



## The Role of Information and Communication Technologies on Financial Development and Economic Growth: PLS-SEM Approach

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### Abstract

The purpose of this paper is to explore the role of ICT diffusion on financial development (FD) and economic growth (EG) by using the PLS-SEM method. The sample size consists of data from 158 countries for the 2015-2020 time period. Test results indicate that ICT diffusion has positive and substantial direct effects on both FD and EG. A one-unit increase could lead to a 0.836 unit increase in FD and a 0.437 unit increase in EG. Test results show that Internet and telephone usage have a similar substantial effect on FD, while Internet usage has a greater effect on EG than telephone usage, as a one-unit increase in Internet usage could cause an increase of 0.509 units in EG, but a one-unit increase in telephone usage could cause an increase of 0.200 units in EG. Lastly, the findings of this paper support the causality running from FD to EG and the moderating role of FD between ICT constructs and EG. Thereby, the novelty of this study is that it examines the relationship between ICT diffusion (in addition to Internet and telephone use), FD, and EG concurrently using the PLS-SEM method in a large data set and finds robust empirical results supporting the theory.

**Keywords:** ICT, Internet usage, telephone usage, financial development, economic growth, PLS-SEM.

**Jel Codes:** G10, O10, O16, O47

### Bilgi ve İletişim Teknolojilerinin Finansal Gelişmişlik ve Ekonomik Büyüme Üzerindeki Rolü: PLS-SEM Yöntemi

#### Özet

Bu çalışma, PLS-SEM yöntemini kullanarak Bilgi İşlem Teknolojileri (BİT) yayılımının finansal gelişme (FG) ve ekonomik büyüme (EB) üzerindeki rolünü araştırmaktadır. Örneklem büyüklüğü 2015-2020 dönemi için 158 ülkeden elde edilen verilerden oluşmaktadır. Test sonuçları, BİT yayılımının hem FG hem de EB üzerinde olumlu ve önemli doğrudan etkileri olduğunu göstermektedir. BİT'deki bir birimlik artış, FG'de 0,836 birim ve EB'de 0,437 birim artışa neden olabilmektedir. Test sonuçları, internet ve telefon kullanımının FG üzerinde benzer önemli bir etkiye sahip olduğunu ancak internet kullanımının EB üzerinde telefon kullanımına göre daha büyük bir etkiye sahip olduğunu göstermektedir. Ayrıca, internet kullanımındaki bir birimlik artış EB'de 0,509 birimlik bir artışa neden olabilirken telefon kullanımındaki birimlik artış ise EB'de 0.200 birimlik bir artışa neden olabilmektedir. Son olarak, bu makalenin bulguları, FG'nin EB üzerinde olumlu ve istatistiksel olarak önemli doğrudan etkisi olduğunu ve ayrıca FG'nin BİT ve EB arasında olumlu ve önemli dolaylı etkisi olduğunu desteklemektedir. Sonuç olarak bu çalışma Bilgi İşlem Teknolojilerinin yayılımı, FG ve EB arasındaki ilişkiyi, geniş bir veri setinde, PLS-SEM methodunu kullanarak eş zamanlı olarak test etmekte ve teoriyi destekleyecek güçlü ampirik sonuçlar bularak literatüre katkı sağlamaktadır.

**Anahtar kelimeler:** BİT, internet kullanımı, telefon kullanımı, finansal gelişmişlik, ekonomik büyüklük, PLS-SEM

**Jel Kodu:** G10, O10, O16, O47

## 1. INTRODUCTION

For decades, the scientific literature has been investigating sources of development in finance (FD), economic growth (EG), and the nexus between them. However, most of the present academic studies concentrate on the social development indicators of the determinants of FD and EG. Even though the role of new technologies, especially communication and information technologies (ICT), in FD and EG has been ignored for many years, new studies examining this matter have begun to emerge recently.

The dynamic of technology is rapid and continuous. ICT products are spreading rapidly and, day by day, becoming an indispensable part of daily life. These advances in ICT also form the basis of financial and social development and globalization. As reported by the International Telecommunication Union (ITU), as of 2022, almost 5.3 billion people (almost 66% of the global population) are using the internet. This points out a big jump of 24% since the year 2019, with 1.1 billion people considered to have become internet users during that period (International Telecommunication Union, 2023a). Similarly, ITU data shows that in practically half of the countries for which data exists for the period of 2018 - 2020, more than 90% of the population has a mobile phone. Considering the situation in Türkiye; according to the Türkiye Electronic Communications Quarterly Market Data Report 2022/3, the number of fixed telephone subscribers is approximately 11.5 million, and the number of mobile subscribers is approximately 90.8 million. The mobile prevalence rate is 114.6%. Looking at the broadband data, a total of 91.4 million broadband internet subscribers, 18.8 million of which are fixed subscribers and 72.6 million of which are mobile subscribers, have increased by 4.5% compared to the same period of the previous year (Authority Türkiye Electronic Communications, 2022).

Thereby, ICT is widely used in financial services and trade for different purposes; specifically, its well-appreciated contribution is the exchange of information. In financial services and business, the importance of information technology has become increasingly vital. Recently, Wu and Wang (2023: 136) examined the importance of communication technologies for Chinese cities, and their test results indicate that information communication is an important assurance for financial development as it facilitates the flow of information, and information communication penetration rates can lead to the development of finance. Likewise, Akerman et.al. (2022: 133) examine how the adaptation of ICT affects bilateral trade. They find that the adoption of ICT lowers information friction and expands the choice set of importers and exporters; moreover, market participants obtain more financial information and participate in financial transactions.

Although a positive causality from new technologies, especially from ICT to FD and EG, is postulated (Andrianaivo and Kpodar, 2011) in theoretical studies, empirical studies produce mixed results; thereby, there is no consensus about the impact of ICT diffusion, Internet usage, and telephone subscriptions on FG and EG. Hence, this study aims to contribute to the existing literature by analyzing the effect of ICT diffusion on FD and EG and the mediating role of FD between ICT and EG. This study contributes to the literature in the following manner: First, contrary to previous studies testing a couple of countries, in this study, a broad dataset covering 158 countries for the period of 2015-2020 is used to concurrently investigate the impact of ICT on FD and EG and the mediating role of FD between ICT and EG using the PLS-SEM method. Second, three PLS-SEM models are set up to separately examine the effect of (a) overall ICT diffusion (Internet usage, telephone usage, and export data together), (b) Internet usage&subscriptions, and (c) telephone subscriptions on FD and EG. Third, unlike past studies mostly using a single indicator such as banks' credit to GDP or bank branches per 100,000 adults as FD proxy, this study uses a broader set of FD indices reflecting the depth, accessibility, and efficiency of the financial markets and institutions as proposed by Svirydzenka (2016). As a result, these three features make this study stand out from other precedents.

This study is designed as follows: section two introduces the review of the literature. Section three focuses on the research methodology and details of the dataset. Section four provides the analysis results with a discussion. Section five concludes the paper and proposes recommendations for relevant parties.

## **2. LITERATURE REVIEW**

Some recently published articles focus on investigating the impact of technological developments such as information technologies, Internet use, and telephone use on FD and EG and the causality among these variables.

For instance, Sassia and Goaid (2013) tested the impact of FD and ICT penetration on EG in a sample of some MENA countries. They identify a negative linkage between FD and EG but a positive linkage between ICT penetration and EG. They also argue that the interaction between ICT penetration and FD has a positive impact on EG.

Pradhan et al. (2017) study the causal relationship between FD, EG, and ICT in a sample of NEXT-11 countries for the short and long term. They stress that, in the short term, the causal relationship between ICT penetration, FD, and EG depends on the type of ICTs, as Internet usage and fixed broadband seem to lead to FD and EG, while the impact of telephone lines and mobile phones on FD and EG is ambiguous. However, they assert a positive relationship among the ICT types, FD and EG, in the long run.

Das et al. (2018) also investigate the linkage among ICT diffusion, FD, and EG in 43 developing countries. They find that ICT diffusion has a positive effect on the EG, while FD doesn't. Moreover, they argue that the joint effect of ICT and FD on EG is significant and positive for low-income countries; however, the results for lower-middle-income countries are not statistically significant. Fernandez-Portilla et al. (2020) test the impact of ICT on EG for OEDC countries. Their empirical results suggest that ICT drives the EG in developed European countries; specifically, Internet usage and broadband connectivity are of specific importance.

The impact of the Internet and mobile usage on FD in 109 economies is tested by Nguyen et al. (2020). They outline that Internet usage has a significant negative impact on the overall FD; on the other hand, mobile usage has a significant positive impact on the FD. On the other side, Mashadihasanli and Zülfikar (2023) examine the impact of information and communication technologies on economic growth in 35 European countries for the period 2001-2021. They state that telephone lines, mobile use, and internet usage have a positive effect on GDP; however, consumer price index, trade, and final consumption expenditure have a negative effect.

Chien et.al. (2020: 1) examine the non-linear and linear effects of ICT penetration on FD for 81 economies over the period of 1990 – 2015 by employing the generalized-momentum method (GMM) and panel smooth transition regression (PSTR). They find that the telephone and Internet positively influence the high-income economies group and the middle- and low-income economic groups' FD, however, mobile phones have a negative impact on those of the high-income countries yet a positive impact on middle and low income countries. Likewise, the penetration of the Internet and telephones leads to FD in all regions; however, mobile phone penetration positively leads to FD only in Africa. They also postulate strong evidence for the smooth nonlinear impact of ICT diffusion on FD, in which the impact of ICT penetration on FD is positive at the lower level of ICT penetration, but becomes negative at the higher level of ICT penetration.

Cheng et al. (2021) examine ICT diffusion, FD, and EG relationships for 72 economies for the period 2000-2015. They mention that FD is unfavorable for EG for all datasets. ICT diffusion can develop EG in high-income countries, but its effect on middle- and low-income countries is ambiguous. They also emphasize that mobile telephone usage can increase EG in middle-and low-income countries, but the

Internet cannot. Moreover, the interaction effect among ICT and FD has a positive effect on EG at all income levels.

The relationship between ICT, FD, and EG for 10 Asian economies is investigated by Aziz et al. (2022). They argue that the linkage between the expansion of finance and economic progress is positive in the long run. They also claim that ICT hurts economic growth on its own, however, if ICT combines with FD, it positively affects EG. Daud and Ahmad (2022) explore the linkage between financial inclusion, digital technology, and EG using data from 84 economies. They assert that there is a dynamic linkage between digital technology and EG, and digital technology infrastructure plays a role in complementing the effect of financial inclusion on EG.

Lechman and Marszk (2015: 355) explore empirically the association between ICT penetration and the introduction of financial innovations in Brazil, Mexico, Japan, South Korea, and the United States from 2002 to 2012. They examine the association between growing ICT penetration and exchange traded funds (ETFs) market development. They find that in all economies, growth in ICT penetration is prevalent and goes along with the swift development of ETF markets. Additionally, the association between ETF market development and increasing ICT penetration level is found to be positive, robust, and significant in Mexico, Japan, the United States, and South Korea; however, in Brazil, the association is comparatively weak but still positive.

Recently, Verma et al. (2023) investigated the relationship between information and communication technologies (ICT) diffusion, financial development, and economic growth in the panel of developing countries for 2005–2019. They find that ICT diffusion, financial development, and trade openness accelerate growth; however, inflation reduces economic growth. Moreover, they postulate a bidirectional causality between ICT growth and financial development growth and a unidirectional causality from financial development to ICT diffusion in developing countries.

In the bottom line, empirical studies are far from producing a definite conclusion about the relationship between ICT, FD, and EG.

### **3. DATA AND METHOD**

This article examines a dataset of 158 countries, covering the period 2015-2020. The dataset is determined according to data availability. The countries missing more than 5% information in one of the indicators are excluded from the data set, and as a result, 158 economies remain. All indicators of the variables are averaged over the period 2015-2020.

#### **3.3.1. Indicators of ICT Construct**

Six indicators are selected to measure ICT diffusion in economies. Three indicators represent Internet usage and subscriptions, and two indicators represent fixed and mobile phone subscriptions. These five indicators are obtained from the International Telecommunication Union (2023b) database. The last indicator representing the export level of ICT goods to total exports is obtained from the World Bank Databank (2023a). Details of ICT indicators are presented below.

##### **3.3.1.1. Internet usage and subscription indicators:**

- AMBSp100 (Active mobile-broadband subscriptions per 100 inhabitants): refers to the wireless Internet access delivered through cellular towers to digital devices and computers using portable modems.
- FBSs100 (Fixed broadband subscriptions per 100 inhabitants): refers to fixed subscriptions to high-speed access to the public Internet via cable modems, fiber-to-the-home or buildings, and other fixed or wired broadband subscriptions.
- Internet Use% (Individuals using the Internet): refers to the proportion of individuals using the Internet.

### **3.3.1.2. Telephone subscription indicators:**

- FTSp100 (Fixed-telephone subscriptions per 100 inhabitants): refers to the sum of the active number of analog fixed-telephone lines, including VoIP subscriptions, fixed wireless, and fixed public payphones.
- MCSp100 (Mobile-cellular subscriptions per 100 inhabitants): refers to the number of subscriptions to public mobile-telephone service.

### **3.3.1.3. Export indicator:**

- ICT exports% (ICT goods exports% of total goods exports): refers to the percentage of ICT goods exports (which consist of electronic components, communication equipment, computers and peripheral equipment, consumer electronic equipment, and many other technologies and information goods) to total exports.

### **3.3.2. Indicators of financial development construct**

The International Monetary Fund (2023) Database provides various indices to measure the FD level of the economies and to reveal how the countries' financial intermediaries are deep, accessible, and efficient. Measures of FD used in this study are presented below.

- FIA (Financial Intermediaries Access Index): represents data on ATMs and bank branches per 100,000 adults.
- FID (Financial Intermediaries Depth Index): represents data on bank credit to the private sector in percent of GDP, pension funds to GDP, mutual fund assets to GDP, and insurance premiums for life and non-life to GDP.
- FIE (Financial Intermediaries Efficiency Index): represents data on banking sector net interest margin, lending-deposit spread, overhead costs to total assets, return on assets (RoA), return on equity (RoE) and non-interest income to total income.
- FM (Financial Market Development Index): aggregates financial markets depth index, financial market access index, and financial market efficiency indices. Due to substantial missing data on financial market access and efficiency indices, an aggregated single index with financial market depth, access, and efficiency is used instead of each index.

### **3.3.3. Indicator of economic growth construct**

Lastly, annual % growth gross domestic product (GDP) per capita is used as an indicator of EG obtained from the World Bank (2023b) Database. It is founded on a constant local currency. The World Bank Database aggregates it based on constant 2015 prices, expressed in U.S. dollars. As known, GDP is the total of gross value plus all resident producers of the economy including taxes on products, but excluding any subsidies that are not included in the value of the products. Moreover, GDP is determined without taking into account the deductions for depreciation of manufactured assets or the depletion and degradation of natural resources (World Bank, 2023b).

### **3.3.4. Methodology**

In this study, we employ the Partial Least Squares Structural Equation Modeling (PLS-SEM) methodology to explore the relationship among ICT diffusion, FD, and EG. PLS-SEM is a "causal-predictive" (Jöreskog and Wold, 1982) multivariate approach to concurrently examine the complex relationships among the multiple dependent and independent variables. PLS-SEM is a suitable econometric analysis tool when the sample size is small, as in this study, and it doesn't require any distribution assumptions, it is also relatively robust as missing values are less than 5% (Hair et.al, 2022: 19). Moreover, PLS-SEM can straightforwardly deal with formative and reflective measurement models, in addition to single-item constructs.

In the PLS-SEM model, if the indicators of a construct are highly correlated with each other, the construct is modeled as a reflective measurement model; however, if the indicators of the construct represent different characteristics of the construct, it is modeled as a formative measurement model. Thus, indicators of ICT constructs are added to the model as a reflective measurement model, but indicators of the FD construct are included in the model as a formative measurement model, as they measure different characteristics of the financial system such as depth, access, and efficiency (Svirydzenka, 2016).

PLS-SEM can be used in a wide variety of research studies. According to Hair et. al. (2021: 11), PLS-SEM provides greater efficiency in estimating parameters, which is shown by its greater statistical power compared to that of CB-SEM. Greater statistical power refers that PLS-SEM is more likely to derive a particular significant association when it is actually present in the population. Moreover, Hair et. al. (2017: 13) also argue that PLS-SEM is specifically superior to multiple regression in the estimation of mediation effects among the constructs. Thereby, PLS-SEM is best suited to examine the relationship among ICT diffusion, FD, and EG.

#### 4. RESULTS AND DISCUSSION

The ICT diffusion construct is a reflective measurement model, and it is assessed on the grounds of the indicator's reliability, convergent validity, internal consistency reliability, and discriminant validity. Table 1 demonstrates that the reliability and validity requirements of the ICT diffusion construct are met.

**Table 1:** Reflective Measurement Model

Latent Construct	Indicators	Convergent Validity	Internal Consistency Reliability		Discriminant Validity				
		AVE	Cronbach's Alpha	Composite Reliability	Cross - Loadings		Fornell - Larcker Criterion		HTMT
		> 0,50		(rho_c)	EG	ICT	EG	ICT	EG
EG	GDPpCapita	Single-item construct			<b>1.000</b>	0.775	1.000		
ICT	AMBSp100	0.619	0.868	0.903	0.672	<b>0.832</b>	0.769	0.787	0.791
	FBSp100				0.757	<b>0.898</b>			
	FTSp100				0.655	<b>0.852</b>			
	ICTexports %				0.221	<b>0.421</b>			
	InternetUse %				0.710	<b>0.921</b>			
	MCSp100				0.414	<b>0.680</b>			

Similarly, redundancy analysis supports the convergent validity of the formative measurement construct, FD. Likewise, Table 2 shows that the variance inflation factors (VIF) values of indicators of FD are < 5, so collinearity is not an issue. FIE's outer weight is not statistically significant, however, outer loading is statistically significant, so it is considered to be kept in the model as offered by Hair et al. (2021).

**Table 2:** Formative Measurement Model.

Construct	Indicators	VIF	Outer Weights	Outer Loadings
FD	FIA	1.485	0.431 ***	0.821 ***
	FID	3.049	0.435 ***	0.899 ***
	FIE	1.174	0.049	0.426 ***
	FM	3.011	0.270 **	0.866 ***

\*\*\*/\*\*/\* significant at 1/5/10% levels

In the following step, the structural model is assessed. VIF for the predictor variables ICT and FD is 3.317, which is below the threshold of 5, thus the collinearity is not a problem for the structural model. Figure 1 presents the standardized path coefficients among the latent variables, and t-values received from bootstrapping routines are also given in parentheses. On the outer models, the arrows from latent variables to indicators show outer loadings/weights, and t-values in parentheses.

The path coefficients between ICT-FD and ICT-EG indicate that overall ICT diffusion has positive and significant, at the 1% significance level, causal effects on both FD and EG. Remarkably, one-unit development in ICT could lead to a 0.836 unit increase in countries' FD and a 0.437 unit increase in their EG. Hence, ICT diffusion has a substantial direct effect on FD compared to EG. Contrary to Sassia and Goaid (2013) and Das et al. (2018), the test results also support a positive and significant causal effect of FD on EG, which indicates that a one-unit increase in FD could lead to a 0.397 unit increase in EG.

**Figure 1:** The structural model for ICT-FD-EG relationship.

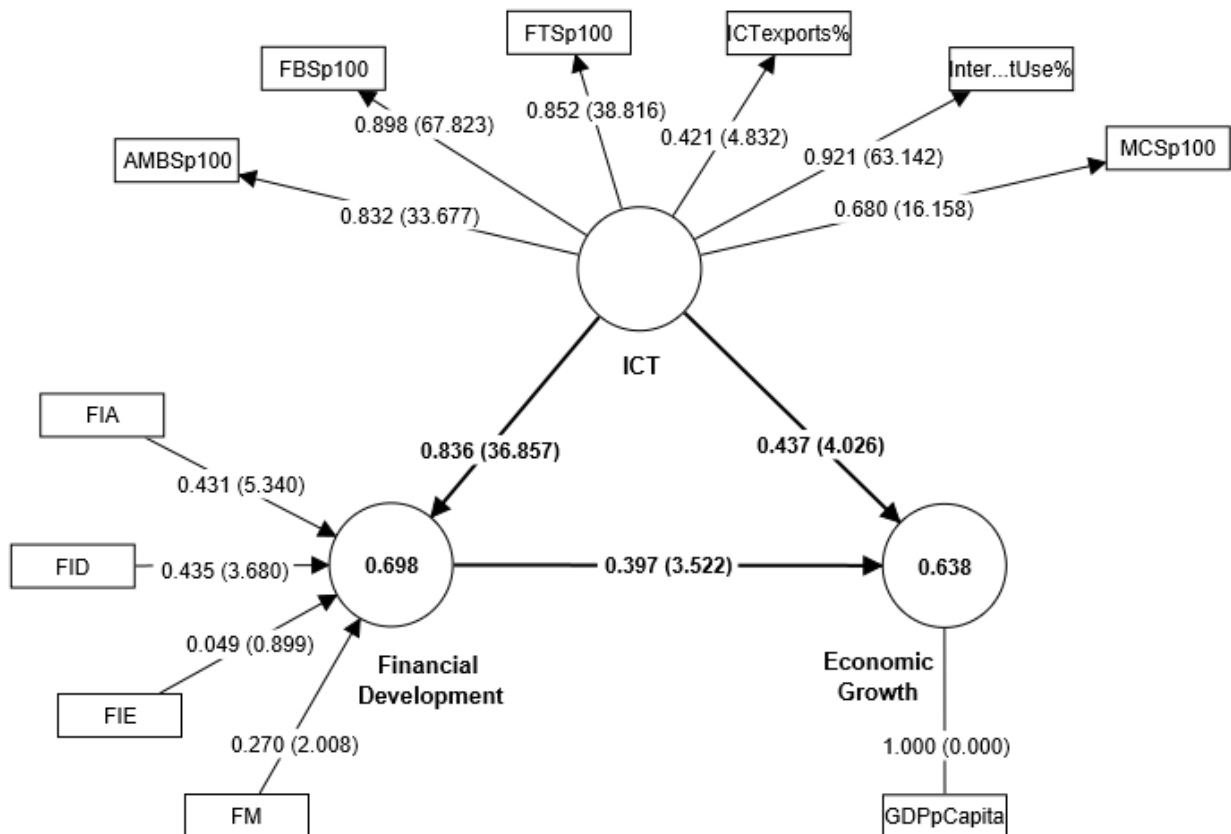


Figure 1 points out the mediating role of FD between ICT diffusion and EG. That is, a change in ICT diffusion leads to a change in the FD, which, in turn, causes a change in the EG. Table 3 displays that the indirect effect (0.331) is statistically significant, and ICT has a positive total effect (0.772) on EG. Interestingly, ICT diffusion has a substantial direct effect on FD (0.836), which is even greater than its total effect on EG (0.772).

Moreover,  $R^2$ , given in the construct ovals in Figure 1, refers to the fact that the ICT construct explains a substantial part (69.80%) of the variance of FD, but ICT and FD together explain the moderate part (63.80%) of the variance of EG<sup>1</sup>. Lastly, Cohen's  $f^2$  test is used to capture the exogenous construct's effect on  $R^2$  of EG.  $f^2$  results in Table 3 show that FD has a small size effect on  $R^2$  of EG (0.131), but ICT has a medium size effect<sup>2</sup> (0.159) on it. This finding is also consistent with the finding that the strength of causality from ICT to EG (0.437) is greater than that from FD to EG (0.397).

**Table 3:** Size of Effects for Figure 1

	Mediator	Direct Effect	Indirect Effect	Total Effect	$f^2$
ICT → FD		0.836***		0.840***	
ICT → EG	FD	0.437***	0.331***	0.772***	0.159**
FD → EG		0.397***		0.397***	0.131***

\*\*\*/\*\*/\* significant at 1/5/10% levels

The findings of this paper support the argument of Andrianaivo and Kpodar (2011) by showing that ICT is crucial for FD and EG. As stressed by Andrianaivo and Kpodar (2011), ICT diffusion improves market functioning and productivity by allowing firms to adopt flexible structures and paving the way for geographical dispersion; thus, firms can take comparative advantage and save on costs. Similarly, test results endorse a strong causality running from ICT to FD as ICT diffusion greatly contributes to countries' financial systems in various ways, such as facilitating access to financial products and services, enabling better information flows to produce and process information about possible investments and allocations of capital, easing exchange of goods, aiding easier payments and transactions, reducing transaction costs such as eliminating physical bank or insurance company branches, and many more.

Also, the empirical results examining the linkage between Internet usage, FD, and EG are mixed. For instance, Nguyen et al. (2020) assert a negative relationship between Internet usage and FD; on the other side, Cheng et al. (2021) claim that mobile telephone usage can increase EG, but internet usage does not. Thereby, to test these arguments in the PLS-SEM model, we replace the ICT construct with the internet usage&subscriptions construct as seen in Figure 2.

<sup>1</sup> Chin (1998) describes  $R^2$  values of 0.19, 0.33, and 0.67 for endogenous latent variables in path models as weak, moderate, and substantial, respectively.

<sup>2</sup> Cohen (1988) states that  $f^2$  values of 0.02, 0.15, and 0.35 depict small, medium, and large sizes of the explanatory power of the exogenous variables, respectively.



**Figure 2:** The structural model for Internet Usage&Subscriptions-FD-EG relationship.

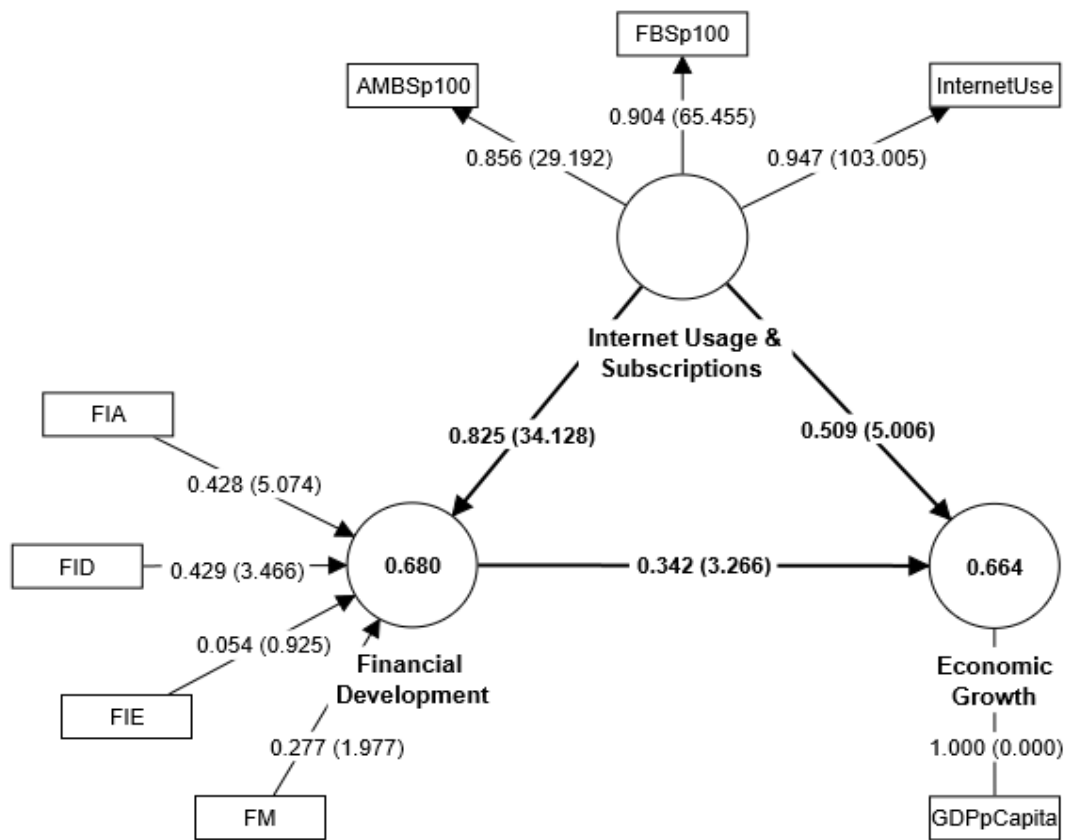


Figure 2 indicates that the internet usage&subscriptions construct has a significant and positive direct effect on FD (0.825) and EG (0.509). When we compare Figure 2 with Figure 1, it is clear that the direct effect of internet usage&subscriptions on FD (0.825) is so close to that of ICT on FD (0.836); however, the direct effect of Internet usage&subscriptions on EG (0.509) is larger than that of ICT on EG (0.437). Table 4 also indicates that the indirect effect of Internet usage&subscriptions on EG is positive and significant (0.282), and  $f^2$  results show that the Internet usage&subscriptions construct has a medium sized effect on  $R^2$  of EG, but the FD construct has a small sized effect on it. Thereby, the substantial effect of the Internet on EG could be due to the fact that the Internet is omnipresent in most business sectors. It could reduce costs and contribute more to innovation and the development of new processes and products.

**Table 4:** Size of Effects for Figure 2

	Mediator	Direct Effect	Indirect Effect	Total Effect	$f^2$
Internet U&S→ FD		0.825***		0.825***	
Internet U&S→ EG	FD	0.509***	0.282***	0.791***	0.247**
FD → EG		0.342***		0.342***	0.111*

\*\*\*/\*\*/\* significant at 1/5/10% levels

Pradhan et al. (2017) assert that telephone usage does not cause FD and EG, yet some researchers argue that it has a positive impact on FD (Nguyen et al., 2020) and EG (Cheng et al., 2021). Thus, to examine these mixed results, telephone subscriptions (fixed phones and mobile phones) construct is added to the PLS-SEM model to examine its impact on FD and EG.

**Figure 3:** The structural model for the Telephone Subscriptions-FD-EG relationship.

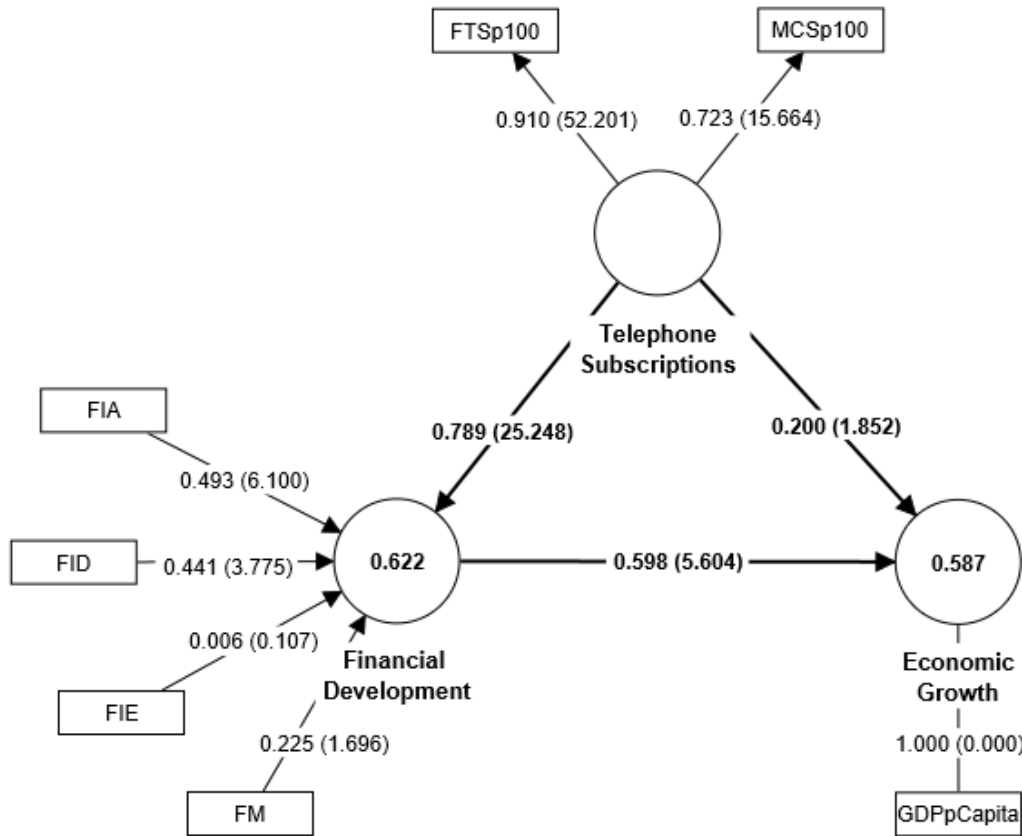


Figure 3 shows that telephone subscriptions construct has a positive and significant direct effect on FD and EG, as do ICT and Internet usage&subscriptions. But, interestingly, the strength of the causality of telephone subscriptions on EG is highly smaller than that of Internet usage&subscriptions. A one-unit increase in Internet usage&subscriptions could lead to a 0.509 unit increase in EG, but a one-unit increase in telephone subscriptions could lead to just a 0.200 unit increase in EG. Furthermore, Table 5 shows that the  $f^2$  coefficient of telephone subscriptions→EG is not statistically significant, but the  $f^2$  coefficient of FD→EG indicates that the FD construct has a medium sized effect on  $R^2$  of EG. Remarkably, the strength of causality running from telephone subscriptions to EG is smaller than that of the Internet usage&subscriptions construct to EG.

**Table 5:** Size of Effects for Figure 3.

	Mediator	Direct Effect	Indirect Effect	Total Effect	$f^2$
Telephone Subs.→ FD		0.798***		0.798***	
Telephone Subs.→ EG	FD	0.200**	0.472***	0.672***	0.037
FD → EG		0.598***		0.598***	0.327**

\*\*\*/\*\*/\* significant at 1/5/10% levels

## 5. CONCLUSION

The results of this paper show that ICT diffusion, Internet usage&subscriptions, and telephone subscriptions have a positive and significant effect on FD. Even though ICT diffusion, Internet usage&subscriptions, and telephone subscriptions have similar substantial impacts on FD, they have varied effects on EG, particularly the Internet usage&subscriptions have a larger direct effect on EG compared to that of telephone subscriptions on EG. Last but not least, FD has a mediating role between each exogenous construct, ICT diffusion, Internet usage&subscriptions, telephone subscriptions, the endogenous construct, and EG.

Even though a positive causality from communication technologies to FD and EG is hypothesized in theoretical studies, empirical studies frequently release mixed results. In addition, many studies examining the relationship among these variables in question generally use a small dataset or focus only on small geographical regions. Moreover, most studies choose to use only one or a few variables to represent ICT diffusion and FD.

Therefore, to fill this gap and mitigate these drawbacks, this study advances the literature providing a detailed analysis by using a comprehensive dataset covering 158 countries for the period of 2015 - 2020. Also, in this study, we use PLS-SEM to concurrently investigate the impact of new information and communication technology diffusion on FD and EG and the mediating role of FD between ICT and EG. Three separate models are set up for this paper. First, the ICT diffusion variable, which consists of indicators of Internet usage, telephone usage, and export data, is used to examine the effect on FD and EG. In the second model, the relationship between Internet use, FD, and EG is examined, and in the last model, Internet use is replaced with telephone use. Moreover, unlike prior studies that mostly use a single indicator for FD, this study uses a broader set of FD indices reflecting the depth, accessibility, and efficiency of the financial markets and institutions.

The results of this study point out that policymakers should increase the usage of ICT as it has a significant effect on the FD and EG of the countries. Policymakers should also be interested in developing ICT training programs for people to exploit the full potential of ICT and improving the physical infrastructure of Internet and telephone technology to boost FD and EG.

The limitation of this study is that we did not group countries according to their level of economic development. In future studies, the linkage among the constructs can be investigated according to economic development levels.

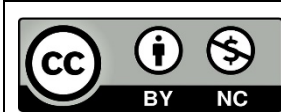
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