

ICT diffusion, financial development and manufacturing propel economic growth in GCC nations: does panel data model provide new evidence?

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Abstract: This study seeks to investigate how financial development, manufacturing and the access and diffusion of information and communication technology (ICT) add value to economies within the Gulf Cooperation Council countries (GCC). Precisely, it is supposed to explain how variables facilitate regional development and economic growth individually and jointly. In this context, the objective of the present study is to shed light on how financial development, Manufacturing and ICT dissemination impact regional economic performance and sustainability, analysing their interactions. The analysis of the variables affecting GDP per capita in the GCC nations throughout during 2001 to 2021 was performed using a panel data model estimation technique. The study at hand attempts to probe the present frame of financial development functions and ICT dissemination, among other economic factors, along with their interaction in influencing regional economic growth and development. In this regard, Financial Development, Manufacturing and ICT diffusion have a positive significant impact on the GDP per capita of the GCC countries; the fact that financial support and access to ICT highlight the major part played in the development of the economy. On the contrary, Manufacturing imparted a minor effect on the GDP, as revealed by its relatively low coefficient of correlation estimated at 0.614. The findings of this study will add new critical information to the scholars, researchers, and policy analysts concerned with the study of ICT, financial development, and economic growth in the GCC. This study merges the impact of financial development and ICT diffusion on regional economic growth by testing the relationship in a new dimension.

1 Introduction

Diffusion of ICT enhances the aspects of productivity, information availability, and connective abilities across sectors, all those factors that have a great impact on economic growth. Inclusion of the marginalized sections of the population, reduction of transaction costs, and inclusiveness-all these have been effectively facilitated by internet and mobile technological development. It further facilitates access to international markets, healthcare, and education, fosters innovation, and enables economies to make use of a networked world [1]. This again supports the fact that growth in both developed and developing countries is influenced by expanding ICT, though more research might be needed concerning the future impact in those regions where technology is being adopted at an increasing rate currently [2].

Through the above, we find that there is a strong relationship between the spread of information and communication technology and Manufacturing and

financial development, which in turn enhances the economic growth of any country, and many developing countries and the Gulf Cooperation Countries seek to develop their financial sector and manufacturing policy using information and communication technology to enhance economic growth. Many scholars have also addressed in recent years the impact of the spread of information and communication technology on economic growth, from the role played by information and communication technology in accelerating production processes, organizing management, and contributing to reducing costs, which in turn is reflected in the development of companies and thus increasing employment and stimulating consumption and thus raising economic growth rates. This is proven by economic theories, but on the part of applied studies, there are studies that have agreed with economic theory, the most important of which are [1,3,4] and other studies. There are other studies that did not agree with economic theory and found negative effects, including [5-9] and other studies.

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In the Cobb-Douglas model the underlying economic theory is that the three major inputs, namely, labour, capital, and technology, combine to form the total production function and thus contribute towards economic growth. Accordingly, in these production conditions, financial development is usually considered to represent the capital, and manufacturing policy is labour, while ICT represents the technological advance. The financial sector alone makes resource allocation more effective through savings mobilization, directing resources to high-productivity investments, reducing information costs and transaction costs that facilitate interindustry trade. Resource allocation is also more effective when there is saving mobilization, directing resources to high-productivity investments, information cost reductions, and transaction cost reductions facilitating interindustry trade as also noted by [10-12]. In this regard, acceleration in money and technology accumulation leads to overall development. Yet, the 2008–2009 financial crisis brought into focus how defective financial institutions can lead to resource misallocation, speculation, underinvestment, and waste. The empirical evidence shows that financial development has brought mixed and sometimes adverse effects on growth, often linked to increased financial crises, thinness of the stock market, or nonlinearities in the relationship between [13-16].

The importance of this study is to understand how the common forces of financial development, industrialization, and ICT proliferation affect GCC economic growth by analyzing these factors as complementary drivers of sustainable growth. Overall, financial development, manufacturing, and ICT are critical to diversifying the economy, increasing productivity, and transforming GCC economies from oil dependence to knowledge-based economic structures. This puts ICT in a strategic position to accelerate e-commerce, innovation, and productivity. In any case, financial development reinforces the role of ICT's spread in providing access to capital across the economy, improving investment efficiency, and promoting entrepreneurship, especially through recent developments in digital banking and financial technology (Fintech). These techniques provide financial inclusion, enabling individuals and SMEs to access finance as part of the formal economy, thus integrating larger segments of the population into the economic process. SMEs' access to finance as part of the formal economy, thus integrating larger segments of the population into the economic process.

The study contributes in two ways: first, by considering the mutual dynamics between financial development, manufacturing and ICT in driving economic growth within the GCC; second, by establishing how such sectors together support resilience, growth, and diversification. To that end, this paper addresses some very important questions related to the interrelationship between financial infrastructure, manufacturing and ICT development and their overall impact on economic stability and

transformation within GCC countries. Given the drive of the region's policy for diversification, these findings bring to the fore the centrality of ICT-enabled financial services in strengthening the economies of GCC countries against external shocks-such as turbulence in oil prices. These are timely and impactful insights, given that the strategies of GCC countries are oriented toward life in a post-oil future.

The research also makes a policy contribution by underlining the interaction between financial development, manufacturing and ICT diffusion in providing actionable insights for policymakers articulating comprehensive strategies leveraging these factors to improve the resilience and global competitiveness of their countries. The study underscores the need for policy action to promote sustainable growth and diversification in the GCC, and ICT infrastructure development and continued financial sector reforms can improve economic performance, improve living standards and increase employment opportunities for the region's citizens. Second, in pursuit of financial inclusion, it points toward a mechanism of integrating the excluded that can bring about well-balanced and inclusive growth. It has finally been made clear in this paper that regional cooperation in the fields of financial sectors, manufacturing sector and ICT diffusion are one means of ensuring innovation, stability, and sustained economic growth in GCC. Using shared resources, knowledge, and technology, GCC countries can work together to create robust, diversified economies capable of dealing with the changing global economy, thus benefiting the region at large. This should serve as a driving force for regional integration and further encourage investment in cross-border ICT projects, financial networks, and economic partnerships across the GCC region.

This paper is organized into six sections; the first section being the introductory part that puts the study in context, the second constitutes the literature review necessary for the background and identification of gaps in the previous literature, the third presents a description of the methodology adopted for conducting this study, while the fourth section sets forth the findings. The discussion section finally interprets the results, while in the conclusion, after summarizing the salient points and their implications, the reader is provided with a comprehensive framework in which to place the contribution of the study and any possible future research directions.

2 Literature review

Diffusion of information and communication technology, or ICT, along with financial development, represents the most vital components of contemporary economic growth for a wide variety of regions. Although various studies evidence that both ICT and financial development contribute positively to economic growth, their impacts differ according to geographical and economic contexts. In comparison, financial development variables tend to be much stronger in their positive impact on the rate of economic growth in developed economies

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than the ICT indicators suggest. The financial system furthers one of the imperative functions: the effective allocation of capital funds to foster entrepreneurship and investment, thus stimulating economic growth. However, the role of ICT can be less pronounced for high-income countries, since their economies already have appropriate infrastructures related to technologies.

On the contrary, for economies like the WAEMU countries, the diffusion of ICT is very important for economic growth, considering that its channels of diffusion are mainly through mobile and internet penetration. An investigation by [17] established that the direct contribution of financial development to economic growth was relatively negative, whereas its spillover effect through ICT diffusion impacts economic growth positively, especially beyond a threshold level of penetration. The tendency here is that possible eventual adoption of ICT may help offset initial economic setbacks from financial development in developing economies through productivity and market accessibility as connectivity improves.

The various works conducted on BRICS economies showed that the inter-play between ICT and growth is dynamic in nature. According to [18], subscription to both mobile cellular and fixed broadband exerts an immediate positive impact on growth, while other categories of ICT-related expenditure such as research and development and imports of ICT goods yields growth benefits long-run. Thus, this distinction suggests that while ICT infrastructure catalyzes near-term gains, investments in technology and innovation-like research and development contribute to sustainable economic expansion in the long run. These results once again underscore the need for a balanced approach to ICT investments, with both infrastructure development and continuous innovation.

Nuancing this view in Asian developing economies, it seems that growth is affected by the interaction of ICT with financial development. [1] observe that even though the mere diffusion of ICTs tends to be economically destructive in the short run due to costs and structure adjustments, their integration with financial development results in substantial economic benefits. This is reasoned on the complementary functions of ICT and finance in that finance supports projects brought forth by ICT that in turn enhance economic activities and markets. Therefore, this synergy goes to help in bringing out the relevance of integrating ICT investment strategies into the growth of the financial sector for optimal economic outcomes.

Aggregately, these studies emphasize the interdependence among the variables of financial development and dissemination of ICTs and economic growth; hence, a need to exploit them jointly toward sustainable economic development. Specific country contexts and their comparison sections show several results presented by various researchers: For instance, [19] find a very strong positive interaction between financial development and ICT diffusion within the MENA region,

which supports the positive role that ICT would have played in economic growth. [20], however, note that though ICT improves GDP within countries inside MENA, financial development sometimes has adverse effects, underlining regional variability in outcome. [21] argue that the spread of ICT in WAEMU has a positive impact on growth, while financial development has a negative impact. The work of [22] is broader because they assess growth fluctuations. They observe that the diffusion of ICT exerts a positively significant impact on the level and stability of economic growth, thus implying that ICT might also be one more factor contributing to economic resilience in turbulent regions. At the same time, country-specific research provides unique insights. This is what [23] pointed out where the study concluded that ICT and technological innovation in Turkey negatively affect financial development, while the study confirmed that globalization and economic growth positively affect the financial sector. Such inconclusive results simply underpin the differential impacts of ICTs on economic growth across different national contexts. Other studies highlight partial aspects of the impact of ICTs on economic growth. For instance, in Saudi Arabia, [24] indicate that ICT diffusion has a positive moderation role in financial development-economic growth nexus, hence suggesting that ICT can further enhance the growth-enhancing role of financial development. In Malaysia, [25] show that electricity consumption and hence the underlying critical infrastructure are related to ICT growth. The study conducted by [26] on Chinese cities confirms that ICT fosters technological advancement as well as urban efficiency and the benefits from the ICT are almost unaltered by geographical distances. It is from such findings that the impacts of the ICT on economic development essentially manifest that while economic development may be generally fostered by ICT, the regional and structural factors often become essential determinants of the magnitude and nature of impacts.

The broad research indicates interlinkage that is multi-dimensional between financial development, ICT diffusion, and economic growth. Results concerning financial development, however, tend to be mixed and often depend on regional and economic conditions. Whereas it is possible, for example, that financial development may, at times, lag growth or even detract from it, the diffusion of ICT is likely to create more immediate benefits in emerging economies. On the other hand, financial development tends to be positive in relatively more developed countries, which is basically supported by well-established capital markets and regulatory frameworks that are usually rather stable. The complementary role of ICT in the process of financial development further underlines the importance of technological improvements for economic development.

Notwithstanding these findings, the variations across studies do suggest that further research is indeed called for regarding how these relationships work out in their

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dynamics and policy implications in diverse contexts. It thus appears that the interactions between ICT, financial development, and economic growth can be complex and often dependent on a set of various factors such as infrastructure, regulatory support, and economic maturity.

In this respect, the integration of AI in ICTs and financial systems in the GCC countries could certainly be regarded as one of the giant leaps forward. AI acts as a catalyst for economic development within the GCC region through an increased speed and reach of its financial services. Examples include [18], who review how AI increases the contribution of ICT to the economy, which then turns out to be an important tool for both banking and general economic strategy in the GCC region. This would further increase financial inclusions through artificial intelligence-driven solutions in ICT and increase the

quality of service, thereby giving rise to sustainable growth within the economy. This can be a certain transformation that could be seen within regional economies themselves with the advent of such technologies.

3 Data and methodological framework

This section delineates the methodology of the study, a statistical analysis of variables involved, and sources from which the data has been gathered.

3.1 Data and summary statistics

Prior to model construction, we evaluated the expected impact of each study variable, obtaining background knowledge from the World Bank's World Development Indicators. A summary of the same is given in Table 1.

Table 1 Descriptions of variables and the sources of data

Type	Acronym	Description	Source
Dependent Variable	LnGDPpc	Gross Domestic Product per capita (constant 2015 US\$)	World Development Indicators (WDI)
	LnFD	Domestic credit to private sector by banks (% of GDP)	
Independent Variables	LnICT	ICT Diffusion: Internet Penetration Rate (Individuals using the Internet (% of population) or Mobile Phone Penetration (Mobile cellular subscriptions (per 100 people).	
	LnMANF	Manufacturing, value added (% of GDP)	

Note: All data available at (DataBank | The World Bank) [27].

Figure 1 shows the trends in ICT Diffusion, financial development, and Manufacturing as drivers of economic growth in GCC nations. The level of ICT Diffusion has gone up gradually during the period, indicating substantial investments in digital infrastructure and connectivity. The financial development has been oscillatory in nature, with rapid growth combined with modest declines probably dictated by global economic conditions and adjustments in policy at the regional level. Manufacturing, too, has shown mixed trends where spells of stability have been interspersed by short-term spikes due to changes in oil prices and external shocks in the economy. Put all these together, and one gets the economic growth trajectory for the GCC economies: an interesting dynamic between technological progress, expansion of financial markets, and price stability comes into play. The figure below shows that ICT and financial policies remain important complements to sustained economic development, particularly in those resource-dependent economies transitioning toward more diversified and knowledge-based growth.

This perhaps has something to do with the way GCC economies have adopted innovation and investment as drivers for growth across major sectors in the economy. Most specifically, the pursuit of ICT Diffusion and financial development has been pursued as mutually reinforcing enablers that can accelerate economic transformation. Integration of ICT enhances efficiency and productivity across industries, while financial development supports capital allocation and innovation. These dynamics have an added layer of significance in the GCC in view of efforts towards de-oil dependence and setting up knowledge-based economies. Second, investment patterns and consumer behaviour could be impacted by inflationary pressures, typically induced via global energy costs and fiscal policies in too many domestic economies. The interaction of Manufacturing with financial development and diffusion of ICT shows how these factors interact in determining sustainable growth trajectories. The emphasis that GCC countries place on digital infrastructure and financial reforms constitutes a strategic commitment to economic resilience and adaptation within global economic currents.

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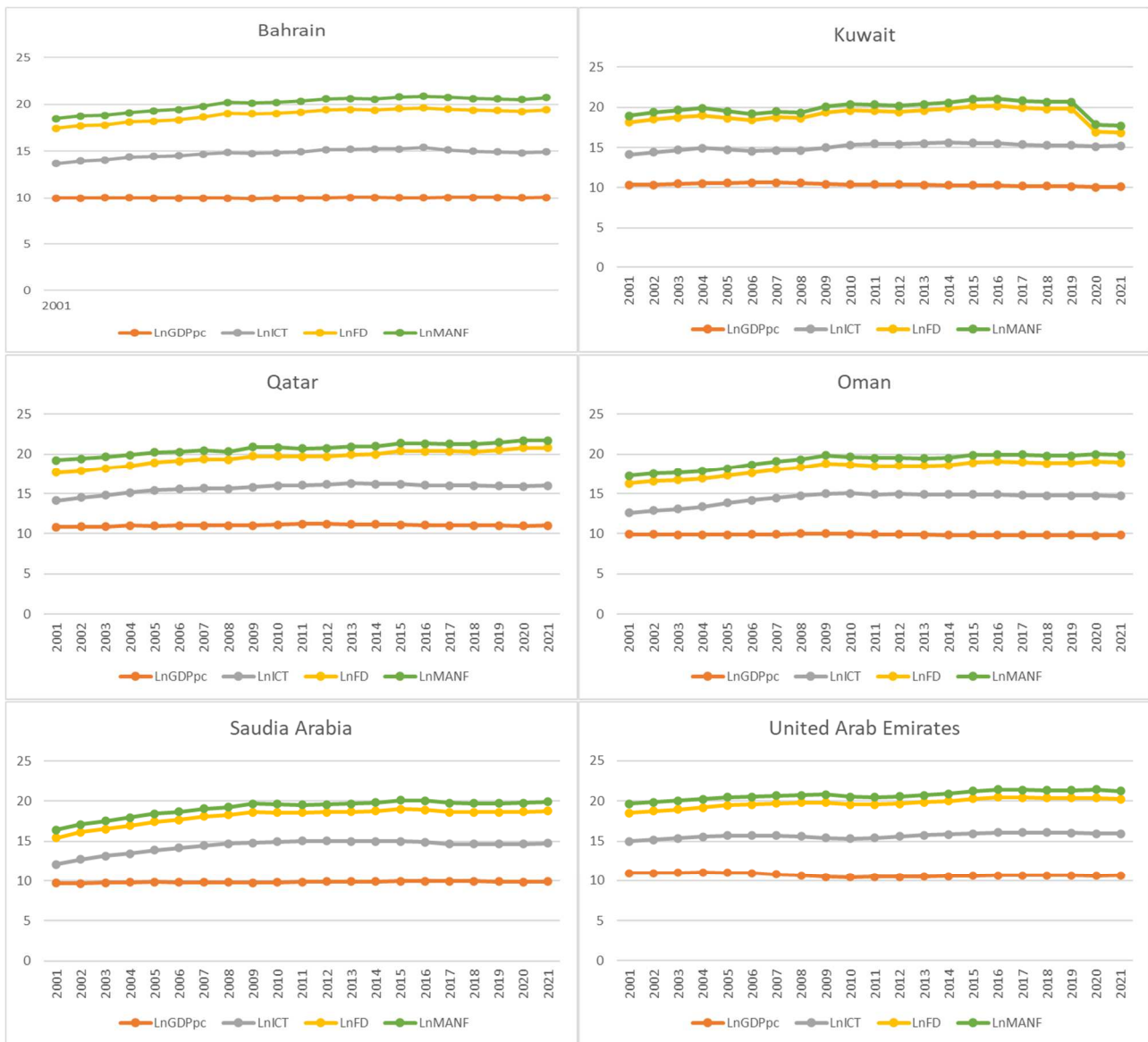


Figure 2 Variable plots

3.2 Research methodology

The approach in undertaking any research is well-structured in the delivery of correct and reliable results. First, there is the presentation of data and descriptive statistics as a way of giving a sneak peek into the dataset for describing means, variances, and distributions. In this respect, a correlation analysis will then be implemented showing the relationship of these variables for either multicollinearity or significant associations. Estimation incorporates appropriate econometric techniques, which quantify the relationships and test hypotheses. Diagnostics After estimation, diagnostics are done that verify the validity of the model and its underlying assumptions of normality, homoscedasticity, and no autocorrelation. The result interpretation therefore provides an explanation of findings in the context of the research objectives. Then, different specifications or methods could be performed to

check the robustness of results. Results are then compiled, organized in a systematic manner, and summarized into reports that clearly present the findings in concise ways (Figure 2).

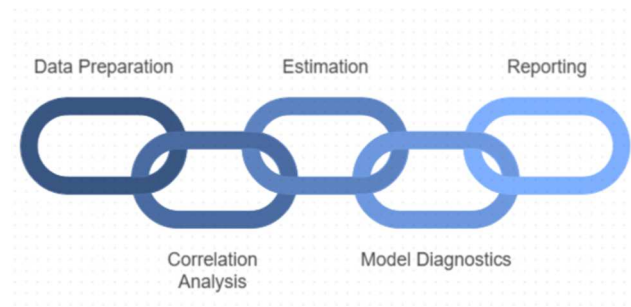


Figure 2 Statistical analysis process

3.3 Specification of the model

This model is specified in a functional form as outlined below. It presents the relationship between the major

variables and parameters in the given framework of analysis:

$$LnGDPp_{Cit} = \beta_0 + \beta_1 * LnICT_{it} + \beta_2 * LnFD_{it} + \beta_3 * LnMANF_{it} + \epsilon_{it} \tag{1}$$

Where:

$LnGDPp_{Cit}$ - Logarithm of Gross Domestic production Product per capita in country i at the time t .

$LnICT_{it}$ - Logarithm of Mobile cellular subscriptions (per 100 people) in country i at the time t .

$LnFD_{it}$ - Logarithm of Domestic credit to private sector by banks (% of GDP) in country i at the time t .

$LnMANF_{it}$ - Logarithm of Manufacturing in country i at the time t .

ϵ_{it} - error term.

3.4 Correlation assessment

From Table 2, it is observable that $LnGDPp_{Cit}$ is weakly correlated with $LnICT$, $LnFD$, and $LnMANF$. This implies that there is no significant relationship between the variation in $LnGDPp_{Cit}$ with $LnICT$, $LnFD$, and $LnMANF$. Besides, $LnICT$ is also weakly negatively related to $LnMANF$ but strongly positively related to $LnFD$. This suggests that large values of $LnICT$ are weakly associated with lower values of $LnMANF$ and strongly associated with high values of $LnFD$. Also, as it were, there is a moderate negative association of $LnFD$ with $LnMANF$ such that with an increase in $LnFD$, there is a tendency of $LnMANF$ to reduce.

While these correlations provide insight into the relationships between variables, it must be kept in mind that not all correlations imply causation. Further analysis, such as regression analysis, would be required to establish the nature and intensity of these correlations (Table 2).

Table 2 Matrix of correlation

	LnGDPpc	LnICT	LnFD	LnMANF
LnGDPpc	1.000			
LnICT	0.098	1.000		
LnFD	0.140	0.401	1.000	
LnMANF	0.016	-0.112	-0.143	1.000

3.5 Descriptive statistics

Table 3 following is the descriptive statistics table showing the per capita GDP, the diffusion of ICT, financial development, and manufacturing for various variables.

Table 3 Descriptive statistics

	LnGDPpc	LnICT	LnFD	LnMANF
Mean	10,308	4,68	3,94	1,012
Median	10,071	4,895	4,01	0,988
Max	11,204	5,399	4,93	1,565
Min	9,652	2,437	1,614	0,645

The descriptive statistics for the four variables used are presented in the table below. Starting with descriptive statistics, the average is 10,308 for per capita GDP, $LnGDPp_{Cit}$, ICT diffusion with 4.68, financial development at 3.94, and Manufacturing at an average of 1.694. Having Manufacturing = 0.988, ICT = 4.895, financial development = 4.01, and per capita GDP = 10,071, the medians are also close in value to their respective means, indicating a distribution symmetric. The minimum values are 9,652 for per capita GDP, 2,437 for ICT, 1,614 for financial development, and 0.645 for Manufacturing, while the maximum values reached 11,204 for per capita GDP, 5,399 for ICT, 4,93 for financial development, and 1.565 for Manufacturing.

4 Results and discussion

The study also evaluates regression results using fixed-effects and GLS methods. Application of Breusch and Pagan's Lagrangian Multiplier Test on the suitability of random effects would result in the robustness of panel data dynamics analysis.

4.1 Regression analysis: Fixed-Effects method

From these results, 94% of the variation among the entities is explained by the model. $Prob > F = 0.0045$ implies that the overall model is significant, and hence, all the predictors combined have a significant effect on $LnGDPp_{Cit}$. $LnICT$ and $LnFD$ are statistically significant at 1%, which indicates that both variables have a positive contribution to $LnGDPp_{Cit}$. However, the coefficient of $LnMANF$ is statistically insignificant. This leads us to believe that $LnGDPp_{Cit}$ is not significantly different for this model. Table 3 shows that most of the variance can be contributed by the differences between entities with a high rho value of 0.85 (Table 4).

Table 4 Results of Fixed-Effects regression

	Coef	T	P-value
Constant	2.531	1.363	0.026
LnICT	3.412	6.074	0.002
LnFD	6.054	3.742	0.005
LnMANF	3.143	0.452	0.067
R-sq	0.94		
Obs	126		
N group	6		
P-Value	0.0045		

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$$LnGDP_{Cit} = 2.531 + 3.412*LnICT_{it} + 6.054*LnFD_{it} + 3.143*LnMANF_{it} \tag{1.1}$$

(0.026) (0.002) (0.005) (0.067)

The regression results show that ICT Diffusion and FD are both strong drivers of GDP per capita; their highly positive coefficients suggest that increasing mobile technology access and better financial services contribute substantially to economic growth. These very low p-values confirm that the relationships are statistically significant, which means the strength and consistency of the impact is evident across the data observed. While the impact of Manufacturing, INF, may be viewed to be insignificant on GDP per capita due to its high p-value, it may imply that Manufacturing stays within manageable levels such that its distortionary impact on economic productivity is minimal, or that the inflationary pressures balance with other macroeconomic policies or structural factors in the observed economies. Combined results point to technological diffusion and financial development as the most relevant determinants of economic performance, while the role of Manufacturing is less important within the same context.

4.2 Regression analysis: Random Effects

The results indicate that the model explains 52.3% of the difference within the area under study, reflecting a balanced interpretive power. There is overall importance to the model through Prob > chi 2 = 0.052, which means that the combined indicators have an impact on economic growth. The coefficients for LnICT (ICT Diffusion) and LnFD (financial development) are statistically significant at the 1% level and positive. This underlines their

$$LnGDP_{Cit} = 3.123 + 6.032*LnICT_t + 7.113*LnFD_{it} + 1.024*LnMANF_{it} \tag{1.2}$$

(0.001) (0.002) (0.005) (0.050)

The significant drivers, as shown by the regression analysis, of GDP growth are ICT Diffusion and FD, as reflected by their highly positive coefficients and extremely low p-values. A relationship of this nature is not only strong but also statistically significant, which can be referred to as the fact that increased access to mobile technology promotes communication, productivity, and market efficiency. Moreover, the expansion of credit supply increases the private sector's investment and economic activity. Both factors are critical in stimulating innovation and entrepreneurship, and in the broadest sense there is an economic dynamic.

Conversely, the high probability of INF Manufacturing is associated with little impact on the model's GDP. This may indicate that the level of Manufacturing was stable compared with the data monitored or not high enough to have any significant impact on economic output. Instead, it may refer to mitigating factors in the form of monetary policies or structural flexibility that neutralize the potential impact of Manufacturing.

significant contribution to per capita GDP growth and validates the hypothesis that technological change and financial development are positively linked to economic performance due to their effects on productivity, innovation, and resource allocation.

However, Manufacturing (LnMANF) is not statistically significant in this model, which may mean that the region's Manufacturing rates remain within an acceptable range or that another factor mitigates its potential negative effects. The R value of 0.614 means a large part of the variation is taken by the variability between entities rather than by variability within entities over time. One would, therefore, say that individual-level attributes or entity-specific features, such as institutional frameworks, economic policies, or structural factors, are crucial determinants of GDP per capita. These findings point out the need for considering cross-entity differences in formulating policies (Table 5).

Table 5 Results of Random-Effects regression

	Coef	T	P-value
Constant	3.123	5.362	0.001
LnICT	6.032	6.253	0.002
LnFD	7.113	3.654	0.005
LnMANF	1.024	8.125	0.050
R-sq	0.614		
Obs	126		
N group	6		
P-Value	0.052		

4.3 Panel data dynamics analysis's sturdiness

Breusch and Pagan Lagrangian Multiplier (LM) test is used to determine whether the random effects model is more suitable than the Oled OLS model. The test also examines the null and void hypothesis that there is no discrepancy between entities (Var (u)), meaning that the random effects model is unnecessary and the Oled OLS model will be more appropriate.

The result of the test, Prob > chibar2 = 0.006, is a p-value less than 0.05, therefore one fails to accept the null hypothesis at 5% significance level or any conventional level. Thus, there is strong evidence to believe that Var(u) ≠ 0, hence justifying the application of the Random Effects Model. Table 5 provides further illustrations and verifies that the Random Effects Model is an appropriate choice in this analysis because it handles random variation across entities [28].

By failing to accept the null hypothesis, we confirm that there is significant variation across entities, and this in turn supports our assertion that the Random Effects Model is a

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more adequate model of data. This model provides a better understanding of the impact of forecasters considering the differences between the two entities. Therefore, the analysis of the team's data using the random effects model must be carried out in agreement with the results of the Breusch and Pagan LM test.

Table 6 LM Test (Breusch and Pagan Test)

	Var	Sd-sq (var)
LnGDP	4.756	1.918
E	3.235	4.852
U	2.512	1.714
Chibar 2(01)	856.68	
Prob>Chibar 2	0.006	

5 Conclusions, policy recommendations and study limitations

This paper evaluates the impact of ICT diffusion and financial development, coupled with other economic variables, on GDP growth in GCC nations. It also makes valuable contributions to the growth literature with Fixed-Effects Within and Random Effects GLS regression estimates for major growth drivers in the region. The Fixed-Effects model estimated that the explanatory variables jointly explained 61.40% of the variation in GDP across the GCC nations, the overall significance of the model indicated by a probability value of Prob > F = 0.052. It showed the positive and statistically significant coefficients of ICT Diffusion and FD at the 1% level each, indicating that the factors positively influence the GDP. However, the Manufacturing (MANF) variable was not statistically significant, therefore its contribution to explaining economic growth in this region was minimal.

The very high rho value of 94% for the Fixed-Effects model shows that the country-specific effects, or rather country-to-country differences, explain a large amount of the variation in the GDP. Similarly, Random Effects GLS model also noted an overall significance model of Prob > chi2 = 0.0045. This model further showed that ICT Diffusion and FD had a positive significant effect on GDP at 1 percent while INF remained insignificant. The high R value of 0.94, which shows that entity-specific variations are very significant in influencing such a variable, confirms other results present in the literature and underlines the fact that country-level differences in economic and structural aspects strongly determine growth outcomes.

The Breusch-Pagan Lagrangian Multiplier test indeed confirmed that the application of the Random Effects model would be necessary, as opposed to the Pooled OLS model. In fact, the results of the test reject the null hypothesis of no variance across entities on the grounds of low probability, hence confirming the adequacy of using the Random Effects model. The fact that structural variations across GCC countries significantly influence growth lends credence to the need for addressing peculiar country-level characteristics in economic policy.

From these results, several policy implications arise for the GCC countries. Since mobile cellular subscriptions were found to impact GDP positively, policymakers should invest more in ICT infrastructure, a fact that agrees with the findings of [29], who note that ICT plays a part in the economic transformation. The need exists for policies that would improve digital literacy, enhance internet access, and develop better mobile networks. Also, the positive relationship observed in domestic bank credit to the private sector and GDP would suggest that financial sector policies to expand access to credit and strengthen banking infrastructure may be a good option. Such policies give the private sector an avenue for investment, and thus the economy should be growing and diversifying.

Although the study found that Manufacturing did not affect GDP statistically, it still is a very important economic stability indicator. To this end, low and stable levels of Manufacturing should be maintained by policymakers to facilitate an enabling environment for growth and avoid further any potential hindrances on the economy. The high rho values in both models indicate that country-specific variations significantly explain variations in GDP and suggest that further diversification efforts may be required to create a situation of balanced and sustainable growth in most sectors, reducing dependence on any single sector or resource. Though quite insightful, this study does acknowledge several of its limitations. Analysis is done based on the current availability of data for the GCC region. This data may not be entirely updated or correct or inclusive. Second, enhancing the quality of data and prolonging the time series would make the results more robust. Third, this research relies only on a very limited number of variables: INF, FD, and ICT Diffusion. Other factors might give an even better view of the situation in the economy, such as government policies, geopolitical factors, or state of the world economy. The threat of endogeneity can appear when one of the explanation variables is correlated with an error term, thus yielding biased results. This could, in turn, be the focus of future research that also tries to minimize the problem of endogeneity by using instrumental variables or other econometric techniques.

Results derived from this study may, therefore, not be generalized to regions holding different economic structures, institutional frameworks, and levels of development. The comparison of different regions could provide an even greater perspective on how these relationships could diverge or converge. Moreover, this study focuses on a certain period, and changes in the relationship between variables might change over time. Further studies should analyse whether the same pattern recurs under different economic regimes or time perspective.

Building on this research, future studies should extend the variables of trade openness, government spending, and foreign direct investment to increase the knowledge base that many factors determine GDP growth in the GCC.

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More work is required to take care of possible endogeneity, and such findings could be made more credible through robustness checks, using various model specifications. Other comparative analyses with countries or regions may decide whether such patterns might be sustained outside of the GCC context, hence how ICT and financial development would play their roles in different economic environments. More pronounced patterns and points of inflection in longer time-series analyses are likely to yield the impact that the diffusion of ICT and the development of financial industries will have on the economy, particularly since the two sectors are still evolving.

The results of this study point out the important role of ICT diffusion and financial development in reinforcing GDP growth in the GCC countries. This paper provides evidence that ICT infrastructure and financial development are key levers of the process of economic development and, consequently, for reaching economic diversification, private sector investment, and financial inclusion. These will help the policy maker in formulating policies that improve the economic performance, build resilience, and spur sustainable growth in the region. Given the possibility of an improvement in economic resilience facilitated by technology-driven financial services, this is an area which deserves collaborative initiatives by policymakers in pursuit of innovation within the ICT and Financial sectors. This may open diversified economic growth opportunities, decrease reliance on oil revenues, and hence encourage the transition of the GCC toward knowledge-based economies.

The findings of the study further confirm an inclusive approach in how ICT and financial development interact with the structural characteristics of the GCC. Given the emphasis on factors peculiar to the region, the research provides useful empirical evidence in formulating policies aimed at exploiting the potentials of ICT and financial infrastructure as drivers of economic growth. Strategic investment in ICT coupled with appropriate financial policies, therefore, offers a feasible way forward towards sustainable economic development within the GCC.

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