https://doi.org/10.48047/AFJBS.6.15.2024.9387-9397

African Journal of Biological Sciences

Journal homepage: http://www.afjbs.com

Research Paper Open Access

Financial development, ICT diffusion and economic growth: Case GCC Countries

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Volume 6, Issue 15, Sep 2024

Received: 15 July 2024

Accepted: 25 Aug 2024

Published: 05 Sep 2024

doi: 10.48047/AFJBS.6.15.2024.9387-9397

Abstract: The study's goal is to find out how the financial sector's expansion and the spread of information and communication technology (ICT) affect the GCC nations' economies. It aims to comprehend how these elements interact to influence regional development and economic performance. The panel data model estimation technique for the GCC countries from 2001 to 2021 was applied. The paper examines factors influencing GDP growth in GCC nations between 2001 and 2021. The GDP was found to be significantly positively impacted by both domestic bank credit to the private sector (DCPSB) and mobile cellular subscriptions (MCS). The rate of inflation (INF) was negligible. with a correlation coefficient of 0.41. The findings of this study can be helpful to academics and researchers studying ICT, financial development, and economic growth, as well as decision-makers in the GCC nations. In a novel way, this study examines how financial development and ICT dissemination interact to influence economic growth in GCC nations.

Keywords: Financial Development; ICT diffusion; Economic Growth; GCC Countries.

1. Introduction

The way we work, learn, communicate, and live has been completely transformed by information and communication technologies, or ICT. ICT is an umbrella term for a wide range of technologies that make it easier to share and transmit information via the internet, wireless networks, telephones, and other digital channels. Almost every facet of our civilization has been profoundly impacted by these technologies. The ability of ICT to enhance communication is one of its main benefits. The development of social media, email, instant messaging, and video conferencing has made it

possible for people to communicate in real time with others anywhere in the globe. This has completely changed the way organizations function by enabling effective cooperation and communication across regional boundaries. ICT has also increased information accessibility, allowing people to have a multitude of resources and knowledge at their fingertips. Additionally, ICT has changed how we operate. With the growing popularity of remote work and telecommuting, employees can now work from any location with an internet connection. For many people, this has improved work-life balance in addition to increasing productivity. Furthermore, automation, data analytics, and other digital tools that optimize performance and simplify operations have increased efficiency across a range of industries thanks to ICT (Androulidakis & Kandus, 2011).

ICT has completely changed how teachers and students learn in the realm of education. Education is now more accessible and interesting thanks to virtual classrooms, instructional apps, and online learning platforms. With the availability of lectures, assignments, and materials online, students can now engage in self-directed and customized learning. All things considered, ICT is essential for fostering innovation, economic expansion, and societal advancement. With the way technology is developing, there is no end to how ICT may change the world. In order to shape the future of our globally interconnected world, it will be imperative that we embrace and fully utilize information and communication technologies.

Information and communication technologies (ICT) are essential for financial development because they make financial services more accessible, increase transaction efficiency, and stimulate economic growth. ICT makes it possible for mobile payment networks, online financial tools, and digital banking services to grow, improving financial inclusion and accessibility for both individuals and companies. Financial markets are becoming more efficient, safe, and transparent thanks to ICT advancements like internet trading platforms and blockchain technology. Increased financial inclusion, economic empowerment, and general advancement in the global economy are made possible by the synergy between ICT and financial development.

The efficient flow of information and increased productivity in the financial services industry are made possible by information and communication technology (ICT), which stimulates economic growth. Especially in underdeveloped areas, ICT integration increases access to financial services, lowers costs, and streamlines transactions. Improved communication technologies help financial markets make decisions, handle risks, and innovate more quickly, which promotes economic growth. Digital financial services also encourage financial inclusion, which enables people and companies to engage in the formal economy. By boosting productivity, lowering entry barriers, and creating a more vibrant and inclusive financial ecosystem, the interaction between ICT and financial development promotes economic growth and eventually propels general economic expansion.

Financial development and information and communication technology (ICT) are key factors in the economic growth of the Gulf Cooperation Council (GCC) nations. Adoption of ICT increases productivity, speeds up e-commerce, encourages creativity, and pushes the economy away from its reliance on oil. Financial development encourages entrepreneurship and effectively directs investments through strong capital markets and banking institutions. Fintech and digital banking also improve financial inclusion by enabling people and small and medium-sized enterprises to obtain financing and engage in the formal economy. In the GCC, ICT and financial development

work hand in hand to foster resilience, quicken economic growth, and facilitate the shift to knowledge-based economies.

Through the aforementioned, we have posed the following questions: What are the dynamics and interrelationships between financial development and the spread of information and communication technology (ICT) as they relate to each other and to the economic growth of the Gulf Cooperation Council (GCC) countries?

The region's investment plans and policy choices will be greatly aided by this study. Fostering sustainable economic development, diversification, and global competitiveness in Gulf Cooperation Council (GCC) countries requires an understanding of the complex linkages among these elements. This research can help create resilient economies, higher living standards, and more possibilities for residents by determining the best ways to leverage financial infrastructure and ICT breakthroughs. Additionally, it can support regional cooperation and integration, fostering innovation and economic stability throughout the GCC.

The paper consists of six parts; initially, there is an introduction, followed by a section that reviews the existing literature. The third part explains the research methodology, and the fourth part presents the findings. Lastly, there is a section for discussing and drawing conclusions.

2. Literature Review

The spread of ICT and financial development are important factors in economic growth in many geographical areas. Research indicates that financial development indicators, such as stock market capitalization and domestic loans to the private sector, have a stronger positive influence on economic growth in high-income nations than ICT indicators (Alpon et al., 2023). The positive impact of ICT diffusion, particularly mobile and internet penetration, becomes evident in promoting economic growth in WAEMU countries, on the other hand, even though financial development initially shows a significantly negative direct effect on economic growth Daniel & Drissa, (2022). This is especially true once a certain threshold of ICT diffusion is reached. Furthermore, studies on the BRICS countries show that there is a dynamic relationship between ICT penetration and economic growth, with fixed broadband and mobile cellular subscriptions having short-term positive effects and R&D spending and ICT goods imports having long-term positive effects (Yelkesen, 2023). Furthermore, in Asian developing economies, the combined impact of ICT progress and financial development is highlighted, showing that while ICT alone may hinder economic growth, its integration with financial development leads to a significant positive impact on economic progress (Tarik et al, 2022). The complex interactions between financial development, ICT dissemination, and economic growth are shown by these studies combined, highlighting the significance of utilizing these variables in concert to promote sustainable economic development.

Examining the relationship between financial development, ICT dissemination, and economic growth, the literature review considers both individual countries and cross-sectional countries. Mugabe et al. (2022) demonstrate a highly positive interaction between financial development and ICT penetration, validating the positive impact of ICT factors on economic growth in the MENA area. On the other hand, Mounir et al. (2022) discover that while ICT has a beneficial impact on GDP in MENA nations, finance has a negative effect. Drama and Guy (2022) note that while ICT diffusion has a favorable growth impact, financial development has a negative impact on economic

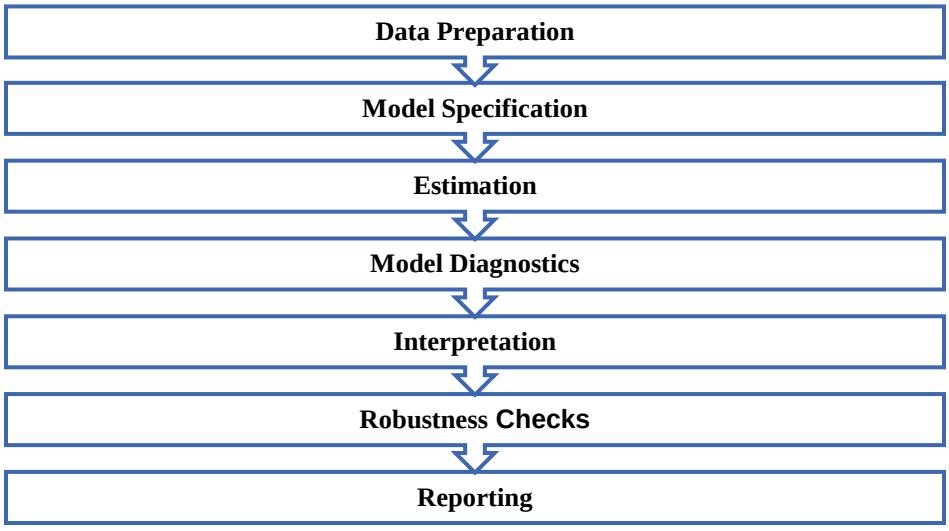
growth in the WAEMU zone. Thanh et al. (2022) provide evidence, using a proxy for growth and volatility interaction, for the beneficial effects of ICT diffusion on growth and its volatility.
Muhammad et al.'s (2023) single-country research show that technological innovation and ICT have a detrimental impact on Turkey's financial development, whereas globalization and economic expansion have beneficial effects. Although there is conflicting data about ICT diffusion's influence on economic growth, Zouhaier et al. (2021) conclude that it favorably moderates financial development and economic growth in Saudi Arabia. According to Sakiru et al. (2021), there is a direct correlation between Malaysia's electricity use and ICT growth. With an emphasis on Chinese cities, Qingsi and Yanrui (2022) demonstrate how ICT can help improve city efficiency and facilitate the spread of technology, with distance having no effect on this process.
The research emphasizes the intricate connections between financial development, ICT diffusion, and economic growth overall. While most people agree that ICT has a good impact on economic growth, different countries and areas have different consequences from financial development. Furthermore, the relevance of technology improvement in propelling economic progress is shown by the moderating function of ICT dissemination between financial development and economic growth. Nevertheless, inconsistent results among studies point to the need for more investigation to fully grasp the complex dynamics and consequences for policy of these interactions in many settings.
The banking industry in the Gulf Cooperation Council (GCC) countries is greatly advanced by the application of artificial intelligence in information and communication technology, which in turn leads to higher economic growth. We list the following works that have examined artificial intelligence in information and communication technology: Sekerci & Alp, (2023); Eli-Chukwu et al., (2019).

3. Methodology and data

This part will include the study's methodology, a statistical analysis of the study variables, and the sources from which the study's data were gathered.

3.1 Methodology

We employ the Panel Data technique in this investigation, which entails multi-dimensional data analysis incorporating measurements made across time. In comparison to merely cross-sectional or time-series analyses, this technique improves the efficiency of econometric estimates, accounts



for individual variation, captures changes across time, and yields more accurate and thorough insights. Figure 1 summarizes the empirical methodology.

Figure 1. Empirical methodology

3.2 Data and descriptive statistics

We determined the expected impact of each study variable and gathered data based on the World Bank's World Development Indicators (WDI) prior to building the model. Table 1 provides a summary of this.

Table 1. Definitions and sources of variables

Proxy	Definition	Source
GDP	Gross Domestic production Product	
FD	Domestic credit to private sector by banks (% of GDP)	WDI
EG	GDP growth (annual %) or GDP per capita growth (annual %)	
ICT	ICT diffusion: Internet Penetration Rate (Individuals using the Internet (% of population)) or Mobile Phone Penetration (Mobile cellular subscriptions (per 100 people))	
INF	Inflation, GDP deflator (annual %)	

3.3 Model Specification

The model's functional shape looks like this:

$$GDP_{it} = \beta_0 + \beta_1 * MCS_{it} + \beta_2 * DCPSB_{it} + \beta_3 * INF_{it} + U_{it} \qquad (1)$$

Where:

GDP_{it}: Gross Domestic production Product in country i at the time t.
MCS_{it}: Mobile cellular subscriptions (per 100 people) in country i at the time t.
$DCPSB_{it}$: Domestic credit to private sector by banks (% of GDP) in country i at the time t.
INF_{it}: Inflation, GDP deflator (annual %) in country i at the time t.
U_{it}: error term.

3.4 Correlation analysis

The weak correlations between GDP and MCS, DCPSB, and INF in Table 2 indicate that there is no significant relationship between GDP fluctuations and these variables. Additionally, MCS has a weak negative connection with INF and a strong positive correlation with DCPSB, suggesting that greater MCS values are marginally correlated with lower INF levels and substantially correlated with higher DCPSB values. There is a moderate negative association between DCPSB and INF, indicating that INF tends to decrease as DCPSB increases.

It's crucial to keep in mind that correlation does not imply causation, even while these correlations shed light on the links between the variables. The type and strength of these correlations require more investigation, such as regression.

Table 2. Correlation matrix

	GDP	MCS	DCPSB	INF
GDP	1			

MCS	0.2165	1		
DCPSB	-0.0732	0.4963	1	
INF	-0.0507	-0.2386	-0.308	1

4. Empirical findings

4.1 Fixed-Effects (Within) Regression Results:

In these results 41.70% of the variation among the entities is explained by the model. Prob > F = 0.0000 indicates that the model as a whole is significant, meaning that the predictors together have a significant impact on GDP. At the 1% level, the coefficients for MCS and DCPSB are statistically significant, indicating that they both have a positive effect on GDP. INF's coefficient is not statistically significant, which suggests that this model's GDP component is not significantly affected. Table 3 illustrates that a significant amount of the variance can be attributed to variations between entities, as indicated by the high rho value of 0.949.

Table 3. Fixed-Effects Regression Results

	Coef	**t**	**P-value**
INF	1.03e+8	0.27	0.787
MCS	6.06e+8	6.05	0.000
DCPSB	7.15e+8	2.84	0.005
C	1.03e+8	1.19	0.235
R-sq	0.417		
Obs	126		
N group	6		
P-Value	0.000		

$$GDP_{it} = 1.03E+8 + 6.06E+8*MCS_{it} + 7.15E+8*DCPSB_{it} + 1.03E+8*INF_{it} \quad (1.1)$$

(0.235) (0.000) (0.005) (0.787)

With both having strong positive coefficients and extremely low p-values, the regression equation shows that GDP increases significantly with more Mobile Cellular Subscriptions (MCS) and Domestic Credit to Private Sector by Banks (DCPSB). Nonetheless, the high p-value of inflation (INF) indicates that its impact on GDP is negligible.

4.2 Random Aspects GLS Regression Analysis:

In these results 41.70% of the variation within the entities is explained by the model. Prob > chi2 = 0.0000 indicates that the model as a whole is significant, meaning that the predictors together have a significant impact on GDP. At the 1% level, the coefficients for MCS and DCPSB are

statistically significant, indicating that they both have a positive effect on GDP. INF's coefficient is not statistically significant, which suggests that this model's GDP component is not significantly affected. Table 4 shows that a significant amount of the variance can be attributed to differences between entities, as indicated by the high rho value of 0.919.

Table 3. Random-Effects Regression Results:

	Coef	**t**	**P-value**
INF	1.08e+8	0.29	0.775
MCS	6.03e+8	6.10	0.000
DCPSB	7.29e+8	2.93	0.004
C	8.06e+8	5.36	0.000
R-sq	0.417		
Obs	126		
N group	6		
P-Value	0.000		

$$GDP_{it} = 8.06E+8 + 6.03E+8*MCS_{it} + 7.29E+8*DCPSB_{it} + 1.08E+8*INF_{it} \quad (1.2)$$

(0.000) (0.000) (0.004) (0.775)

The regression equation shows that GDP increases significantly with more Mobile Cellular Subscriptions (MCS) and Domestic Credit to Private Sector by Banks (DCPSB). It also exhibits high positive coefficients and exceptionally low p-values. The high p-value of inflation (INF) indicates that it has little effect on GDP.

4.3 Lagrangian Multiplier Test for Random Effects by Breusch and Pagan

In contrast to the Pooled OLS Model, the Breusch and Pagan Lagrangian Multiplier (LM) test is used to evaluate the suitability of the Random Effects Model. The test investigates the null hypothesis that there is no variance among entities (Var(u)), suggesting that the Random Effects Model need not be utilized and that the Pooled OLS Model would be a better option.

Prob > chibar2 = 0.0000: The null hypothesis is rejected at the 0.05 significance level (or at any conventional significance level) because the p-value is zero. Put another way, there is substantial evidence that the variation between entities (Var(u)) is not zero, supporting the suitability of the Random Effects Model (see Table 5).

Table 5. Breusch and Pagan LM Test

	Var	**Sd-sq(var)**
GDP	3.81E+22	1.95E+11

e	2.26E+21	4.76E+10
u	2.59E+22	1.61E+11
Chibar 2(01)	924.67	
Prob>Chibar 2	0	

We may infer that the Random Effects Model, which takes into account the random variance between entities, is more appropriate for your analysis based on the findings of the Breusch and Pagan LM test. As a result, you should continue with your panel data analysis using the Random Effects Model. We reject the null hypothesis—which states that there is no variance between entities—based on the test result. These findings suggest that the Random Effects Model is a better fit for your data study.

5. Conclusion, Policy Implications and Limitations

This study looked at the effects of ICT spread, financial development, and other economic factors on economic growth in the Gulf Cooperation Council (GCC) nations. Significant insights into the drivers of GDP growth were discovered by the research using Fixed-Effects (Within) and Random Effects GLS regression models. With a significant overall model (Prob > F = 0.0000), the Fixed-Effects Regression Analysis revealed that the model explained 41.70% of the variation among the entities. The positive impact on GDP was indicated by the positive and significant coefficients for Mobile Cellular Subscriptions (MCS) and Domestic Credit to Private Sector by Banks (DCPSB) at the 1% level. The Inflation (INF) variable, however, lacked statistical significance. With a high rho value of 0.949, it was clear that entity differences may account for a large portion of the variance. Similarly, with a significant overall model (Prob > chi2 = 0.0000), the Random Effects GLS Regression Analysis likewise explained 41.70% of the variation within entities. At the 1% significance level, MCS and DCPSB once more demonstrated positive and substantial effects on GDP, whereas INF continued to be non-statistically significant. The high rho value of 0.919 indicated that variations between entities could account for a sizable portion of the variance, this is consistent with the study Levine, (2005). The necessity of employing the Random Effects Model instead of the Pooled OLS Model was assessed using the Breusch and Pagan Lagrangian Multiplier Test. Prob > chibar2 = 0.0000 rejected the null hypothesis that there was no variance among the entities, demonstrating the applicability of the random effects model.

The GCC countries will need to consider several policy options in light of the study's conclusions. Policymakers should keep funding and encouraging the development of ICT infrastructure in light of the considerable positive impact that mobile cellular subscriptions have on GDP, like Sassi & Goaied, (2013) study. This entails developing digital literacy, increasing internet accessibility, and improving mobile networks. The GDP is positively impacted by domestic bank credit to the private sector, which implies that enhancing financial development can promote economic expansion. It is imperative to implement policies that fortify the banking industry, expand corporate credit availability, and stimulate private sector investment. Stable and low inflation is generally beneficial for economic stability, even though the study's inflation variable was not statistically significant. To prevent any potential harm to economic growth, policymakers should keep an eye on inflation and take steps to manage it. The high rho values in both models suggest that entity differences account for a significant portion of GDP variance. This shows that economic

diversification is necessary to promote balanced and sustainable growth across various sectors and lessen reliance on a particular industry or resource.

Although this study offers insightful information, there are several limitations that should be taken into account. The research is predicated on GCC country data that is currently accessible, which may have limitations regarding timeliness, accuracy, and completeness. More comprehensive time series data and higher-quality data may strengthen the findings' resilience. The study makes use of particular variables including INF, DCPSB, and MCS. If taken into account, additional potentially significant elements including governmental policies, geopolitical factors, and worldwide economic situations could offer a more thorough picture. When the explanatory variables have a correlation with the error term, there may be endogeneity problems that could skew the findings. In order to decrease endogeneity, future research could address this by utilizing instrumental variables or other econometric methodologies. The results may not apply to other locations with distinct institutional frameworks, economic structures, or levels of development because they are particular to the GCC countries. Regional comparison studies may yield more comprehensive understanding. The research focuses on a certain era. Variable relationships and economic situations are subject to alter over time. Subsequent investigations may explore the persistence of the noted correlations across diverse temporal epochs or economic circumstances.

Future research could improve on the conclusions of this study by incorporating additional variables like trade openness, government spending, and foreign direct investment to provide a more thorough examination of the factors impacting GDP growth. Reliability can be increased by utilizing techniques to deal with possible endogeneity and by doing robustness tests using various model specifications. To ascertain whether the results are specific to the GCC or if comparable trends can be found elsewhere, comparative research with other nations or areas can be conducted. Longer time periods for analysis can be used to spot trends and modifications in the way that ICT dissemination and financial development affect economic growth over time.

The study concludes by highlighting the important contributions that ICT diffusion and financial development have made to the economic growth of the GCC countries. These findings will be helpful to policymakers who want to improve economic performance.

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