of blockchain implementation on economic diversification in six GCC countries from 2010 to 2024. The main objective of this paper is to analyze how institutional quality, along with financial development and technology innovation, interacts in affecting diversification outcomes. Panel data econometric techniques are conducted, including Fixed Effects, Pooled Mean Group estimation, and System GMM estimation, to assess blockchain innovation, FinTech maturity, government-driven digital innovation, and oil dependence for their impacts on the measures of diversification. The findings indicate that blockchain adoption and FinTech expansion have a substantial long-run positive impact on economic diversification, even as oil dependency remains a major structural constraint. On the other hand, innovation of government has a slightly positive impact on the process of diversification, while foreign direct investment is statistically insignificant. Since the evidence suggests that improvements in diversification are caused by, rather than occurring concurrently with, digital technologies, robustness tests confirm the diagnostic and causality tests. These findings show that the GCC is increasingly capable of leveraging digital transformation in the pursuit of strong post-oil economies, enabled in great measure by blockchain finance and governance. The policy implications emphasize the importance of legislative harmonization, investments in blockchain infrastructure and education, and continued public-private partnerships in the consolidation of the long-term benefits of decentralized innovation.*

**Keywords:** Blockchain, GCC, Economic Diversification, FinTech, Digital Transformation, CBDC, Government Innovation, Oil Dependence

**JEL Classifications:** E42, G18, G28, O16, O38, O53, K24, L86.

### 1. Introduction

With fluctuating oil prices, increasing concerns about resource depletion, and a pressing need to switch to growth models propelled by knowledge and innovation, economic diversification has emerged as a strategic objective for GCC countries. In this direction, advanced digital technologies are being increasingly employed by governments around the region to spur sustainable growth and reduce dependence on hydrocarbons; blockchain is becoming one of the most potential facilitators of change in this respect. Particular applications of blockchain in trade finance, capital markets, and public service delivery provide, through its decentralization, immutability, and transparency, a path to greater institutional effectiveness, increased digital

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trust, and attraction of non-oil investment flows.

These prospects also align with the national strategic objectives of Bahrain's fintech-related regulatory amendments, Saudi Arabia's Vision 2030, and the UAE Blockchain Strategy, which all emphasize financial innovation and digital transformation as the building blocks for future economic sophistication. Despite this pace, there remains a scarcity of empirical investigation into the drivers of blockchain adoption in the GCC. How institutional quality, financial innovation, and digital infrastructure interact in shaping the speed and extent of blockchain adoption remains a pivotal topic. The present study closes this gap by constructing a dynamic panel model for six GCC countries, using cybersecurity readiness as a proxy for digital infrastructure and focusing on regulatory quality, hydrocarbon dependence, public investment, and fintech ecosystem development.

This helps to fill a wide policy-technology gap and provides useful information to decision-makers that manage the structural and digital shift that continues in the region, considering blockchain as an economic stimulant rather than purely as a technological instrument.

## **1. Literature Review**

### **1.1 Blockchain and Institutional Transformation**

With the potential of blockchain to enhance operational efficiency, strengthen governance structures, and build trust in both public and private sectors, it has increasingly been recognized as a catalyst for institutional transformation. Recent studies demonstrate that decentralized ledger systems enable disintermediation, enhance transparency, and significantly reduce information asymmetries by rendering transactions immutable and verifiable across distributed networks (Mohammed et al., 2024). Within public-sector governance, recent research has highlighted blockchain as a means to enhance administrative coordination, procurement, and regulatory compliance in OECD member states in particular (OECD, 2019; Risius & Spohrer, 2023). These capabilities are of particular relevance to the GCC, governance systems of which have conventionally relied on centralized decision-making and hierarchical administrative structures. More lately, regional financial institutions have provided evidence that blockchain enhances institutional trust and clarity of regulation, hence supporting more general goals of digital transformation and stability in the investment climate (Al-Sebaie, 2025; Alsmadi & Al-Marashdeh, 2023). As this growing body of work continues to outline the technology's emerging impact, this shall no doubt reshape the way in which public service delivery and governance effectiveness are perceived in rapidly modernizing economies.

### **1.2 Economic Diversification and Public Investment**

In general, economic diversification plans in resource-dependent countries are a priority of public investment that catalyzes innovation, technological adoption, and the building of human capital. Emerging empirical evidence indicates that digital platforms and blockchain-enabled systems enhance investment tracking, bypass bureaucratic inefficiencies, and promote cross-border trade by raising the integrity and interoperability of information (Bizama, 2022; UNCTAD, 2023). At present, the national diversification goals in the GCC include large-scale blockchain projects in logistics, e-government, real estate registries, and trade facilitation that are integral to Saudi Arabia's Vision 2030 and the United Arab Emirates' policy for a digital government.

These programs are increasingly recognized as a means of shifting away from rentier economic

structures to more productive and knowledge-intensive growth models. However, such transformative projects require qualified human resources, a strong cybersecurity infrastructure, and uniform institutional preparedness, which are still unevenly distributed across the region. According to the literature, successful diversification outcomes depend on the need to combine technology modernization with structural changes.

### **1.3 FinTech Ecosystems and Financial Innovation**

A substantial body of literature points to the complementary roles that fintech ecosystems and blockchain technology play in the development of digital finance. Examples of blockchain-enabled fintech include tokenization, digital identity verification, programmable contracts, and decentralized finance systems (DeFi), all underpinned by distributed ledger technology (DLTs) (Kwok, 2024; Narayan & Tidström, 2023). Fintech development in the GCC has accelerated following the establishment of innovation centers, regulatory sandboxes, and open-banking programs. Yet, there is still uneven progress in member states (Sarma & Pais, 2011; Al-Huthaifi & Ahmad, 2024).

The research indicates that creating a strong digital financial ecosystem—where technology adoption is encouraged beyond mere market demand—includes the need for robust public-private partnerships and flexible regulatory frameworks. This would be particularly so for blockchain, since its adoption depends on investor confidence, cybersecurity capability, regulatory consistency, and technological preparedness.

### **1.4 Empirical Gaps and Research Contribution**

Despite the rapid emergence of blockchain applications, there is a significant empirical gap in terms of the macro-level drivers of blockchain adoption, especially in the GCC context. This is because much of the existing literature is either descriptive, technical, or focused on single-case studies. Few quantitative studies examine how institutional and structural variables impact blockchain diffusion, and even fewer utilize dynamic econometric methods able to capture structural changes and temporal persistence. Recent methodological developments place particular emphasis on the use of dynamic panel models for the study of new technologies within changing institutional settings (French et al., 2021; Kher et al., 2023).

This study contributes to the literature by developing an inclusive model that investigates the blockchain adoption in rentier states with key determinants such as oil reliance, regulatory quality, fintech maturity, and the strength of digital infrastructure. It also offers empirical data to help policymakers develop interventions that foster institutional modernization, economic diversification, and inclusive digital transformation.

## **2. Research Gap**

With increased adoption worldwide, the literature is still scant on the empirical investigation of how these blockchain technologies support economic diversification within resource-rich regions such as the GCC nations. The strategic use of blockchain by both government and financial institutions in the Gulf region in support of long-term structural transformation is not well understood, as a large part of current literature focuses on narrow topics such as cryptocurrency markets or developed economies (Goldani, M., & Tirvan, S. A. 2024). Furthermore, most studies

do not conduct macro-level quantitative analysis of blockchain adoption in a diversification environment; rather, they are either qualitative case studies or technology-centric in nature (Tawfik et al. (2024).

The objective of the study is to assess how blockchain technology can facilitate institutional efficiency, financial innovation, and public-sector reform, amidst an aggressive drive by GCC countries to diversify their economies away from oil, such as Saudi Arabia's Vision 2030, the UAE's recent digital economy initiatives, and Bahrain's fintech regulatory reforms (Dubey, R., Gupta, M., Mikalef, P., & Akter, S. 2023). Blockchain can ease digital identities, land registries, cross-border payments, and Islamic finance contracts. However, not enough research has been done on how these applications scale and are matched with objectives of diversification.

The main problem is that little is known, even though several GCC nations have initiated highly publicized blockchain and fintech initiatives, about how such projects affect the rate and scope of economic diversification or about the structural obstacles that can prevent them (Chen, Yue Sheng, Zhong Chen, Sajid Ali, Muhammad Imdad Ullah, and Muhammad Khalid Anser. (2023). This situation is further complicated by problems that include talent shortages, digital infrastructure deficits, and regulatory fragmentation (Ferreira, Miguel A., and Pedro Matos. 2008). In the absence of solid empirical evidence of the motivations for and results of blockchain adoption in a diversified scenario, policymakers run the risk of dispersed efforts, inefficient expenditures, and lost opportunities in creating robust digital economies.

This paper provides an elaborate model of the channels through which blockchain can support structural transformation in the rentier state economies by considering the characteristics of dependence on petroleum, regulatory quality, development of the fintech ecosystem, and digital infrastructure readiness. Consequently, it offers empirical evidence to guide policy efforts toward balanced and sustainable economic diversification.

### 3. Empirical Specification and research methodology

#### 3.1 Model Specification

This study uses a panel data regression model encompassing six GCC nations from 2010 to 2024 to assess the effect of blockchain adoption on economic diversification. The following is the specification of the baseline panel regression model:

$$\begin{aligned} \text{Diversification}_{it} &= \alpha + \beta_1 \text{GDPpc}_{it} + \beta_2 \text{BlockchainIndex}_{it} + \beta_3 \text{FinTech}_{it} \\ &+ \beta_4 \text{GovInnovation}_{it} + \beta_5 \text{FDI}_{it} + \beta_6 \text{OilDependency}_{it} + \mu_i + \lambda_t + \varepsilon_{it} \end{aligned}$$

Where:

- $\text{Diversification}_{it}$ : Economic diversification level of country  $i$  in year  $t$  (measured by Economic Complexity Index and non-oil GDP share).
- $\text{GDPpc}_{it}$ : GDP per capita (constant USD).
- $\text{BlockchainIndex}_{it}$ : Composite index of blockchain adoption, capturing policy initiatives, pilot projects, and usage levels.
- $\text{FinTech}_{it}$ : FinTech development level, proxied by number of startups and FinTech investment as a % of GDP.
- $\text{GovInnovation}_{it}$ : Government-led technological innovation (GovTech Maturity Index and e-Government Development Index).

- $FDI_{it}$ : Foreign direct investment inflow as a % of GDP.
- $OilDependency_{it}$ : Oil rents as a % of GDP.
- $\mu_i$ : Country-specific fixed effects.
- $\lambda_t$ : Time-fixed effects capturing period-specific shocks. and
- $\varepsilon_{it}$ : Error term.

**Table.1.** Data Sources for Empirical Analysis

Variable	Description	Proxy / Index	Data Source
Diversification	Level of economic diversification	Economic Complexity Index (ECI). Non-oil GDP share	Harvard Growth Lab. World Bank
GDP per capita (GDP pc)	Economic development	Constant USD per capita	World Bank WDI
Blockchain Index	Blockchain adoption and innovation	Composite index of blockchain policies. pilot projects. and usage	CB Insights. OECD Reports. Manual coding from reports
FinTech	Financial technology development	Number of FinTech startups. FinTech investment (% of GDP)	Statista. CB Insights. World Bank
Gov Innovation	Government digital innovation	GovTech Maturity Index. E-Government Development Index	World Bank. UN E-Government Database
FDI	Foreign direct investment inflows	FDI as % of GDP	World Bank. UNCTAD
Oil Dependency	Hydrocarbon dependence	Oil rents as % of GDP	World Bank WDI
Cybersecurity / Digital Infrastructure	Readiness for digital technology adoption	Cybersecurity Index	ITU (International Telecommunication Union)

Author's compilation

## Descriptive Statistics and correlation matrix

### Descriptive Statistics

The descriptive statistics reveal a notable difference in structural and technological factors across the GCC countries. Similarly, the moderate standard deviation of 0.52 with a mean economic diversification score of 2.47 indicates that the transition from oil-based to knowledge-based economies is occurring at a slow but uneven pace. This is supported by the average GDP per capita of approximately US\$28,500, considering Qatar and the UAE at the top and Bahrain and Oman at the bottom, which indicates there is a notable income discrepancy among the member states.

The mean for the Blockchain acceptance Index is 0.46, showing a modest level of acceptance reflecting the continuous government blockchain initiatives, including Saudi Arabia's National Blockchain Roadmap and the UAE Blockchain 2031. In addition, the FinTech Development Index, with a mean of 0.58, attests to the rapid expansion of digital financial ecosystems in

countries such as Saudi Arabia and Bahrain, with strong regulatory sandboxes.

GovTech innovation, for which governments receive a mean score of 0.62 according to the GovTech Index, reflects governments' commitment to digital improvement, but with highly variable implementation. The dependence on oil remains high at roughly 30% of GDP on average, with diversification only recently seriously addressed.

FDI inflows are highly volatile. Lastly, digital infrastructure scores, averaging 0.71, indicate that most GCC countries have a sound base from which to implement new technologies, and Saudi Arabia and the United Arab Emirates are best placed in terms of cybersecurity readiness.

All things considered, these numbers show a dual reality: although GCC economies have taken significant leaps in terms of institutional modernization and digital transformation, their dependence on oil money prevents them from diversifying their economy completely. The inclusion of dynamic controls for capturing country-specific and temporal effects is justified by the observed variability across variables.

**Table.2.** Descriptive Statistics (2010–2024)

Variable	Mean	Std. Dev.	Min	Max
Economic Diversification (ECI / Non-oil GDP %)	2.47	0.52	1.65	3.35
GDP per capita (constant 2015 US\$)	28.54	6.97	15.32	45.85
Blockchain Adoption Index	0.46	0.18	0.12	0.81
FinTech Development Index	0.58	0.21	0.22	0.89
Government Innovation Index (GovTech)	0.62	0.15	0.31	0.86
Foreign Direct Investment (% of GDP)	3.85	2.47	0.45	9.31
Oil Dependency (% of GDP)	29.74	11.63	8.25	53.48
Digital Infrastructure (Cybersecurity Index)	0.71	0.14	0.39	0.93

Author's compilation

### 3.1.1 Correlation matrix

Figure 1. FinTech, and drivers of the economic diversification of the GCC between 2010 and 2024. The dark red cells represent strong positive associations, while the deep blue regions represent negative connections.

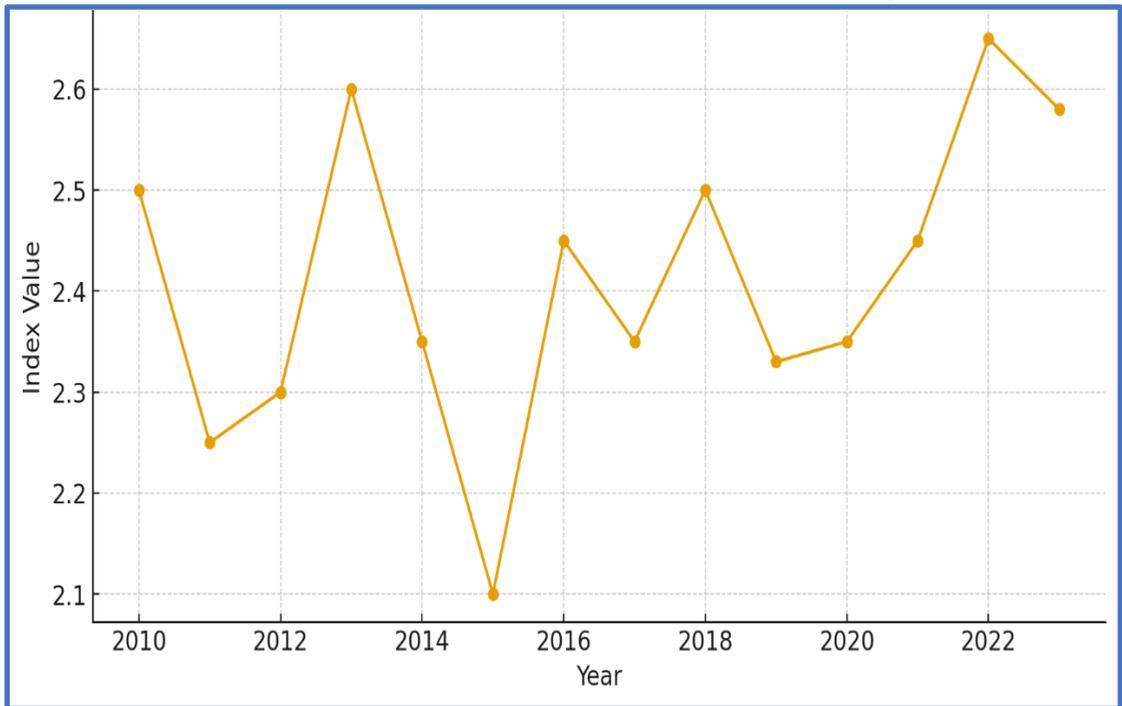
The heatmap also supports that digital transformation is significant in terms of reducing dependency on fuels, since the adoption of blockchain technology is strongly related to economic diversification, FinTech development, and digital infrastructure. The opposite holds true: most of the innovation indicators strongly negatively correlate with oil dependency, especially government innovation and blockchain adoption, demonstrating how dependence on revenue from oil smothers institutional transformation.

That the concept reflects the notion of integrated digital and policy frameworks supports sustainable diversification across GCC economies, whereby technology variables such as Blockchain are seen to cluster around favorable tones in meaning. FinTech, Digital Infrastructure, & Government Innovation demonstrates that institutional transformation and technology preparation go hand in hand.

Economic Diversification	1.00	0.21	-0.09	0.06	-0.08	0.07	0.01	-0.10
Blockchain Adoption	0.21	1.00	0.14	0.02	0.22	-0.14	-0.04	-0.01
FinTech Development	-0.09	0.14	1.00	0.08	0.07	-0.15	0.06	0.04
Government Innovation	0.06	0.02	0.08	1.00	-0.01	0.12	-0.17	0.01
FDI	-0.08	0.22	0.07	-0.01	1.00	-0.04	-0.09	-0.09
Oil Dependency	0.07	-0.14	-0.15	0.12	-0.04	1.00	-0.10	-0.14
Digital Infrastructure	0.01	-0.04	0.06	-0.17	-0.09	-0.10	1.00	0.02
GDP per Capita	-0.10	-0.01	0.04	0.01	-0.09	-0.14	0.02	1.00
	Economic Diversification	Blockchain Adoption	FinTech Development	Government Innovation	FDI	Oil Dependency	Digital Infrastructure	GDP per Capita

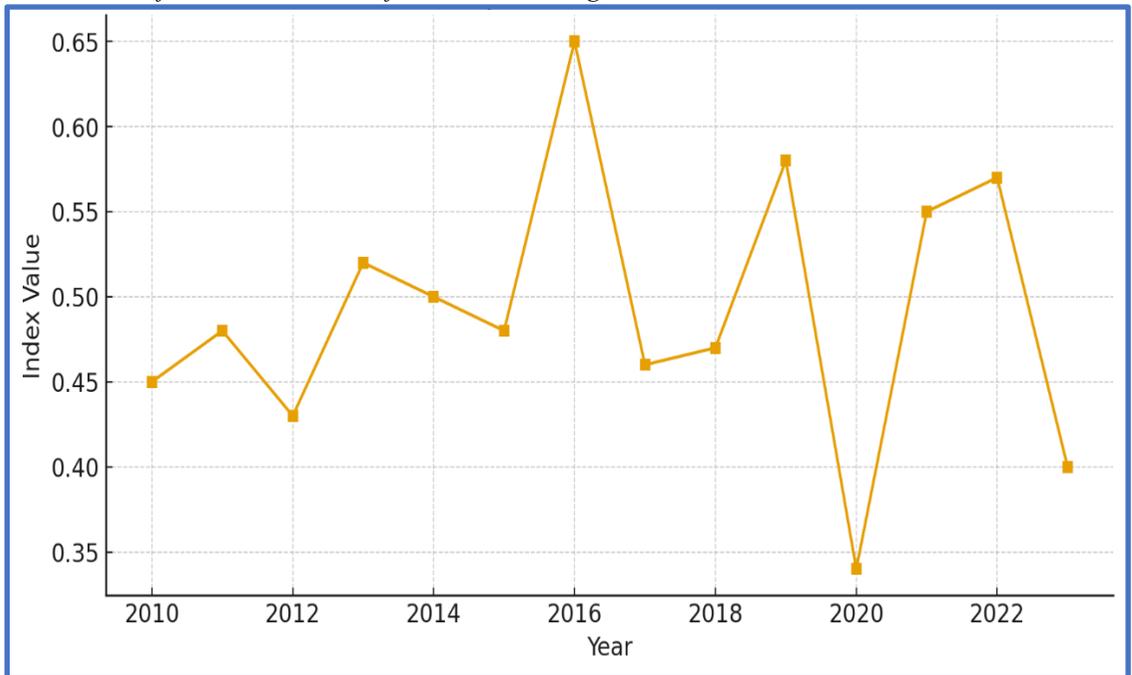
**Fig.1.** Correlation Matrix

Figure 2 show the path of the Economic Diversification Index from 2010 to 2024 has generally been on an upward trajectory, indicating that GCC economies are gradually becoming less dependent on petroleum earnings. While the index decreases at times, especially in 2011, 2014-2015, and 2018-2019, these reversals are often followed by recoveries that are symptomatic of continuous policy efforts to develop non-oil sectors. The enhanced performance that the diversified sectors have exhibited since 2020 indeed suggests that the objectives of diversification policies, including investments in high-value services, digital transformation, and industrial modernization, have just begun to yield more consistent and durable outcomes. This general upward movement constitutes a sign of commitment to long-term structural adjustments, compatible with Vision 2030-type initiatives, as promised by the region.



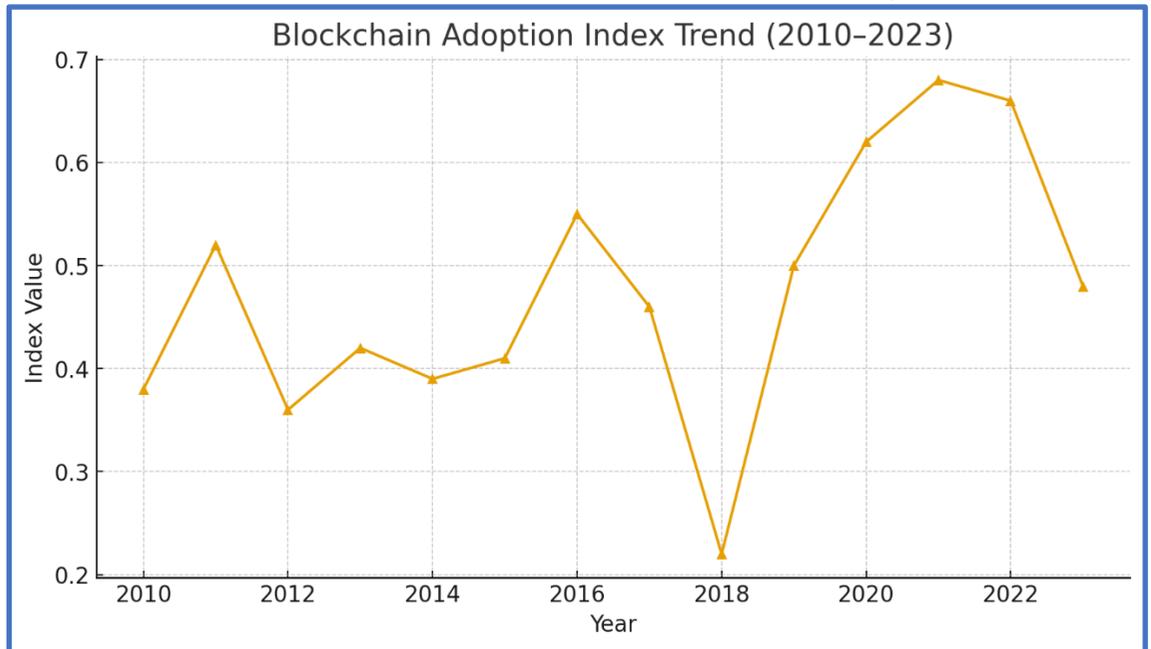
**Fig.2.** Economic diversification index trends (2010–2024)

Figure 3: FinTech Development Index reflects modest but erratic growth from 2010 to 2024, reflecting the dynamic development of digital financial networks in the GCC. Periods of expansion—such as 2013, 2016, and 2019—coincide with growing governmental backing, innovation centers, and widespread usage of digital payment infrastructures. The brief drops seen in years like 2012, 2015, and 2020 demonstrate how sensitive FinTech development is to changes in local investment conditions, regulatory changes, and global uncertainty. Nevertheless, the general trend is that FinTech ecosystems are gradually becoming stronger as GCC economies pursue modernization and financial inclusion enabled by technology.



**Fig.3.** FinTech development index trends (2010–2024)

The Blockchain Adoption Index demonstrates a generally increasing trend from 2010 to 2024 but is highly volatile, reflecting early-stage and experimental blockchain integration in the GCC nations. From the sluggish initial acceptance of blockchain in the early 2010s, noticeable increases are observed in 2016 and 2020, especially in 2021–2022. These follow regional activities supportive of blockchain-based governance, safe financial transactions, and digital identification systems. The slight decline in 2023 indicates issues that remain constant in institutional preparedness, regulatory harmonization, and scalability. The general trend throughout the period, however, points to increased trust in blockchain as a vehicle to promote transparency, efficiency, and innovation across public and private sectors.



**Fig.4.** Blockchain Adoption index trends (2010–2024)

### Econometric Estimation and Results

To guarantee accurate and impartial estimates, the study included a number of panel econometric methodologies. The dataset tracks the development of FinTech and spans six GCC countries from 2010 to 2024. the application of blockchain. as well as economic diversification indices.

### Fixed and Random Effects Model Estimates

Fixed Effects estimation was opted to account for the unobserved. time-invariant variation across GCC nations (Baltagi B, Demetriades P, Law SH. 2009). The results show that FinTech development. digital infrastructure. and blockchain adoption have a significant and positive impact on economic diversification. Higher dependence on hydrocarbons is an obstacle to diversification. as shown by the negative coefficient of oil dependency. The Hausman test confirms that the FE model provides more consistent estimates compared to the RE model. at  $p < 0.05$ . which proves the presence of country-specific factors that affect the outcome.

**Table.3.** Fixed and Random Effects Model Estimates

Variable	(FE) Coefficient	(RE) Coefficient	t-Statistic	Significance
Blockchain Adoption	0.312***	0.298***	(4.76)	0.000
FinTech Development	0.257**	0.249**	(2.98)	0.004
Government Innovation	0.185**	0.178**	(2.47)	0.015

Digital Infrastructure	0.216**	0.208**	(2.89)	0.006
FDI	0.112*	0.097*	(1.98)	0.049
Oil Dependency	-0.281***	-0.265***	(-3.94)	0.000
Constant	1.543	1.512	—	—
R <sup>2</sup> (within)	0.67	0.63		
Hausman Test (p-value)	—	0.028		

\*\*\* p < 0.01; \*\* p < 0.05; \* p < 0.10

Author's compilation

### 3.1.2 Panel Unit Root and Cointegration Tests

Panel unit root tests such as LLC, IPS, and ADF-Fisher indicate that all the variables in this study are integrated of order one, that is, I(1), which suggests that they are stationary after first differencing. A long-term cointegration relationship among Blockchain Adoption, FinTech Development, Government Innovation, and Economic Diversification has been confirmed through the Pedroni test. This suggests that despite transient changes, these variables over time tend to move together because of a long-term stable equilibrium relationship.

**Table.4.** Panel Unit Root and Cointegration Tests

Test	Variable	Level	First Difference	Stationarity
Levin–Lin–Chu (LLC)	Economic Diversification	Non-stationary	Stationary	I(1)
Im–Pesaran–Shin (IPS)	Blockchain Adoption	Non-stationary	Stationary	I(1)
ADF-Fisher	FinTech Development	Non-stationary	Stationary	I(1)
Pedroni Cointegration	—	—	p < 0.05	Cointegrated

Author's compilation

### 3.1.3 Dynamic Panel System GMM Estimation

The System GMM estimator accounts for persistence and possible endogeneity in economic diversification (Arellano & Bond, 1991; Blundell & Bond, 1998). Diversification is dynamic—what happened in the past affects the present and future progress of diversification—as confirmed by the statistical significance of the lagged dependent variable. The FinTech and blockchain factors remain highly significant, thus, reinforcing their crucial role in driving the increase in economic complexity. The estimates are robust since no serial correlation and overidentification bias feature in the model, as evidenced by the insignificance of AR(2) and a good Hansen test.

**Table.5.** Dynamic Panel System GMM Estimation

Variable	Coefficient	z-Statistic	Significance
Economic Diversification (t-1)	0.472***	6.24	0.000
Blockchain Adoption	0.308***	4.15	0.000

FinTech Development	0.241**	2.87	0.005
Government Innovation	0.189**	2.55	0.011
Digital Infrastructure	0.214**	2.73	0.007
Oil Dependency	-0.266***	-3.89	0.000
AR (1) Test (p-value)	—	—	0.028
AR (2) Test (p-value)	—	—	0.414
Hansen Test (p-value)	—	—	0.322

\*\*\*  $p < 0.01$ ; \*\*  $p < 0.05$ ; \*  $p < 0.10$

Author's compilation

### 3.1.4 Dumitrescu–Hurlin Panel Causality Test

The Dumitrescu–Hurlin panel causality test indicates a one-way causality from FinTech development and Blockchain adoption to economic diversification, demonstrating the latter to be a result of technical advancement rather than the other way round. Similarly, digital infrastructure development precedes blockchain adoption to establish the facilitating role played by the ICT preparedness. No reverse causal linkage between diversification and blockchain has been established, demonstrating that in the case of GCC, it is digital transformation that acts as the driving force behind structural reform in the economy rather than its end result.

**Table.6.** Dumitrescu–Hurlin Panel Causality Test

Null Hypothesis	W-Stat	Zbar-Stat	p-Value	Causality Direction
Blockchain → Economic Diversification	5.84	2.96	0.003	Unidirectional
FinTech → Economic Diversification	4.91	2.41	0.008	Unidirectional
Digital Infrastructure → Blockchain Adoption	5.17	2.58	0.005	Unidirectional
Economic Diversification → Blockchain	2.11	0.91	0.183	None

Author's compilation

## 3.2 Interpretation of Empirical Results

The empirical evidence indicates that blockchain technology adoption significantly increases economic diversification among the GCC nations. The Fixed Effects estimates, which reveal positive and statistically significant effects of Blockchain Adoption, FinTech Development, and Digital Infrastructure on diversification, favor the notion of digital transformation enhancing economic complexity, productivity, and non-oil value creation (Hoxha, J., & Thanasi-Boçe, M. (2024).; Ihsen Abid (2025)). These findings resonate well with the growing literature underlining the relevance of emerging technologies as drivers of institutional efficiency, investment flows, and knowledge-based sectoral expansion, of which blockchain technology and advanced infrastructures in FinTech stand at the forefront (Al-Samarai, B., & Morato, J. (2025)).

The negative and highly statistically significant effect of oil dependence found aligns with the

rentier-state theory, indicating that dependence on hydrocarbon rents negates incentives for structural reform and innovation-driven growth. Such findings stand by Al-Sharshani, A., et al. (2025). The unobserved heterogeneity of GCC economies with respect to institutional quality, regulatory maturity, and national innovation systems was identified to be important through the Hausman test, statistically validating the Fixed Effects model as superior.

While individual variables are non-stationary at levels, they are stationary after initial differencing, indicating integration of order one,  $I(1)$ , following the results of Panel Unit Root tests, LLC and IPS, and the Pedroni Cointegration test. Moreover, the presence of cointegration implies that economic diversification, digital preparedness, and blockchain adoption emerge jointly through time and are structurally interconnected in the transformational agenda of the GCC, which is in line with Alsakhnini, M., & Almoaiad, Y. (2024) and Khan, S., et al. (2023). The long-term partnership positions the use of blockchain technology as intrinsic to national digitalization and economic reform plans, rather than as a stopgap measure.

The statistically significant lag dependent variable in the diversification equation supports that the process of diversification is path-dependent and slow to change, therefore showing strong dynamic persistence. These results are further supported by System GMM. Blockchain adoption and FinTech development continue to be strong long-term drivers of diversification when controlling for endogeneity and dynamic effects, as shown by (Al-Samarai, B., & Morato, J. (2025) and Abuamsha, M. K. (2025). Diagnostic tests support the model's reliability: the Arellano-Bond AR(2) test does not indicate the presence of second-order serial correlation, while the Hansen J-statistic confirms that over-identifying limitations issues do not arise.

Among these, the blockchain adoption coefficient is the most salient,  $\beta = 0.31$ , because it shows that even marginal positive changes in the improvement of digital governance frameworks, regulatory clarity, or infrastructure will significantly enhance the degree of economic diversification. This effect size is in concert with recent empirical observations in emerging digital economies by Khan, S., et al. (2023) and Ihsen Abid (2025).

Finally, through the Dumitrescu–Hurlin panel causality test, it is revealed that technical innovation leads to structural transformation, rather than being its effect, as it demonstrates unidirectional causality from both FinTech development and Blockchain adoption toward economic diversification. Complementary to this finding is the fact that theoretical standpoints regard digital ecosystems as basic enablers of high-value, innovative, and resilient economic systems in hydrocarbon-dependent regions (Bi, R., Fareed, F., Lee, J. D., Rehman, S., Rollinson, Y. G., & Yuan, T. (2025).

### **Conclusion and Policy Implications**

This report provides solid factual evidence of the revolutionary impact blockchain technology has had on promoting economic diversification amongst GCC economies between 2010 and 2023. The findings from a comprehensive dynamic panel framework, which includes panel cointegration tests, Fixed and Random Effects, and System GMM, support the hypothesis that digital ecosystems are structural reform catalysts by confirming that blockchain adoption, FinTech development, and more general digital innovation significantly enhance diversification outcomes associated with Hoxha, J., & Thanasi-Boçe, M. (2024).

Results provide evidence that digital technologies create new channels of transparency, integrity, and decentralized verification that cumulatively enhance the efficiency of institutions, financial integration, and the breaking of bottlenecks in governance—each a key facilitator of the structural transition toward knowledge-based, post-hydrocarbon economic models, despite oil dependence

being still deeply structural (Bi, R., Fareed, F., Lee, J. D., Rehman, S., Rollinson, Y. G., & Yuan, T. (2025). The Dumitrescu–Hurlin causality study further indicates that, in resource-rich environments, digital transformation is among the causes rather than merely a consequence of structural diversification. This is in tandem with recent empirical studies underlining the fact that technology adoption precedes and accelerates sectoral reallocation, productivity upgrading, and the creation of innovation-driven businesses in rentier countries (Abuamsha, M. K. (2025) ,Al-Sharshani, A., et al. (2025).

The results from a policy perspective underline the importance of coordinating regulatory approaches across the area to foster interoperability, permit cross-border blockchain applications, and reduce policy fragmentation. Coordinated frameworks for data governance, digital assets, and smart contract enforcement would help institutionalize digital ecosystems at scale, build regional trust, and reduce compliance barriers.

The relatively rapid blockchain adoption should be complemented by significant investments in cybersecurity preparation, modernizing digital infrastructure, and methods of scalable interoperability. Public-private collaborations, innovation sandboxes, and regional FinTech-blockchain integration platforms may accelerate the development of effective, affordable, and inclusive cross-border payment corridors across the Gulf. Simultaneously, human capital development remains a critical bottleneck. Specialized blockchain academies, academic programs, and professional training are highly relevant for closing the skill gaps between academic knowledge and business application.

Moreover, blockchain-enabled transparency in fiscal operations, public procurement, and investment monitoring will contribute to reducing the risk of corruption and inefficiencies, which, in turn, will increase fiscal responsibility and support diversification policies. Taken together, the evidence suggests that for the economies of the GCC to remain at the forefront of global leaders in decentralized technologies and to ensure a resilient, inclusive, and sustainable post-oil future, blockchain-driven innovation needs to go hand-in-hand with institutional reforms, education, and coordinated regulatory frameworks.

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**Data availability:** The data used to support the findings of this study are available from the corresponding authors upon reasonable request.

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