

ANALYSIS THE INFLUENCE OF THE INFORMATION AND COMMUNICATION INDUSTRY ON GDP SECTOR AND ECONOMIC GROWTH



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Abstract

This research aims to delve into the influence of the information and communication industry on the economic growth of a country or region. The information and communication industry has become a major driver in the global economic transformation, especially in the rapidly evolving digital era. According to its methodology, this research falls under ex post facto research, examining cause-and-effect relationships. Meanwhile, in terms of data type and analysis, this research is quantitative. This research utilizes the Error Correction Model (ECM) data analysis technique. The results of this research show that the economic growth of Indonesia tends to increase, while the stock prices of information and communication industry companies fluctuate with varying trends of increase and decrease. The information and communication industry has been proven to influence the economic growth of Indonesia positively and significantly.

Keywords: Information Industry, Communication, Economic Growth

INTRODUCTION

Economic growth is one of the most important indicators for describing and analyzing economic development in a country. This is because economic growth indicates the extent to which economic activities can generate additional income for the population. Economic growth is influenced by direct and indirect factors. Examples of direct factors include human and natural resources, capital accumulation, and technological advancements. On the other hand, examples of indirect factors include bureaucracy, interest rates and investment, fiscal policies, and financial system efficiency (Paksi, 2020). The direct factor of technological advancement influencing economic growth aligns with Schumpeter's theory, which emphasizes the role of entrepreneurs in innovating and investing to achieve economic growth (Tanjung, A. A., et al., 2023).

Remeikiene, et al. (2021) revealed that over the last decade, substantial developments in information and communication technology (ICT) have led to various economic and non-economic changes in all countries worldwide. Advances in ICT can significantly affect macroeconomic outcomes and are widely recognized as crucial factors in transitioning towards a new economic system. This transition poses significant challenges for previous command economies characterized by relatively low living standards, poor infrastructure, and continuous changes in economic structures and regulatory frameworks. The development of ICT can have adverse effects on economic activities. Remeikiene, et al. (2021) discuss the role of ICT development in enhancing economic growth in 11 transition economies of the EU (European Union) during the period 2000-2019. The results obtained indicate that ICT development has a positive impact on economic growth in the examined countries.

Kurniawati's research (2021) examines the causal relationship between Information and Communication Technology (ICT) and economic growth in high and middle-income Asian countries. This study utilizes high-quality data from 25 Asian countries from 2000 to 2018. The results illustrate that high-income Asian countries have achieved positive and significant economic development from high Internet penetration. Additionally, middle-income countries have begun to benefit from Internet-based ICT. Findings indicate that telephone and mobile phone penetration significantly drive economic growth in middle-income Asian countries.

Technological advancements have transformed the telecommunications industry worldwide. The shift from legacy telecommunications (voice and SMS) to data-based telecommunications supported by massive Internet development has occurred. The availability of telecommunications infrastructure and access in Indonesia has spurred rapid growth in Internet usage through wireless access. The telecommunications service sector has contributed to Indonesia's GDP as the largest contributor to non-tax state revenue (PNBP) from the Information and Communication sector, through Frequency Usage Fee (BHP) payments (Ministry of Communication and Information, 2018).

Gross Domestic Product (GDP) per capita, which serves as a proxy for living standards in ASEAN countries in Figure 1, shows that Singapore and Brunei Darussalam recorded the highest values in 2019, namely USD 65,232.9 and USD 29,343.3. These values are 13.5 times and 6.1 times the average GDP of other ASEAN countries, which is USD 4,827.4.

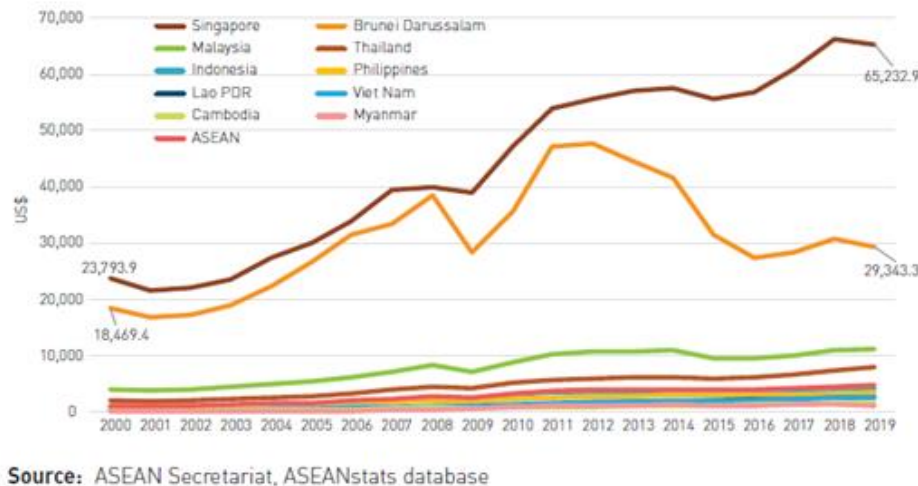


Figure 1
GDP Per Capita of ASEAN Countries (USD), 2000-2019

Like other world countries, ASEAN member countries also realize the importance of the growth of the information technology industry (digitalization) in supporting their economic growth. One indicator of the growth of the information technology industry (digitization) is to look at the number of internet subscribers. The number of internet subscribers for each ASEAN country can be seen in the following graph:

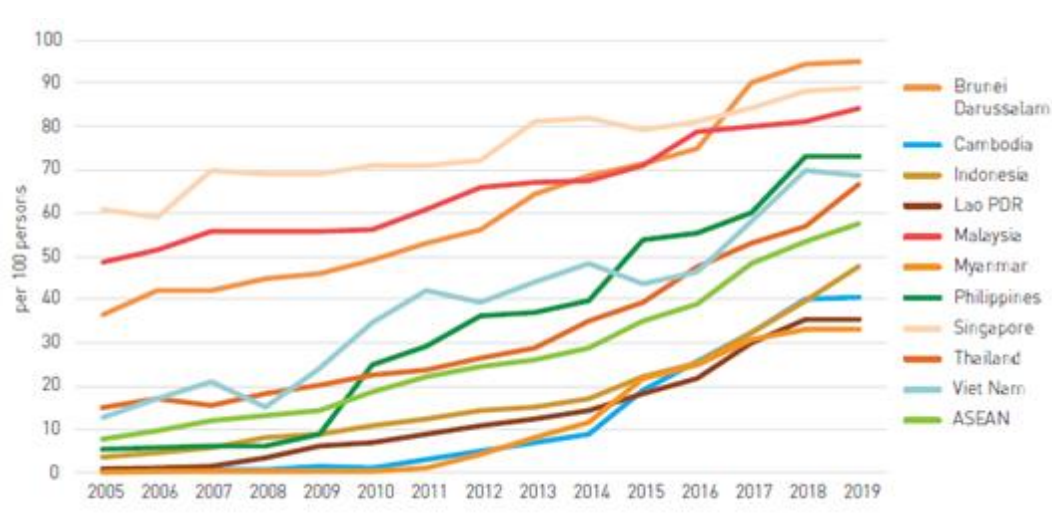


Figure 2
Number of Internet Subscribers Per 100 People in ASEAN Countries 2005-2019

Figure 2 shows that in 2019, the number of internet subscribers in ASEAN reached 57.6 percent per hundred people, increasing sevenfold compared to 2005. Brunei Darussalam, Singapore, and Malaysia achieved the highest milestones, with 95.0, 88.9, and 84.2 percent respectively, per 100 people.

Figures 1. and 2. indicate that the economic growth (GDP) of ASEAN countries is directly proportional to the growth of the number of internet subscribers per 100 people in each country. Meanwhile, in Indonesia, according to BPS (2022), in 2020, the percentage of the population aged 5 years and above who stated that they had accessed the internet in the last three months was around 53.73 percent, increasing to 62.10 percent in 2021. This BPS (2022) record shows a significant gap between the growth of internet subscribers (an indicator of progress in information and communication technology) and GDP growth compared to countries like Brunei Darussalam, Singapore, and Malaysia.

BPS records for 2023 show that Indonesia's GDP for the years 2011-2021, according to the field of business based on constant prices, is as follows:

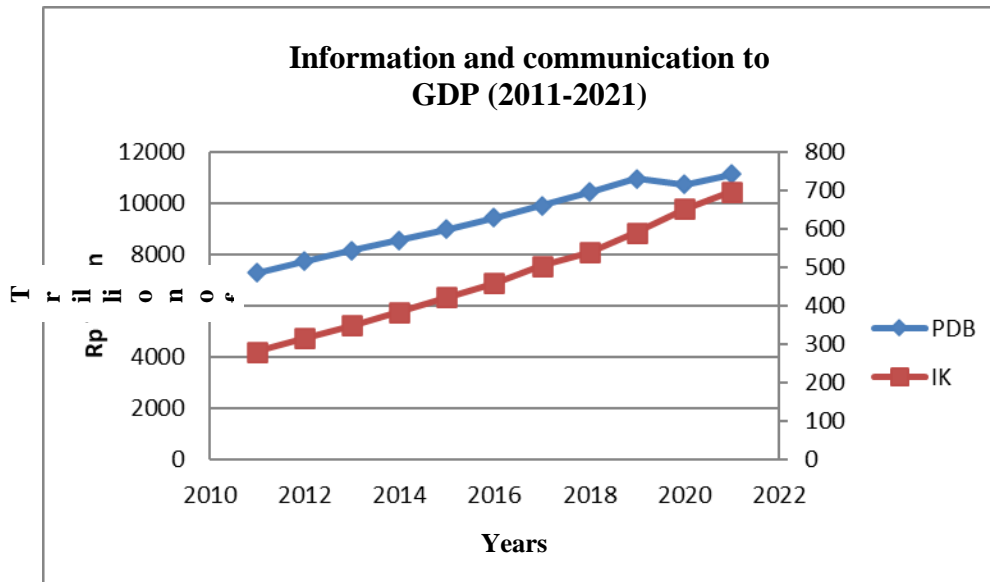


Figure 3
Indonesia's GDP Growth 2011-2021

Figure 1-3 shows that the contribution of the information and communication industry to Indonesia's GDP during the period 2011-2021 exhibits a consistent and increasing trend. Previous research studies on the relationship between the telecommunications industry and economic growth, such as the study by Shodiev et al. (2020), indicate that ICT positively and significantly affects per capita GDP in Central Asian countries. The research by Fawaz et al. (2021) demonstrates that telecommunications infrastructure contributes to economic growth in Latin American countries. Makun and Jayaraman's study (2020) indicates that ICT has a positive and significant impact on the process of economic growth in Pacific countries. The research by Enahoro & Olawade (2021) shows that GSM networks have a direct positive socio-economic impact in Nigeria. Katz and Emara's study (2022) indicates that the significant penetration of mobile broadband-enabled devices contributes to GDP growth in Egypt between 2000 and 2019. On the other hand, Ogbonna et al.'s research (2020) shows that mobile phone subscriptions do not have a positive and significant impact on the growth of the telecommunications sector, and the formation of fixed capital, as well as exports of medium and high technology, remain insignificant in the long run. The causality results indicate a two-way relationship between foreign direct investment and telecommunications GDP. Meanwhile, Sharif's research (2017) suggests that the telecommunications industry may have a strong and positive relationship with economic growth. Tanjung, A. A., et al.'s

study (2022) indicates that in Indonesia, the digital economy has been proven to make a significant contribution to Indonesia's GDP in 2017, reaching 7.3 percent. Based on the description of the relationship between the telecommunications industry and economic growth studies above, it can be identified why this research is important. Previous studies also indicate that the commonly used proxy for economic growth is Gross Domestic Product (GDP).

Information and communication sector companies that went public before 2011 and actively traded stocks consist of:

Table 1
Information and Communication Sector on the Indonesia Stock Exchange (IDX)

No.	IDX Code	Company Name	IPO Date
1	CENT	Centratama Indo Telekomunikasi	01 Nov 2001
2	EXCL	XL Axiata Tbk	Sep 29, 2005
3	FREN	Smartfren Telecom Tbk	Nov. 29, 2006
4	GOLD	Telecommunications Infrastructure Vision	07 Jul 2010
5	ISAT	Indosat Tbk	Oct 19, 1994
6	TBIG	Tower Bersama Infrastruktur Tbk	26 Oct 2010
7	TLKM	Telekomunikasi Indonesia Tbk	Nov. 14, 1995
8	TOWR	Sarana Menara Nusantara Tbk	08 March 2010

Source: Indonesian Stock Exchange 2022

Since the research period spans from 2011 to 2021, the listed companies in the information and communication sector that are studied are those that went public before 2011 and continuously traded during that period.

In the literature review of previous studies related to the relationship between the telecommunications industry and economic growth, the independent variables commonly used include the telecommunications industry with indicators ranging from the amount of ICT investment, broadband penetration, mobile phone subscribers, telecommunications revenue, telecommunications GDP percentage, teledensity, FDI, exports, inflation, market openness, internet access, to electricity availability. In this study, the indicator of the

independent variable of the telecommunications industry used is the performance of telecommunications service provider companies listed on the Indonesia Stock Exchange, as reflected in the stock prices of these companies.

The literature review results from Sulistyowati (2020) indicate that the development of the stock market significantly contributes to economic growth. Meanwhile, Afrizal and Farlian (2017) in their research revealed that capital market variables significantly affect Indonesia's economic growth. Causality test results indicate a two-way relationship between Corporate Bonds and GDP, and a one-way relationship between the IHSG variable and GDP, but Government Bonds have no one-way or two-way relationship with GDP. Vector Error Correction Model (VECM) estimation results also show that current GDP is positively influenced by the IHSG from two periods before, and negatively influenced by Corporate Bonds from two periods before. Meanwhile, Taufiq et al. (2021) in their analysis found that capital market variables significantly affect Indonesia's economic growth. Causality test results indicate a two-way relationship between Corporate Bonds and GDP, and a one-way relationship between the IHSG variable and GDP, but Government Bonds have no one-way or two-way relationship with GDP. VECM estimation results also show that current GDP is positively influenced by the IHSG from two periods before, and negatively influenced by Corporate Bonds from two periods before.

The above descriptions indicate the importance of the telecommunications industry's role in a country's economic growth. Therefore, this study will attempt to verify the influence of the telecommunications industry, represented by the performance of publicly listed telecommunications service provider companies, on economic growth. The above descriptions also indicate that GDP can be used as an indicator of economic growth, and stock prices as an indicator of the telecommunications industry.

REVIEW OF LITERATURE

Economic Growth

For a long time, economists have analyzed the important factors influencing economic growth. Based on the economic growth observed in various countries, it can be concluded that the main factors influencing the growth and development of a country are the richness of its natural resources and land, the quantity and quality of its labor force, available

capital goods, the level of technology used, and the social system and attitudes of the society. The theoretical foundation of development is based on the belief that capitalism is the best system for creating rapid economic development. However, Schumpeter pessimistically forecasted that in the long run, capitalism would experience stagnation. This view aligns with the classical economists' perspective.

According to Schumpeter, the primary factor driving economic development is the process of innovation, with entrepreneurs as the key actors. The economic progress of a society can only be achieved through innovation by entrepreneurs. This economic progress is interpreted as an increase in the total output of the society. In summary, this theory emphasizes the role of entrepreneurs in innovating and investing to achieve economic growth.

In short, Schumpeter's paradigm begins with the production function determined at the industrial level.

$$Y_{it} = A_{it}^{1-\alpha} x_{it}^{\alpha}, \quad 0 < \alpha < 1 \quad (1)$$

Where A_{it} is the productivity parameter inherent in the latest technology used in industry i at time t . In this equation, x_{it} represents the flow of unique products used in this sector. Aggregate output is simply the sum of the specific industry outputs Y_{it} . Each unique product is produced and sold exclusively by the latest innovator. A successful innovator in sector i increases the A_{it} technology parameter and thus can replace the previous innovator as the monopolistic intermediary holder in that sector until replaced by the next innovator.

Like the product diversity model, the Schumpeterian paradigm derives the innovation frequencies μ_m and μ_n from the research arbitrage equation that equates the marginal cost of the innovator from research activities related to the marginal profit of these activities. The solution to the innovator's maximization problem (and thus the arbitrage equation of the researcher) will depend on the economic institutional characteristics such as property rights protection and financial systems, as well as government policies (The Schumpeterian Framework, 2006). In this study, the definition of economic growth is the development of activities in the economy that cause the production of goods and services in society to increase (Sukirno, 2010).

Based on Faisol's research titled "The Influence of Gross Domestic Product (GDP) Growth, Inflation Rate, and Exchange Rate of Rupiah on Indonesian Import Value," it was found that Gross Domestic Product (GDP) is an important indicator that measures the value of production, income, and national expenditure in an economy. GDP includes all final products produced by individuals and companies, both domestically and abroad, in a country's region and specific period, usually within a year. GDP is considered the most representative economic indicator in evaluating the economic development of a country. In economic development theory, GDP has a positive and mutually influential relationship with government spending. GDP itself consists of household consumption, investment, government consumption, and net exports, and serves as the basis for measuring economic growth. Therefore, it can be concluded that the primary indicator of economic growth is Gross Domestic Product (GDP), which reflects the value of production and economic activity in a country.

Information and Communication Industry

Kusmaryanto, in his learning module titled "Telecommunications: Fundamental Concepts of Telecommunications," provides a comprehensive understanding of communication and telecommunications. Communication is defined as a process in which individuals or groups create and utilize information to connect with the environment and others, either in verbal or non-verbal forms. Meanwhile, telecommunications are long-distance communication involving the transmission of information from one place to another. Telecommunications encompasses various types of information such as text, voice, images, and other objects. According to the Republic of Indonesia Law No. 36 of 1999 concerning Telecommunications, Telecommunications refers to any emission, transmission, and/or reception of any information in the form of signs, signals, writing, images, sounds, and noises through wire, optical, radio, or other electromagnetic systems.

Business, economic, social, and other sector needs to drive the importance of easy access to global information and communication, thus telecommunication systems are built to connect individuals worldwide. Telecommunication systems consist of various elements, including infrastructure, devices, facilities, and providers, enabling long-distance communication. Furthermore, the module also provides definitions for several relevant terms, such as telecommunication devices, facilities and infrastructure, telecommunication

providers, telecommunication services, customers, users, and interconnections. With the existing telecommunication systems, individuals can utilize them for various activities in daily life, including work, learning, and leisure. Additionally, information from around the world, such as economic, political, social, cultural, and educational issues, can be accessed through telecommunication systems.

Furthermore, Government Regulation No. 52 of 2000 concerning Telecommunications covers activities aimed at providing telecommunication services and ensuring communication. The provision of telecommunication network involves the provision and related services of telecommunication network infrastructure necessary to support communication. While the provision of telecommunication services focuses on providing network and telecommunication services to facilitate communication. Special telecommunication provision refers to the provision of communication with specific objectives and characteristics that are different from general telecommunication services. Universal service obligations are responsibilities given to network and telecommunication service providers to ensure accessibility and availability of services in areas or for certain communities that were previously not covered by telecommunication network and service provision. All of these definitions serve as important foundations in the regulation and management of telecommunication services, referring to specific regulations and obligations that must be complied with by telecommunication providers.

According to Arief (2011), telecommunication companies in Indonesia have provided various types of telecommunication services, both domestic and international. The offered telecommunication services include fixed and mobile connections, data communication and connection rentals, and various value-added services. The Indonesian Telecommunications Market is highly competitive, and competition has been intense in recent years, especially for the International Direct Connection (SLI) and Long-Distance Direct Connection (SLJJ) sectors, cellular, fixed wireless, and internet data. Telecommunication industry companies are listed on the Indonesia Stock Exchange (IDX) and categorized into the infrastructure sector's Telecommunications subsector. These companies are:

Table 2
Telecommunications Subsector on the Indonesia Stock Exchange (IDX)

No.	IDX Code	Company Name	IPO Date
1	BALI	Bali Towerindo Sentra Tbk	13 Mar 2014
2	BTEL	Bakrie Telecom Tbk	03 Feb 2001
3	CENT	Centratama Telekomunikasi Indo	01 Nov 2001
4	EXCL	XL Axiata Tbk	29 Sep 2005
5	FREN	Smartfren Telecom Tbk	29 Nov 2006
6	GHON	Gihon Telekomunikasi Indonesia	09 April 2018
7	GOLD	Visi Telekomunikasi Infrastruk	07 Jul 2010
8	IBST	Inti Bangun Sejahtera Tbk	31 Aug 2012
9	ISAT	Indosat Tbk	19 Oct 1994
10	JAST	Jasmita Telekomindo Tbk	16 May 2019
11	LCKM	LCK Global Kedaton Tbk	16 Jan 2018
12	MTEL	Dayamitra Telekomunikasi Tbk	22 Nov 2021
13	OASA	Protech Mitra Perkasa Tbk	18 Jul 2016
14	SUPR	Solusi Tunas Pratama	11 Oct 2011
15	TBIG	Tower Bersama Infrastruktur Tbk	26 Oct 2010
16	TLKM	Telekomunikasi Indonesia Tbk	14 Nov 1995
16	TOWR	Sarana Menara Nusantara Tbk	08 March 2010

Source: Indonesian Stock Exchange 2022

Edison et al (2019) stated that stock price is the price of a stock that occurs in the stock market at a certain time determined by market participants. The stock price in the market will reflect the performance of the company, the higher the stock price, the better the company's performance. Because the stock price in the market reflects the performance of the company, the stock price can be used as an indicator of the company. Therefore, in this

study, what is meant by the Telecommunication Industry indicator is the stock price of companies listed on the Indonesia Stock Exchange.

Relationship between Information Communication Industry and GDP

Research by Shodiev et al (2020) shows that ICT positively and significantly influences GDP per capita in Central Asian countries. Ogbonna et al's (2020) study shows that there is a two-way relationship between foreign direct investment and telecommunications GDP. Research by Makun and Jayaraman (2020) shows that ICT-related indicators along with basic variables of capital stock. The effects of control variables such as investment and foreign direct exports have a positive effect on real gross domestic product per capita. Similarly, the study by Katz and Emara (2022) shows that the penetration of mobile broadband-enabled devices significantly contributes to Egypt's GDP growth between 2000 and 2019.

RESEARCH METHOD

This study aims to describe the relationship between the information and communication industry and economic growth. According to its method, this research belongs to ex post facto research. According to Ibrahim et al (2018:66), ex post facto research examines cause-and-effect relationships that are not manipulated or treated by the researcher. Cause-and-effect research is conducted on activities or events that have already occurred. According to the type of data and analysis, this study is quantitative research, with its data being quantitative, thus the data analysis employs quantitative analysis (inferential), systematic, planned, and structured from the beginning to the design of the research (Tanjung, A. A., & Mulyani, S. E., 2021)

The data in this study consist of independent variable data in the form of stock prices of information and communication sector issuers listed on the Indonesia Stock Exchange, and dependent variable data in the form of Indonesia's GDP, published by the Central Statistics Agency. The data for this study are secondary. The population of the dependent variable data is all Indonesia's GDP data. The sample of the dependent variable data is quarterly GDP data in constant prices for the period from 2011 to 2021, published by the Central Statistics Agency. The population of the independent variable data is the quarterly

stock prices of all issuers in the information and communication subsector listed by the Indonesia Stock Exchange.

The sample of the independent variable data is quarterly stock prices for the period from 2011 to 2021. The number of research data samples from each sample of issuers in the information and communication subsector and GDP variables is 44 (quarterly data for the period from 2011 to 2021). In determining the sample, Sugiyono (2019:143) suggests that the appropriate sample size in research is between 30 and 500. The independent variable in this study is the Information and Communication Industry represented by 8 (eight) issuers in the information and communication subsector on the IDX, namely CENT (X1), EXCL (X2), FREN (X3), GOLD (X4), ISAT (X5), TBIG (X6), TLKM (X7), and TOWR (X8), while the dependent variable is Economic Growth (Y).

This study uses the Error Correction Model (ECM) data analysis technique. The usefulness of this model is to address non-stationarity problems and spurious regression in time series data. (Dhewanty et al., 2019). The multiple regression equation of the study is as follows:

Economic Growth	= f (Information and telecommunications industry)
Economic growth	= f (CENT, EXCL, FREN, GOLD, ISAT, TBIG, TLKM, TOWR)
PDB	= f (stock price CENT, EXCL, FREN, GOLD, ISAT, TBIG, TLKM, TOWR)
PDBt	= $\beta_0 + \beta_1 \text{CENT}_t + \beta_2 \text{EXCL}_t + \beta_3 \text{FREN}_t + \beta_4 \text{GOLD}_t + \beta_5 \text{ISAT}_t + \beta_6 \text{TBIG}_t + \beta_7 \text{TLKM}_t + \beta_8 \text{TOWR}_t + \varepsilon$
Information	
PDB	= Indonesia's Gross Domestic Product
k	= Constant
a – h	= Regression coefficient
CENT	= Centratama Telekomunikasi Indo share price
EXCL	= XL Axiata Tbk share price
FREN	= Smartfren Telecom Tbk share price
GOLD	= Vision Telecommunications Infrastructure share price
ISAT	= Indosat Tbk share price
TBIG	= Tower Bersama Infrastruktur Tbk share price
TLKM	= Telekomunikasi Indonesia Tbk share price
TOWR	= Sarana Menara Nusantara Tbk share price
ε	= Standard error

Based on the research multiple regression equation, it can be concluded that the research data is time series data. The unit root test was carried out using the Augmented Dicky Fuller (ADF) method, with the following hypothesis:

H0: there is a unit root (data is not stationary)

H1: there is no unit root (stationary data)

In econometrics, for a model to be said to be good and efficient, it is necessary to carry out a Normality Test using the Jarque-Bera test (J-B test), Multicollinearity Test, Heteroscedasticity Test using the White test, Autocorrelation Test using the Breusch-Godfrey method and often known as the Lagrange Multiplier (LM) method).

RESULTS AND DISCUSSION

Stationarity Test

The stationarity test was carried out on the data to find out whether the time series data used was stationary or not. The results are as follows:

Table 3
Data Stationarity Test

Variable	Stationarity Test	
	Probability Level	Differentiation Probability-1
LNCENT	0.3646	0.0003
LNEXCL	0.1349	0.0000
LNFREN	0.0339	0.0000
LNGOLD	0.5698	0.0000
LNISAT	0.0476	0.0000
LNTBIG	0.5743	0.0000
LNTLKM	0.4435	0.0000
LNTOWR	0.1953	0.0000
LNPDB_TIK	0.1550	0.0000

Table 4. shows that in the level stationarity test, only one variable has a probability < 0.05, namely EXCL, and then in the differentiation-1 stationarity test all research variables have a probability < 0.05. The results of this stationarity test show that the research data is classified as an ECM (Error Correction Model) where the underlying variables have a long-

term general stochastic trend, known as cointegration. So, data analysis was carried out using the Engle-Granger two-step model.

Long-Term ECM Model (Cointegration Model)

The long-term ECM model data processing can be seen in the attachment, with the following calculation results:

Table 4
Long-Term ECM Model Data Processing Results

Variable		Coefficient	Probability	Probability (F Statistics)	R_Squared
Bound	Free				
PDB-TIK	LNCENT	-0.066803	0.0079	0.000000	0.948904
	LNEXCL	-0.298851	0.0000		
	LNFREN	0.061966	0.0140		
	LNGOLD	0.237043	0.0002		
	LNISAT	-0.150397	0.0006		
	LNTBIG	0.202353	0.0023		
	LNTLKM	0.155185	0.0134		
	LNTOWR	0.189869	0.0175		

Source: Data Processing

Long number ECM equation:

$$\begin{aligned}
 \text{PDB_TIK} = & 10.22 - 0.07*\ln\text{CENT} - 0.30*\ln\text{EXCL} + 0.06*\ln\text{FREN} + 0.24*\ln\text{GOLD} \\
 & - 0.15*\ln\text{ISAT} + 0.20*\ln\text{TBIG} + 0.15*\ln\text{TLKM} + 0.19*\ln\text{TOWR}
 \end{aligned}$$

Cointegration Test

Cointegration testing of the long-term ECM model is carried out to determine the balance of the equation variables in the long term. The test results (see attachment) show that the residuals of the econometric equation are stationary at a level with a probability of 0.0000 which is smaller than the research error rate of 0.05. The results of the cointegration test are as follows:

Table 5
Long-Term ECM Model Cointegration Test

	t-Statistic	Prob.*
Augmented Dickey-Fuller Test Statistic	-5.187970	0.0001

Source: Data Processing

Therefore, the long-term ECM model of the study can be used to predict the relationship between variables in the long term.

Classical Assumption Tests

Classical assumption testing can be conducted after the regression model is estimated. In this study, classical assumption tests are performed after estimating the long-term ECM regression. Classical assumption testing (normality, multicollinearity, heteroskedasticity, and autocorrelation) is conducted to ensure that the obtained long-term ECM model is good and efficient. The results of the classical assumption testing (see the appendix) are as follows:

Normality Test

The Jarque-Bera test (J-B test) results show a J-B probability value of 0.546557, which is greater than 0.05, indicating that the normality of the long-term ECM model is confirmed.

Multicollinearity Test

The Variance Inflation Factor (VIF) values of each independent variable are as follows: CENT = 4.089028; EXCL = 2.783767; FREN = 1.941815; GOLD = 2.176415; ISAT = 1.961125; TBIG = 6.963792; TLKM = 3.763223; all are less than 10, except TOWR = 11.53361, which is greater than 10. The multicollinearity test results indicate that overall, the independent variables do not exhibit multicollinearity symptoms.

Heteroskedasticity Test

This test aims to determine whether there is an inequality of variance from one observation to another in the regression model. The Breusch-Pagan-Godfrey test shows a Prob. Chi-Square (8) value of 0.6279, which is greater than 0.05, indicating that the long-term ECM model does not have heteroskedasticity problems.

Autocorrelation Test

This test aims to determine whether there is a correlation among the data in the observation variables. The Breusch-Godfrey Serial Correlation LM Test shows a Prob. F (2,33) value of 0.3023, which is > 0.05 , indicating that the long-term ECM model does not exhibit autocorrelation symptoms.

With the fulfillment of the classical assumption tests requiring normal distribution of residuals, absence of multicollinearity, heteroskedasticity, and autocorrelation, it can be said that the econometric model (long-term ECM model) produced is good and efficient.

Short-Term ECM Model

Data processing of the short-term ECM model yielded the following findings:

Table 6
Short-Term ECM Model Data Processing Results

Variable		Coefficient	Probability	Probability (F Statistics)	R_Squared
Bound	Free				
D(PDB_TIK)	D(LNCENT)	0.001	0.8663	0.113708	0.324692
	D(LNEXCL)	-0.028	0.0155		
	D(LNFREN)	-0.0016	0.6019		
	D(LNGOLD)	0.01	0.3244		
	D(LNISAT)	-0.01	0.5928		
	D(LNTBIG)	0.042	0.0031		
	D(LNTLKM)	0.01	0.7696		
	D(LNTOWR)	0.01	0.6823		
	RES (-1)	-0.08	0.0161		

Source: Data Processing

Table 6 shows the probability of Res (-1) or ECT of $0.0161 < 0.05$ which means it is significant. Meanwhile, the Short-Term ECM model equation is as follows:

$$D(PDB) = 0.006 - 0.007 \cdot D(CENT) - 0.037 \cdot D(EXCL) + 0.004 \cdot D(FREN) + 0.041 \cdot D(GOLD) - 0.048 \cdot D(ISAT) + 0.069 \cdot D(TBIG) + 0.121 \cdot D(TLKM) - 0.033 \cdot D(TOWR) - 0.462 \cdot RES(-1)$$

$$D(PDB_TIK) = 0.02 + 0.001 \cdot D(\ln CENT) - 0.03 \cdot D(\ln EXCL) - 0.002 \cdot D(\ln FREN) + 0.01 \cdot D(\ln GOLD) - 0.01 \cdot D(\ln ISAT) + 0.04 \cdot D(\ln TBIG) + 0.01 \cdot D(\ln TLKM) + 0.01 \cdot D(\ln TOWR) - 0.08 \cdot RES(-1)$$

Because the probability of ECT is significant and has a negative effect on $D(GDP_TIK)$, it is said that the ECM model can be said to be valid, in other words the direction of the variables used will be closer to long-term balance, so that the short-term ECM model can be used.

The influence of share prices of information and communication industry companies on ICT GDP growth

In the long term, share prices of information and communications industry companies positively and simultaneously influence ICT GDP growth. In contrast, in the short term, only

one issuer, TBIG, significantly and positively influences ICT GDP. These results show that in the long term, the influence of stock prices on ICT GDP is as follows:

Influence of LNCENT on LNPDB_TIK

LNCENT has a negative effect on LNPDB_TIK, meaning that if the LNCENT stock price increases by 1% while other independent variables are assumed to be zero, then LNPDB_TIK will decrease by 0.07%. Conversely, if the LNCENT stock price decreases by 1% while other independent variables are assumed to be zero, then LNPDB_TIK will increase by 0.07%.

Influence of LNEXTL on LNPDB_TIK

LNEXCL has a negative effect on LNPDB_TIK, meaning that if the LNEXCL stock price increases by 1% while other independent variables are assumed to be zero, then LNPDB_TIK will decrease by 0.30%. Conversely, if the LNEXCL stock price decreases by 1% while other independent variables are assumed to be zero, then LNPDB_TIK will increase by 0.30%.

Influence of LNFREN on LNPDB_TIK

LNFREN has a positive effect on LNPDB_TIK, meaning that if the LNFREN stock price increases by 1% while other independent variables are assumed to be zero, then LNPDB_TIK will increase by 0.06%. Conversely, if the LNFREN stock price decreases by 1% while other independent variables are assumed to be zero, then LNPDB_TIK will decrease by 0.06%.

Influence of LNGOLD on LNPDB_TIK

LNGOLD has a positive effect on LNPDB_TIK, meaning that if the LNGOLD stock price increases by 1% while other independent variables are assumed to be zero,

then LNPDB_TIK will increase by 0.24%. Conversely, if the LNGOLD stock price decreases by 1% while other independent variables are assumed to be zero, then LNPDB_TIK will decrease by 0.24%.

Influence of LNISAT on LNPDB_TIK

LNISAT has a negative effect on LNPDB_TIK, meaning that if the LNISAT stock price increases by 1% while other independent variables are assumed to be zero, then LNPDB_TIK will decrease by 0.15%. Conversely, if the LNISAT stock price decreases by 1% while other independent variables are assumed to be zero, then LNPDB_TIK will increase by 0.15%.

Influence of LNTBIG on LNPDB_TIK

LNTBIG has a positive effect on LNPDB_TIK, meaning that if the LNTBIG stock price increases by 1% while other independent variables are assumed to be zero, then LNPDB_TIK will increase by 0.20%. Conversely, if the LNTBIG stock price decreases by 1% while other independent variables are assumed to be zero, then LNPDB_TIK will decrease by 0.20%.

Influence of LNTLKM on LNPDB_TIK

LNTLKM has a positive effect on LNPDB_TIK, meaning that if the LNTLKM stock price increases by 1% while other independent variables are assumed to be zero, then LNPDB_TIK will increase by 0.15%. Conversely, if the LNTLKM stock price decreases by 1% while other independent variables are assumed to be zero, then LNPDB_TIK will decrease by 0.15%.

Influence of LNTOWR on LNPDB_TIK

LNTOWR has a positive effect on LNPDB_TIK, meaning that if the LNTOWR stock price increases by 1% while other independent variables are assumed to be zero, then LNPDB_TIK will increase by 0.19%. Conversely, if the LNTOWR stock price decreases by 1% while other independent variables are assumed to be zero, then LNPDB_TIK will decrease by 0.19%.

In the short term, only the TBIG stock has a significant effect on $D(LNPDB_TIK)$, where if the TBIG stock price increases by 1%, then $D(LNPDB_TIK)$ will increase by 0.04%. Conversely, if the TBIG stock price decreases by 1%, then $D(LNPDB_TIK)$ will decrease by 0.04%.

These findings also indicate that stock prices in the information and communication industry have partial and simultaneous effects on the growth of LNPDB in the Information and Communication sector, proxied by LNPDB_TIK based on constant prices. The results of this study are consistent with the research conducted by Shodiev et al (2020), Fawaz et al (2021), Ogbonna et al (2020), Makun and Jayaraman (2020), Sharif (2017), Enahoro & Olawade (2021), Katz and Emara (2022), Ngatono (2016), Lee et al (2011), and Aryanto (2014).

The study by Shodiev et al (2020) indicates that ICT positively and significantly affects GDP per capita in Central Asian countries. The research by Ogbonna et al (2020) shows a two-way relationship between foreign direct investment and telecommunications GDP. The study by Makun and Jayaraman (2020) indicates that ICT-related indicators, along with basic capital stock variables, have a positive effect on real per capita GDP. Similarly, the research by Katz and Emara (2022) demonstrates that the penetration of mobile broadband-enabled devices significantly contributes to the GDP growth of Egypt between 2000 and 2019.

The econometric equation model (long-term equation) shows the ranking of the influence of independent variables on the dependent variable based on their regression coefficients as follows: 1) Rank one positive is LNGOLD with a coefficient of +0.24; 2) The second positive ranking is LNTBIG with a coefficient of +0.20; 3) The third positive ranking is LNTOWR with a coefficient of +0.19; 4) The fourth positive ranking is LNTLKM with a coefficient of +0.15; 5) The fifth positive ranking is LNFREN with a

coefficient of +0.06; 6) The variables LNCENT, LNEXTCL, and LNISAT each have a negative influence.

Table 4.3 also shows the ranking of the influence of the independent variable on the dependent variable based on the significance of the influence, which is as follows: 1) Rank 1 is LNEXTCL which has a p-value of 0.0000; 2) Rank 2 is LNGOLD and LNISAT having a p-value of 0.0003 and 0.0007; 3) Rank 3 is LNTBIG and LNCENT having a p-value of 0.0029 and 0.0089; 4) Rank 4 is LNTLKM, LNFREN, and LNTOWR with p-values of 0.0134, 0.0140, and 0.0175.

The Influence of the Information and Communications Industry on Economic Growth

Based on the ranking of the influence of the independent variables on the dependent variable above, a ranking of the influence of the information and communication industry on the growth of LNPDB_TIK can be arranged as follows:

Table 7
Ranking of the Influence of Independent Variables on LNPDB_TIK

Independent Variable	Influence Ranking Based		Conclusion
	Significance	Regression Coefficients	
LNCENT	3 (p-value 0.0089)	Negative effect	-
LNEXCL	1 (p-value 0.0000)	Negative effect	-
LNFRN	4 (p-value 0.0140)	5	Rank five
LNGOLD	2 (p-value 0.0003)	1	First rank
LNISAT	2 (p-value 0.0007)	Negative Effect	-
LNTBIG	3 (p-value 0.0029)	2	Rank two
LNTLKM	4 (p-value 0.0134)	4	Rank four
LNTOWR	4 (p-value 0.0175)	3	Rank three

Table 7 shows that the independent variables LNFREN, LNGOLD, LNTBIG, LNTLKM, and LNTOWR have a positive influence on the growth of the GDP in the information and communication sector. These results are consistent with previous research by Shodiev et al (2020), Fawaz et al (2021), Ogbonna et al (2020), Makun and Jayaraman (2020), Sharif (2017), Enahoro & Olawade (2021), Katz and Emara (2022), Ngatono (2016), Lee et al (2011), and Aryanto (2014). Meanwhile, the independent variables LNCENT, LNEXTCL, and LNISAT have a negative impact on the growth of LNPDB in the information and communication sector, which is not consistent with previous research.

Table 4.5 also indicates the ranking of the influence of the information and communication industry on the growth of GDP in the information and communication sector, viewed from the perspective of the significance of the influence and the regression coefficients, as follows: 1) The first rank is held by LNGOLD; 2) The second rank is held by LNTBIG; 3) The third rank is held by LNTOWR; 4) The fourth rank is held by LNTLKM; 5) The fifth rank is held by LNFREN.

The findings of this study reveal that during the period from 2011 to 2021, the GDP growth of the information and communication sector showed an increasing trend, while the stock prices of companies in the information and communication industry fluctuated with varying trends of both increase and decrease. The information and communication industry proved to have an impact on the GDP growth of the Indonesian information and communication sector, with the most positive and significant contributions being demonstrated primarily by the companies LNGOLD, LNTBIG, LNTOWR, LNTLKM, and LNFREN.

The findings regarding the relationship between the stock prices of ICT industries and the economic growth of the ICT sector (PDB_TIK) are consistent with the results of the literature review by Sulistyowati (2020), which showed that the development of the stock market significantly contributes to economic growth. Meanwhile, Afrizal and Farlian (2017) revealed in their research that the variables of the capital market significantly affect the economic growth of Indonesia. Additionally, Taufiq et al (2021) found in their analysis that capital market variables significantly influence the economic growth of Indonesia.

One of the important theories of Schumpeter, which forms the basis of his development theory, is the belief that the economic progress of a society can only be achieved through innovation by entrepreneurs. Economic progress is interpreted as an increase in the total output of the society. In summary, this theory emphasizes the role of entrepreneurs who innovate and invest to achieve economic growth. As the ICT industry is known for its innovation and rapid development, the findings of this study support Schumpeter's theory and opinion.

Regarding the research findings showing that TLKM as a state-owned enterprise (SOE) with all its facilities and government preferences only ranked fourth in its contribution to PDB_TIK (losing to private companies), and the negative influence of LNCENT,

LNEXCL, and LNISAT on the information and communication sector's GDP, can be explained in the following figure.

No	Nama Emiten	Kode IDX	Business Profile	Coverage Area	ARPU											Avg ARPU
					2021	2020	2019	2018	2017	2016	2015	2014	2013	2012	2011	
1	Telekomunikasi Indonesia Tbk	TLKM	Penyedia jasa dan jaringan telekomunikasi	Indonesia	44.000	44.000	46.000	41.000	42.000	44.000	43.000	39.000	37.000	37.000	39.000	41.455
2	Indosat Tbk	ISAT	Penyedia jasa dan jaringan telekomunikasi	Indonesia	34.400	31.900	27.900	18.700	20.300	25.200	26.000	27.198	27.979	27.400	28.381	26.851
3	XL Axiata Tbk	EXCL	Penyedia jasa dan jaringan telekomunikasi	Indonesia	37.000	34.000	35.000	32.000	34.000	35.000	34.000	26.000	27.000	31.000	32.000	32.455
4	Smartfren Telecom Tbk	FREN	Penyedia jasa dan jaringan telekomunikasi	Indonesia	28.300	29.600	33.200	44.200	34.600	28.200	21.700	20.600	16.600	15.200	11.600	25.800
5	Visi Telekomunikasi Infrastruktur	GOLD	Penyedia infrastruktur telekomunikasi	Indonesia	-	-	-	-	-	-	-	-	-	-	-	-
6	Tower Bersama Infrastruktur Tbk	TBIG	Penyedia infrastruktur telekomunikasi	Indonesia	-	-	-	-	-	-	-	-	-	-	-	-
7	Sarana Menara Nusantara Tbk	TOWR	Penyedia infrastruktur telekomunikasi	Indonesia	-	-	-	-	-	-	-	-	-	-	-	-
8	Centratama Telekomunikasi Indo	CENT	Penyedia infrastruktur telekomunikasi	Jakarta, Bandung, Denpasar	-	-	-	-	-	-	-	-	-	-	-	-

Figure 4
Issuer Profile and ARPU of TLKM, ISAT, EXCL, and FREN 2011-2021

In the transparency of information in the Indonesia Stock Exchange and the Annual Reports of the Issuers, the following profiles of companies and ARPU (Average Revenue Per User) figures of each service and network provider are provided, where ARPU represents the amount of revenue generated from consumption per user (IDR).

From Figure 4, it is evident that out of 8 independent variables, 4 variables represent companies focused on telecommunications service and network providers, namely TLKM, EXCL, ISAT, and FREN, while the other 4 variables focus on telecommunications infrastructure providers, namely TBIG, GOLD, TOWR, and CENT.

To address the research findings showing the contribution of state-owned enterprises (BUMN), in this case, TLKM, being below that of private companies, it is known that in carrying out their operations, telecommunications service, and network providers lease BTS (Base Transceiver Stations) from telecommunications infrastructure providers. Thus, this aligns with the research findings showing TLKM as a state-owned enterprise ranking fourth in its contribution to PDB_TIK due to the burden of leasing BTS, with the top three being GOLD, TBIG, and TOWR, which are telecommunications infrastructure providers as BTS

lessee companies. However, when grouped into the category of companies operating in the field of telecommunications service and network provision, TLKM provides the largest contribution compared to the other 3 companies, namely FREN (positive), EXCL, and ISAT (negative).

Furthermore, the negative influence of the independent variables CENT, EXCL, and ISAT on the growth of PDB_TIK is due to: Based on figure 4.1, it is known that CENT's service coverage area is only for Jakarta, Bandung, and Denpasar, while for other issuers, the coverage area is nationwide. The negative influence of EXCL and ISAT is indicated by the ARPU figures of these issuers, where ARPU is a measure to determine the average revenue obtained by telecommunications companies from customers. ISAT and EXCL, in the period from 2011 to 2021, are known to have an average ARPU of 26,851 with the highest ARPU of 34,400 and the lowest of 18,700, while EXCL has an average ARPU of 32,455 with the highest of 37,000 and the lowest of 26,000. These figures are still significantly lower than TLKM's ARPU of 41,455 with the highest ARPU of 46,000 and the lowest of 37,000. Meanwhile, FREN has an average ARPU of 25,800 with the highest ARPU of 44,200 and the lowest of 11,600. However, for FREN itself, according to the transparency of information from FREN's Annual Reports on the IDX, from 2011 to 2019, FREN is not only a provider of telecommunications services and networks but also produces devices such as modems known as Mifi and smartphones known as Andromax, thus its contribution is not only from telecommunications services (legacy and data) but also from production and hardware (modems and smartphones). This aligns with the research by Faisol, which reveals that Gross Domestic Product (GDP) measures the value of production, income, and/or national expenditure of an economy.

CONCLUSION

Referring to the research objectives and results of data analysis, the following research conclusions can be identified: 1) The CENT share price has a significant negative effect on GDP_TIK; 2) EXCL share prices have a significant negative effect on GDP_TIK; 3) The FREN share price has a significant positive effect on GDP_TIK; 4) GOLD share prices have a significant positive effect on GDP_TIK; 5) ISAT share prices have a significant negative effect on GDP_TIK; 6) TBIG share price has a significant positive effect on

GDP_TIK; 7) TLKM share price has a significant positive effect on GDP_TIK; 8) TOWR share prices have a significant positive effect on GDP_TIK; 9) The share prices of CENT, EXCL, FREN, GOLD, ISAT, TBIG, TLKM, and TOWR simultaneously influence GDP_TIK.

The findings of this research reveal that in the 2011-2021 period, GDP growth in Indonesia's information and communication sector showed an increasing trend, while the share prices of information and communication industry companies fluctuated with a stable trend. The information and communications industry has been proven to influence GDP growth in the Indonesian information and communications sector, and a positive and significant contribution is shown primarily by the issuers GOLD, TBIG, TOWR, TLKM, and FREN.

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