Research Article

ICT Diffusion and the Finance-Growth Nexus: A Panel Analysis on GCC Countries

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Abstract: This study examines the relationship between financial development, economic growth, and the dissemination of information and communication technology (ICT) in a panel of three Gulf Cooperation Council (GCC) nations—Qatar, Oman, and the United Arab Emirates—from 2008 to 2022. Through a panel data analysis using the GMM system, we demonstrated that financial development and economic growth are positively correlated. We also demonstrated how ICT complemented the relationship between finance and growth. In order to increase the impact of the relationship between financial development and the diffusion of ICT in generating economic growth, the research findings emphasize the necessity of encouraging the use of contemporary financial technologies and accelerating the shift to digital financial services through the utilization of existing structures (the Internet and communication services).

Keywords: Financial Development, ICT Diffusion, Economic Growth, Panel Data.

I. INTRODUCTION

Actually, information and communication technology (ICT) is essential to the growth of the information society and can actively support social cohesion, human advancement, and economic growth (Yahyaoui, 2024). Therefore, the development of ICT is often recognized as the main catalyst and important element in fostering economic growth (Tang and Rosidi, 2024; Horvey and Odei-Mensah, 2024). ICT advancements are thought to lower production costs, increase worker productivity and efficiency, and facilitate quick access to data for decision-making (Hussain et al., 2024). Furthermore, it improves the clarity of financial transactions, streamlines various business operations, and accelerates business interactions (Islam et al., 2024). Many countries have been driven to constantly improve their current ICT structures due to the benefits that come with it. Furthermore, integrating artificial intelligence (AI), the Internet of Things, the Metaverse, and other sophisticated data-driven methods is deemed essential in the current Fourth Industrial Revolution (IR4.0) age (Tang and Rosidi, 2024). ICT has, therefore, become a need in our day-to-day lives (Horvey and Odei-Mensah, 2024). In an effort to emulate the advancements made by more established nations in the use of ICT, emerging economies like the GCC (Oman, Qatar, and the United Arab Emirates) have embraced the widespread usage of cutting-edge technologies.

According to Horvey and Odei-Mensah (2024), the diffusion of ICT is widely documented as a vital factor of economic growth in both developed and developing countries. It affects the economy directly as well as indirectly. The economy's competitive edge is increased by direct benefits such as drawing in new foreign direct investment in the ICT industry, generating demand-side economies of scale through network effects, and promoting innovation and education. ICT affects other sectors of the economy in several indirect ways as well. In many areas of a nation, ICT is essential for increasing the profitability of foreign investment. It also makes it easier for people to absorb the knowledge and advantages of foreign investments (Behera et al., 2024).

Furthermore, it provides effortless access to a diverse range of economic products and services that improve financial inclusion and promote financial development in the economy (Verma and Giri, 2022). The corporate, financial, and economic sectors all benefit from this (Horvey and Odei-Mensah, 2024). ICT encourages private investment, increases government transparency, and stimulates commercial innovation (Behera et al., 2024). Conversely, the financial system makes it easier to trade, diversify, pool resources, pool risks, mobilize funds, and exchange products and services. By building up capital, mostly through technological advancements, these activities, in turn, support economic expansion (Levine, 1997). Financial institutions also support and foster creativity and innovation. As a result, they choose and finance investments that benefit society, which boosts economic progress (Schumpeter, 1911).

Through a variety of instruments, ICT is becoming more widely acknowledged for its impact on the green economy (Verma and Giri, 2022). To help developing nations achieve sustainable and all-encompassing economic growth, the modern digital shift has both benefits and drawbacks. Therefore, a number of macroeconomic factors, such as ICT infrastructure, financial

development, research and development spending, and the standard of governance in nations, are necessary to realize the possible advantages of ICT and achieve the Sustainable Development Goals (Behera et al., 2024).

Financial development and ICT are crucial drivers of real GDP growth in the GCC countries. ICT adoption increases productivity, accelerates e-commerce, fosters creativity, and moves the economy away from its dependence on oil. Financial development inspires entrepreneurship and effectively channels investment through developed capital markets and banking institutions. According to Alshubiri et al. (2019), fintech and digital banking also promote financial inclusion by allowing individuals and small and medium-sized enterprises to access finance and participate in the formal economy. In the GCC countries, ICT and financial development accelerate economic growth and facilitate the transition to knowledge-based countries.

Through the above, we asked the following questions: What are the dynamics and interrelationships among financial development and the diffusion of ICT in their relationship with each other and with the economic growth of the GCC countries?

The resulting findings demonstrate how economic growth responds favourably and significantly to the interplay between financial development and ICT diffusion. Furthermore, trade openness and economic freedom, two auxiliary variables, have a positive and considerable impact on economic growth. In contrast, inflation affects economic growth negatively. Overall, the results offer pertinent economic implications for policymakers of the GCC countries.

The study's remaining sections are organized as follows. The current literature review is covered in Section 2. The data and methodology used are presented in Section 3. Section 4 presents the empirical findings. Section 5 concludes by outlining the study's key findings and conclusions.

II. LITERATURE REVIEW

A) ICT Diffusion and Economic Growth

In theory, ICT diffusion and economic growth seem closely related. ICT is an inexplicable external factor that results from company or government initiatives and shows up as increases in productivity in actual economic activity. For economists, economic growth is a hotly debated and ever-changing subject.

Smith (1776) established in his groundbreaking theory of economic development that technological advancements in the economy directly lead to gains in worker productivity. Neoclassical ideas (Solow, 1956) noted that economic growth results from gains in labour and productivity through technical advancement, whereas classical theory (Smith, 1776) placed an emphasis on specialization to boost productivity. Therefore, by investing in human capital through nutrition, health care, and education programs, productivity increases. Romer (1986), in contrast to the then-prevailing neoclassical growth theories, proposed a growth model that incorporated technological knowledge as an endogenous factor of development.

The ICT diffusion theory of economic growth, often referred to as the supply-side hypothesis, argues that ICT diffusion has a unidirectional impact on economic growth (Pradhan et al., 2018). This argument is that increased investment in ICT infrastructure and the resulting better utilization improve employment opportunities and firm productivity, which contributes positively to economic growth. The development of ICT infrastructure generates new digital activities, which enhance economic growth.

B) Financial Development and Economic Growth

With theoretical roots in Gurley and Shaw (1955) and Thornton and Poudyal (1990), the second section explores the potential connection between financial development and economic growth. They maintained that the establishment of financial organizations like banks may promote economic growth by maximizing the distribution of resources and accelerating technological advancements in production. Furthermore, according to King and Levine (1993), financial development contributes to the reduction of transaction costs, monitoring expenses, information symmetry, and financial inclusion. Allocative efficiency and the function of the financial system in promoting financial inclusion were the main topics of early endogenous theories (Goldsmith, 1969). However, King and Levine (1993) affirmed financial development because it generates diverse portfolios, lowers risk, boosts liquidity, and boosts demand, which in turn drives economic expansion.

There are conflicting theories regarding the relationship between financial development and economic growth (Franciskovic and Miralles, 2021; Salahuddin and Gow, 2016; Saqib, 2015). First, the idea of economic growth driven by the financial sector contends that economic growth is granger-caused by financial development activities. According to the theory, economic agents who have access to credit and other financial services are better able to maximize social benefit. As a result, the industry becomes more competitive, which raises salaries generally, especially for formerly neglected groups. Economic growth is accelerating as a result. Second, the theory of economic growth-driven financial development (Asongu and Odhiambo, 2019; Sehrawat and Giri, 2016) is predicated on the notion that a growing economy necessitates the provision of new financial services that a larger population will subsequently utilize. More people become economically active as a result of these variables'

expansion of access to financial services. It is anticipated that as the nation's wealth increases, more investment will follow, which will eventually result in the delivery of more advanced financial services that enhance socioeconomic outreach and wealth. Strong economic growth is therefore anticipated to enhance financial development initiatives.

C) ICT Diffusion and Financial Development

The relationship between ICT diffusion and financial development is examined in another section of the research. The causal relationship between ICT diffusion and economic growth is explained by two schools of thinking. According to the first school, the ICT-led financial growth hypothesis, financial development is solely due to ICT infrastructure (Marszk and Lechman, 2019). This idea states that the advancement of ICT will directly lead to the creation of new financial services and products. Digital financial services offer two significant advantages: greater accessibility and the possibility of personalized service delivery. Financial organizations can provide services at reduced prices by using digital architecture to achieve economies of scale and scope. For those who are excluded, these initiatives help increase access to these crucial financial services. ICT development is, therefore, essential to the financial industry's success. These projects help improve access to these essential financial services for excluded people. Therefore, ICT development is vital for the success of financial development initiatives in different countries.

According to Das et al. (2018), the second school of thinking concurs that the spread of ICT is a direct result of financial development. Increased use of financial services and products gives vulnerable and marginalized people the information and resources they need to improve their financial circumstances. Spending on ICT, including smartphones and the internet, has surged as a result of rising purchasing power. Some schools of thought that support this causal direction contend that improved access to cutting-edge financial instruments and skills for underprivileged populations directly leads to higher infrastructure spending in these places. Making such infrastructure expenditures is a necessary first step in developing a modern, technologically sophisticated monetary system.

D) ICT Diffusion, Financial Development and Economic Growth

There is a wealth of research on the relationship between financial development and ICT diffusion. However, little research has looked into the trivariate relationship between financial development, economic growth, and ICT diffusion. Researchers are becoming more interested in the combined effects of ICT dissemination and financial development on economic growth as a result of the expansion of ICT and the financial system, particularly in developing nations.

Most studies on economic growth, whether focusing on the effect of financial development or ICT diffusion, rarely consider the impacts of the interaction between the two. Compared with many sectors, the financial sector has a deeper and wider application of ICT because the diffusion of ICT can significantly promote the operational efficiency of financial institutions. According to Shamim (2007), financial technologies reduce processing costs and information costs and further enhance economic growth. Therefore, in recent years, some papers have focused on the joint impacts of financial development and ICT diffusion on economic growth.

Shamim's (2007) research findings examined the relationships between e-finance technology and economic growth for 61 economies with varying degrees of financial development between 1990 and 2002. He discovered that a high degree of connection, as evidenced by rising numbers of Internet users and mobile cellular subscribers, supports the financial system and, consequently, economic expansion. Regarding the results' practical ramifications, he suggested that emerging nations with fragile banking systems make investments in ICT.

For their part, Andrianaivo and Kpodar (2011) analyzed financial development as a channel through which ICT diffusion effects economic growth in 44 African countries from 1898 to 2007. They demonstrated that mobile diffusion had a bigger influence on economic growth in nations with higher levels of financial inclusion and confirmed that ICT has a favourable impact on economic growth. They also came to the conclusion that nations with high mobile penetration rates typically experience faster economic growth. Sassi and Goaied (2013) observed that the application of the GMM technique in 17 Middle Eastern and North African nations between 1960 and 2009 was favourably significant when they included the interaction effects of ICT and financial development into the economic growth model. Once ICT reaches an acceptable threshold, it clearly promotes financial development and boosts economic growth.

For their part, Das et al. (2018) argued that ICT diffusion and financial system development can contribute to improving economic growth in low-income countries but not in lower-middle-income countries in 43 developing countries from 2000 to 2014. On the other hand, Sepehrdoust and Ghorbanseresht (2019) studied the effect of ICT diffusion and financial development on developing countries of petroleum-exporting countries from 2002 to 2015. They used a composite index of ICT as a proxy of ICT development and found that ICT had a vital role in promoting economic growth. For their part, Abeka et al. (2021) looked at how telecommunications infrastructure related to the relationship between economic growth and financial development in 44 Sub-Saharan African nations between 1996 and 2017. They emphasized that the financial system's ability to support economic

growth may be enhanced by telecommunications infrastructure. Additionally, they contended that establishing a strong telecommunications infrastructure will directly affect economic expansion. The trivariate connection in South Asian connection for Regional Cooperation countries from 2000 to 2017 was also studied by Verma and Giri (2022). They came to the conclusion that financial development and ICT diffusion work together to promote economic growth using sophisticated co-integration methods and Granger causality testing.

Gheraia et al. (2022) studied the relationship between Saudi Arabia's economic growth and financial development between 1990 and 2019 and the moderation of ICT dissemination. They discovered that the financial development interaction term with ICT diffusion has a positive and statistically significant impact on economic growth using the bootstrap ARDL model. They suggested that ICT dissemination increases the indirect effect of financial development on economic growth in addition to having a direct impact. Additionally, they demonstrated how the spread of ICT enhances the contribution of financial development to economic growth. This implies that only when ICTs are advanced will financial development support the Saudi economy.

However, Aziz et al. (2023) examined how financial development and ICT dissemination affected economic growth in ten Asian nations between 2001 and 2017. They demonstrated a clear connection between economic expansion and financial development. However, they discovered that while ICT alone has a detrimental impact on economic growth when paired with financial development, its positive effects are more noticeable. This demonstrates how ICT and financial development work together to produce a synergistic effect on real GDP growth. Verma et al. (2023) looked at the relationship between ICT use, financial development, and economic growth in emerging nations between 2005 and 2019. They found that the dissemination of ICT, financial development, and the openness of trade have a favourable impact on economic growth. Furthermore, a reciprocal causal relationship was revealed between ICT and financial development.

More recently, Behera et al. (2024) studied the effect of ICT on economic growth by considering its interaction with financial development, research and development spending, and foreign direct investment from 2000 to 2020 in 13 newly emerging countries. They indicated that the usage of ICT has a beneficial effect on economic growth. Moreover, they recognized that ICT improves economic growth when it interacts with financial development and research and development spending.

Based on current empirical studies, telecommunication strategies could be pertinent in explaining the influence of financial development on economic growth. This provides a strong foundation for a more in-depth investigation of the ways in which various telecommunications infrastructures might be employed as useful tools in financial policies and initiatives to achieve economic growth in GCC nations.

III. DATA AND EMPIRICAL METHODOLOGY

A) Data

This paper examines a sample of 3 GCC countries, namely, Oman, Qatar and the United Arab Emirates. The choice of countries selected for this study is mainly dictated by the availability of reliable data over the sample period. The panel covers the period 2008-2022.

The World Bank's World Development Indicators (2024) are the source of the core variable of interest (ICT diffusion) and additional control variables. To gauge ICT dissemination, we use the percentage of the population that uses the internet. People who have used the internet in the past three months, regardless of where they are, are considered Internet users. A computer, smartphone, PDA, game console, digital TV, etc. can all be used to access the internet.

We include the level of financial development of a country as another explanatory variable because it helps in making savings and investment decisions. Financial development (FD) is measured by domestic credit to the private sector by banks (% of GDP), which allows for a measure of the degree of intermediation carried out by the banking sector, including credit to the private sector.

The dependent variable is economic growth, proxied by the growth rate of real GDP per capita at 2015 prices in US dollars. Our base model contains the explanatory variables common to most growth regressions shown in the literature:

➢ Initial GDP per capita (log): log of real GDP per capita. A negative coefficient is expected, signifying the existence of conditional convergence between countries (La Porta et al. 1998).
➢ Inflation rate: The growth of the consumer price index measures the annual percentage change in the consumer price index that determines the inflation rate. A negative coefficient is expected because high inflation can deteriorate price competitiveness, leading to negative effects on foreign trade and economic growth (Elder, 2004).

➢ The ratio of imports to exports in GDP is known as the trade openness rate. Specialization in a variety of industries is encouraged by trade liberalization, which has raised economic scales that promote efficiency and productivity (Chang and Mendy, 2012). A positive coefficient is anticipated if economic growth benefits from opening to worldwide trade.

The extended model will also include the following institutional variable:

➢ The Fraser Institute's Economic Freedom of the World index. The freedom of a nation's economic activity is gauged by this indicator. Indeed, smaller governments (Area 1), a more robust legal system and protection of property rights (Area 2), access to sound currency (Area 3), increased freedom of exchange with foreigners (Area 4), and more lenient labour, business, and credit regulations (Area 5) are all associated with higher indexes. According to Azman-Saini et al. (2010), the comprehensive and area scores are all on a scale of 0 to 10, where 10 represents the highest level of freedom and zero is the lowest. This suggests that the more economic freedom there is, the more it contributes to economic growth. Therefore, a positive coefficient is expected. Moreover, the data are obtained from Gwartney et al. (2024).

B) Empirical Methodology

Therefore, the purpose of our empirical study is to examine if ICT diffusion (ICT) plays a significant role in influencing the impacts of financial development (FD) on economic growth in the GCC countries. To this end, we employ a specification that is broadly similar to Abeka et al. (2021). We consider the following model:

$$y_{i,t} = \alpha y_{i,t-1} + \beta_1 FD_{i,t} + \beta_2 ICT_{i,t} + \beta_3 X_{i,t} + \mu_t + \eta_i + \varepsilon_{i,t} \qquad (1)$$

Eq. (1) can also be alternatively written with the growth rate as a dependent variable:

$$Growth_{i,t} = y_{i,t} - y_{i,t-1} = (\alpha - 1) y_{i,t-1} + \beta_1 FD_{i,t} + \beta_2 ICT_{i,t} + \beta_3 X_{i,t} + \mu_t + \eta_i + \varepsilon_{i,t} \qquad (2)$$

The subscript "" represents the period, whereas i represents the country, y is the logarithm of the real GDP per capita, FD is the financial development variable, ICT is the ICT diffusion variable, and X is the matrix of the control variables described in the previous section, μ_t is a time specific effect, η_i is an unobserved country-specific fixed effect and $\varepsilon_{i,t}$ is the error term. Eq. (2) forms the basis for our estimation, where $(\alpha - 1)$ is the convergence coefficient.

Furthermore, to test whether ICT plays a catalytic role in the relationship between financial development and economic growth, we present in the model an interactive term between ICT and financial development. This enables us to observe how much the impact of financial development on growth is influenced by the spread of ICT. To do this, in addition to the normal variables used in the economic growth equation, we include an interaction term in equation (2) that is constructed as the product of FD and the ICT (i.e., FD*ICT) as an extra explanatory variable. It is implied that ICT diffusion can enhance the financial system's ability to provide high levels of economic growth if the interaction term's coefficient is positive and significant.

The empirical model used can be presented as follows:

$$Growth_{i,t} = (\alpha - 1) y_{i,t-1} + \beta_1 FD_{i,t} + \beta_2 ICT_{i,t} + \beta_3 (FD_{i,t}.ICT_{i,t}) + \beta_4 X_{i,t} + \mu_t + \eta_i + \varepsilon_{i,t} \qquad (3)$$

This bias will raise the value of the lagged variable on the right side of real GDP per capita, making it impossible to estimate the dynamic econometric equation (3) using the pooled OLS estimator. In fact, this model shows a positive correlation between lagged real GDP per capita and unobserved country-specific variables. Using fixed and random effects approaches is one way to address this issue, particularly by eliminating country-specific impacts. However, due to endogeneity and/or simultaneity bias, the model cannot be evaluated using the aforementioned methods. In this study, ICT and financial development are regarded as potentially endogenous. Indeed, in the literature on finance and economic growth, the study argues that financial development impacts economic growth. Likewise, economic growth is a determinant of ICT as ICT infrastructure is attracted to countries that experience sustained economic growth (Wolde-Rufael, 2007). Similarly, while ICT can foster financial development, the liberal environment creates a new and large market for the operation of the financial system, and economic growth also affects financial development (Kaushal and Pathak, 2015). Consequently, if these reverse causalities are not modelled in equation (3) and are true, then an estimate of equation (3) would be false.

Blundell and Bond (1998) and Arellano and Bover (1995) created the system method generalized moments (SGMM) estimator to solve these problems. By producing more accurate and less biased estimates, the estimator contributes to increased efficiency. The two-stage SGMM is specifically used in the study because it yields more accurate estimates and is more resilient to autocorrelation and heteroscedasticity than the one-stage estimator. The SGMM estimator likewise addresses the endogeneity issue.

Since the reliability of the instrument is the primary determinant of the consistency of the SGMM estimator, we employ the Sargan test of overidentifying limitations to determine the validity of the instruments. The instruments are considered valid if the null hypothesis of instrument validity, which is assumed by this test, is not rejected. For second-order serial correlations in the first-difference errors, we apply the Arellano-Bond autocorrelation test, which predicts that there ought to be no second-degree autocorrelation among disturbance terms. The SGMM estimator is consistent if the null hypothesis—that the disturbance term is uncorrelated—is not rejected.

IV. EMPIRICAL RESULTS

At the level of Table (1), the results clearly show that the coefficient of the financial development variable is positive and statistically significant at the 5% threshold, which advocates that the financial development, proxied by domestic credit to the private sector by banks (% of GDP), play a vital role in economic growth in the GCC countries. The result means that a 1% increase in financial development will lead to a 0.384% increase in real GDP growth. Our findings corroborate the predictions of the supply-side hypothesis, endogenous growth models, and the findings of some empirical studies, such as those of Al-Jarallah (2022) and Riache et al. (2024).

Table 1. ICT, financial development and economic growth (2008-2022)

Variable	
Initial GDP per capita	-0.537***
	(-5.556)
Financial development	0.384**
	(4.821)
ICT	0.181***
	(2.966)
Financial development*ICT	0.151*
	(2.01)
Inflation	-0.775***
	(-2.984)
Trade openness	0.483*
	(1.966)
Economic freedom index	0.353***
	(2.962)
Constant	2.396***
	(3.308)
R-squared	0.91
AR(2) test (p-value)	0.561
Sargan test (p-value)	0.591

Note: AR(2) is a test of second-order residual serial correlation, while the J-test is the Sargan over-identification test. T-statistics are in parentheses. *, ** and *** indicate a statistical significance at 10%, 5% and 1% levels, respectively.

In Table (1), ICT diffusion is proxied by the individuals using the internet (% of the population). The estimated coefficient of the ICT variable is statistically significant at the 1% threshold, which advocates that ICT diffusion plays a positive role in economic growth in the Maghreb countries. More precisely, the results show that if the ICT increases by 1%, the economic growth will be increased by 0.181%. Thus, this result is consistent with those obtained by Sepehrdoust and Ghorbanseresht (2019).

This study also reveals the regression findings based on interaction specification using an interaction term among financial development and ICT diffusion (FD*ICT). We used the interaction term to determine what was included in this specification. If the term is positive and substantial, it indicates that as ICT spread increases, so does the impact of financial development on economic growth. First, it should be noted that the interaction term is statistically significant at the 10 percent level and positively signed. This finding implies that considering the complementarity and link between financial development and the spread of ICT is necessary for an increased contribution of financial growth to economic growth. Therefore, ICT diffusion can improve the capacity of the financial system in terms of improving economic growth. This result is consistent with that of Verma et al. (2023).

In accordance with the conditional convergence hypothesis, we introduce the natural logarithm, or the beginning GDP per capita, as an independent variable. The conditional convergence hypothesis—which states that when all other growth variables are held constant, nations with lower GDP per capita tend to expand faster—is supported by the initial GDP per capita coefficient, which is negative. According to the neoclassical view, the economy's starting position is, therefore, a key factor in determining economic growth. Economic growth is negatively impacted by initial income, which is consistent with the theoretical analysis and statistically significant at the 1% level. The outcome supports Barro and Sala-i-Martin's (1997) research.

The coefficient of the inflation rate has a negative sign. It is then statistically significant at a 1 percent level, suggesting that a high inflation rate will have an adverse impact on economic growth. The result shows that a 1% increase in inflation would decrease real GDP growth by 0.775%. This finding suggests that inflation harms economic growth. Indeed, inflation reduces the purchasing power of money, discourages investment and consequently slows down economic growth. This clearly supports the works of Sadeghi et al. (2023), who affirmed that high inflation decreases economic growth in Middle Eastern countries. Trade openness is also significant, at a 10 percent level, in explaining the economic growth in Maghreb countries. The positive sign of this variable suggests that the higher the trade openness, the higher the economic growth. The results show that for every 1% change in trade openness, economic growth will increase by 0.483%, suggesting trade openness also has an important effect on economic growth. This finding is in line with the study by Altaee (2018), which found a positive association between trade openness and economic growth.

However, because it increases the productivity of investment, the economic freedom coefficient has a positive sign and is statistically significant at the 1% level, suggesting that economic growth is stronger when economic freedom is high. As a result, real GDP growth will improve by 0.353% for every 1% increase in economic freedom. This result is consistent with the survey by De Haan (2007) and Azman-Saini et al. (2010), who made the case that economic freedom is essential to economic expansion. Furthermore, the calculated regression met both specification tests. The null hypothesis that there is no second-order serial relationship has to be rejected at the 5% level. The regression does not suffer from simultaneity bias because the orthogonality criteria cannot be rejected at the 5% level, as revealed by the Hansen test. This implies that the equation is well stated and that the tools used in the evaluation are reliable.

V. CONCLUSION AND POLICY IMPLICATIONS

This study examines the empirical evidence of the relationship between economic growth and the interaction between financial development and ICT diffusion as well as three drivers of economic activity, namely inflation, trade openness, and economic freedom, for a panel of 3 GCC countries, namely, Oman, Qatar and the United Arab Emirates from 2008 to 2022 by opting for the GMM system in the framework of panel data models. Theoretically, the study considers the function of ICT in supporting financial policies to achieve the objective of promoting economic growth. From the empirical analysis, we drew three significant conclusions. First, financial development and ICT diffusion are shown to be a crucial factor in economic growth in the selected countries. Second, the effects of financial development on economic growth are conditioned by the diffusion level of ICT in particular. Third, the results indicate that inflation affects economic growth negatively. On the other hand, trade openness and economic freedom exert significant and positive effects on economic growth, which is expected, as they are considered the conventional drivers of economic activity.

For GCC officials, the study's conclusions have pertinent economic ramifications. Governments might, in fact, bolster laws and regulations to encourage the use of contemporary financial technologies and supply the necessary infrastructure to facilitate the shift to digital financial services. Additionally, they might enhance digital financial transformation and boost reliance on digital financial services by leveraging the Internet and communications services to create banking and financial services and provide them to beneficiaries in a quick, easy, and safe way. Enhancing the relationship between financial development and ICT spread by taking these steps may be essential to attaining inclusive economic growth.

VI. REFERENCES

[1]   Abeka, M.J, Andoh, E, Gatsi, J.G, and Kawor, S, (2021), "Financial development and economic growth nexus in SSA economies: The moderating role of telecommunication development", Cogent Economics and Finance, 9: 1862395

[2]   Al-Jarallah, R, (2022), "Impact of financial development and resource rents on total factor productivity in Gulf Cooperation Council countries", Global Journal of Management and Business Research, 22(5), 1-9.

[3]   Alshubiri, F, Jamil, S.A, and Elheddad, M, (2019), "The impact of ICT on financial development: Empirical evidence from the Gulf Cooperation Council countries", International Journal of Engineering Business Management, 11, 1-14.

[4]   Altaee, H, (2018), "Trade openness and economic growth in the GCC countries: A panel data analysis approach", International Journal of Business and Economic Sciences Applied Research,11(3), 57-64.

[5]   Andrianaivo, M, and Kpoda, K, (2011), "ICT, financial inclusion, and growth: Evidence from African countries", IMF Working Paper N°73.

[6]   Arellano, M., and Bover, O, (1995). "Another look at the instrumental variable estimation of error-component models", Journal of Econometrics, 68(1), 29-51.

[7]   Asongu, S.A, and Odhiambo, N.M, (2019), "Mobile banking usage, quality of growth, inequality and poverty in developing countries", Information Development, 35(2), 303-318.

[8]   Aziz, T, Khan, M.G.U, Islam, M.T, and Pradhan, M.A.H, (2023), "An analysis on the relationship between ICT, financial development and economic growth: Evidence from Asian developing countries", The Journal of International Trade and Economic Development, 32(5), 705-721.

[9]   Azman-Saini, W.N.W, Law, S.H, and Ahmad, A.H, (2010), "FDI and economic growth: New evidence on the role of financial markets", Economics Letters, 107(2), 211-213.

[10]   Barro, R. J, and Sala-i-Martin, X, (1997), "Technological diffusion, convergence, and growth", Journal of Economic Growth, 2(1), 1–27.

[11]   Behera, B, Haldar, A, and Sethi, N, (2024), "Investigating the direct and indirect effects of Information and Communication Technology on economic growth in the emerging economies: Role of financial development, foreign direct investment, innovation, and institutional quality", Information Technology for Development, 30(1), 33-56.

[12]   Blundell, R, and Bond, S, (1998), "Initial conditions and moment restrictions in dynamic panel data models", Journal of Econometrics, 87, 115-143.

[13]   Chang, C, and Mendy, M, (2012), "Economic growth and openness in Africa: What is the empirical relationship?", Applied Economics Letters ,19(18), 1903-1907.
[14]   Das, A, Chowdhury, M, and Seaborn, S, (2018), "ICT diffusion, financial development and economic growth: New evidence from low and lower middle-income countries", Journal of the Knowledge Economy, 9(3), 928-947.
[15]   De Haan, J, (2007), "Political institutions and economic growth reconsidered", Public Choice, 127, 281-292.
[16]   Elder, J, (2004), "Another perspective on the effects of inflation uncertainty", Journal of Money, Credit, and Banking, 36, 911-928.
[17]   Franciskovic, J.M, and Miralles, F, (2021), "The use of the mobile phone in the rural zones of Peru", Journal of Economics, Finance and Administrative Science, 26(52), 390-399.
[18]   Gheraia, Z, Abid, M, Sekrafi, H, and Abdelli, H, (2022), "The moderating role of ICT diffusion between financial development and economic growth: A bootstrap ARDL approach in Saudi Arabia", Information Technology for Development, 28(4), 816-836.
[19]   Goldsmith, R.W, (1969), Financial Structure and Development, Yale University Press, New Haven.
[20]   Gurley, J.G, and Shaw, E.S, (1955), "Financial aspects of economic development", The American Economic Review, 45(4), 515-538.
[21]   Gwartney, J, Lawson, R, and Murphy, R, (2024), Economic Freedom of the World-2024, Annual Report. Fraser Institute.
[22]   Horvey, S.S, and Odei-Mensah, J, (2024), "Towards economic growth in Sub-Saharan Africa: Is there a synergy between insurance market development and ICT diffusion?", Information Technology for Development, 1-28.
[23]   Hussain, M.N, Li, Z, Yang, S, and Benabdejelil, M, (2024), "Effect of ICT and urbanization on economic growth: new insight from OIC countries", Journal of Global Information Technology Management, 27(2), 100-118.
[24]   Kaushal, L.A, and Pathak, N, (2015), "The causal relationship among economic growth, financial development and trade openness in Indian economy", International Journal of Economic Perspectives, 9(2), 5-22.
[25]   King, R.G, and Levine, R, (1993), "Finance and growth: Schumpeter might be right", Quarterly Journal of Economics, 108(3), 717-737.
[26]   La Porta, R, Lopez-de-Silanes, F, Shleifer, A, and Vishny, R.W, (1998), "Law and finance", Journal of Political Economy, 106, 1113-1155.
[27]   Levine, R, (1997), "Financial development and economic growth: Views and agenda", Journal of Economic Literature, 35(2), 688-726.
[28]   Marszk, A, and Lechman, E, (2019), "New technologies and diffusion of innovative financial products: Evidence on exchange-traded funds in selected emerging and developed economies", Journal of Macroeconomics, 62, 103064.
[29]   Pradhan, R.P, Mallik, G, and Bagchi, T.P, (2018), "Information Communication Technology (ICT) infrastructure and economic growth: A causality evinced by cross-country panel data", IIMB Management Review, 30, 91-103.
[30]   Riache, S, Louail, B, Arous, J.A, and Tayeb, M.E, (2024), "Financial development, ICT diffusion and economic growth: Case GCC countries", African Journal of Biological Sciences, 6(15), 9387-9397.
[31]   Romer, P.M, (1986), "Increasing returns and long-run growth", Journal of Political Economy, 94(5), 1002-1037.
[32]   Sadeghi, M.H, Kalmarzi S.H, and Nademi, Y, (2023), "Inflation and economic growth in East Middle countries: A threshold panel approach", Applied Economics Studies, 12(47), 159-179.
[33]   Salahuddin, M, and Gow, J, (2016), "The effects of Internet usage, financial development and trade openness on economic growth in South Africa: a time series analysis", Telematics and Informatics, 33(4), 1141-1154.
[34]   Saqib, N, (2015), "Review of literature on finance-growth nexus", SSRN Electronic Journal, 5(4), 175-195,
[35]   Sassi, S, and Goaied, M, (2013), "Financial development, ICT diffusion and economic growth: Lessons from MENA region", Telecommunications Policy, *37*(4-5), 252-261.
[36]   Schumpeter, J.A, (1911), The theory of economic development, Cambridge: Harvard University Press.
[37]   Sehrawat, M, and Giri, A.K, (2016), "Panel data analysis of financial development, economic growth and rural-urban income inequality", International Journal of Social Economics, 43 (10), 998-1015.
[38]   Sepehrdoust, H, and Ghorbanseresht, M, (2019), "Impact of information and communication technology and financial development on economic growth of OPEC developing economies", Kasetsart Journal of Social Sciences, 40, 546-551.
[39]   Shamim, F, (2007), "The ICT environment, financial sector and economic growth: a cross-country analysis," Journal of Economic Studies, 34(4), 352-370.
[40]   Smith, A, (1776), "An inquiry into the nature and causes of the wealth of nations", Oxford University Press, London.
[41]   Solow, R.M, (1956), "A contribution to the theory of economic growth", The Quarterly Journal of Economics, 70(1), 65-94.
[42]   Tang, C.F, and Rosidi, M.A.I, (2024), "Investigating the effects of ICT infrastructure on Malaysia's economic growth: Insights from the Solow growth model", Information Technology for Development, 1-16.
[43]   Thornton, J, and Poudyal, S.R, (1990), "Money and capital in economic development: a test of the McKinnon hypothesis for Nepal: note", Journal of Money, Credit and Banking, 22(3), 395-399.
[44]   Verma, A, and Giri, A.K, (2022), "ICT diffusion, financial development, and economic growth: Panel evidence from SAARC countries", Journal of Public Affairs, 22(3), e2557.
[45]   Verma, A, Dandgawhal, P.S, and Giri, A.K, (2023), "Impact of ICT diffusion and financial development on economic growth in developing countries", Journal of Economics, Finance and Administrative Science, 28(55), 27-43.
[46]   Wolde-Rufael, Y, (2007), "Another look at the relationship between telecommunications investment and economic activity in the United States", International Economic Journal, 21(2), 199-205.
[47]   World Bank, (2024). World Development Indicators. World Bank, Washington DC.
[48]   Yahyaoui, I, (2024), "Does the interaction between ICT diffusion and economic growth reduce CO2 emissions? An ARDL approach", Journal of the Knowledge Economy, 15(1), 661-681.