EcceS:
Economics, Social, and Development Studies
Fakultas Ekonomi dan Bisnis Islam, UIN Alauddin Makassar
Volume 11 Number 1 Ed. June 2024 : page: 73-97
p-ISSN: 2407-6635 e-ISSN : 2580-5570

How Technological Development and E-Commerce Drive Economic Growth in Indonesia

EcceS: Economic, Social and Development Studies

A.Muh. Kayyum[1], Ahmad Kafrawi Mahmud[2], Baso Iwang[3], Nor Hayati Binti Sa'at[4]
E-mail:
ahmad.kafrawi@uin-alauddin.ac.id

Economics Department [1, 2, 3]
Islamic Economic and Business Faculty, UIN Alauddin Makassar-Indonesia

Faculty of Business, Economics and Social Development[4]

(Article history) Received: 2024-05-1, Revised: 2024-06-24, Accepted: 2024-06-25
Available online: 2024-06-26, DOI: 10.24252/ecc.v7i1.13382,
Stable URL: http://journal.uin-alauddin.ac.id/index.php/ecc/index

Abstract: How Technological Development and E-Commerce Drive Economic Growth in Indonesia

The economy is a very important thing in a country, the success of the State in controlling its economic activities can be seen in the country's economic growth rate. The purpose of this study is to determine the influence of the development index of information communication technology and E-commerce on economic growth in Indonesia. This study aims to demonstrate the impact of the correlation between the Information and Communication Technology (ICT) Development Index and E-Commerce on economic growth and increase understanding of the influence of developments in the ICT and E-Commerce domains on Indonesia's economic expansion. The variables in this study are the development index of communication, information technology, and E-commerce as independent variables and economic growth as the dependent variable. The type of research used is quantitative research with panel data analysis using the EViews10 application with the Fixed Effect Model (FEM) method. The population and sample in this study are time series data for 3 years and cross-section data for 34 provinces in Indonesia. The results show that the Information Communication Technology Development Index has a significant effect on Indonesia's economic growth in 2019-2021 which shows the direction of positive influence and E-Commerce (the percentage of businesses doing e-commerce) has a significant effect on economic growth, but shows the direction of negative influence. The impact of this research demonstrates the importance of allocating investments and policies to advance ICT development in Indonesia, which requires allocating government resources to initiatives such as infrastructure upgrades, digital literacy programs, and supportive regulatory frameworks. In addition, the research also highlights the potential to foster more inclusive

economic growth through improving access to ICT tools, empowering marginalized communities, and addressing regulatory barriers to facilitate e-commerce growth in Indonesia.

Keywords: ICT; E-Commerce; Economic Growth

INTRODUCTION

The economy is very important in a country, the success of a country in controlling its economic activities can be seen from the country's economic growth rate, where natural wealth and the quality of human resources, as well as technological advances and the ability to utilize them, are some of the factors that drive a country's economic growth rate which of course must be supported by adequate infrastructure. Digital infrastructure significantly promotes cross-regional corporate collaborative innovation (Tian and Lu, 2023). As digital infrastructure develops, closing the urban-rural digital divide will benefit the real economy as a whole (de Clercq, et.al, 2023).

This is referred to as the new economy, which is the birth of a new economic structure as a result of the development of Information and Communication Technology (ICT). Ideas, information, and relationships are the three main characteristics that distinguish the new economic order from the traditional economy. In line with this, Economics sees it as a transformation that cannot be avoided but must still be accommodated. Starting from classical economic ideas that place natural resources and population growth as sources of economic growth, to neo-classical and endogenous ideas that begin to take into account elements of technology and knowledge as sources of economic growth (Dianari, 2018).

Until now, the development of information technology has intensified as an implication of the Industrial Revolution 4.0 which is supported by the massive development of network-based telecommunications supporting infrastructure built by the government and the private sector (Aini, 2020). Along with the penetration of technology into almost all areas of life, the penetration of information technology has now shifted traditional trade patterns towards electronic transactions or also called E-commerce. At first, the use of the Internet in the economy was limited to securities transactions. Then the massive development of computers and the internet made it easier for the public to communicate and access information. The convenience offered which promises unlimited, fast, and interactive access makes it easier for consumers to get the product they want. This opportunity is then utilized by business people, both producers and distributors, to market products online. Globalization processes are accompanied by the dynamic use of information and communication technologies (ICT), which

has prompted changes in global economic activities (Skare, Gavurova and Rigelsky, 2023).

Some of the factors accelerating the development of the digital economy in Indonesia include; 1). High growth of Internet users, the number of Internet users in Indonesia continues to increase from year to year. In 2020, the number of internet users reached more than 170 million people or about 64% of Indonesia's total population. This creates huge opportunities for technology companies and online businesses, 2). Pro-innovation regulations, the Indonesian government has introduced pro-innovation regulations to support the development of the digital economy. These include initiatives to increase broadband penetration, facilitate technology investment, and strengthen personal data protection, 3). Investment in education and training: The Indonesian government has invested resources in education and training to enhance technological and digital expertise. This includes developing information and communication technology (ICT) curricula in schools and advanced training for existing employees, 4). Partnerships between public and private sectors: There is a strong partnership between the public and private sectors to support the development of the digital economy in Indonesia. The Indonesian government has launched several programs such as the "1000 Digital Startups" program to help start-up companies expand and increase global market access (Sudiantini *et al.*, 2023).

Referring to the Solow-Swan growth model, it shows that the most important factor influencing economic growth is not only due to the influence of capital and labor growth but because of technological progress and skills mastered by labor based on technological developments that occur. The implications of the Solow-Swan theory in economics include optimizing the use of factors of production and developing technology. Thus, the theory provides a strong basis for analyzing the relationship between technology and economic growth (Awan and Yaqoob, 2023).

Solow-Swan uses a production function model that allows for substitution between capital (K) and labor (L). The growth rate comes from three sources viz: capital accumulation, increased labor supply, and technological progress. This technology can be seen in the improvement of skills or technical advances so that productivity increases. In the Solow-Swan model, the technology problem is considered a function of time (Irfanudin *et al.*, 2020).

Therefore, the development of information technology is increasingly vigorous as a result of the shift to the industrial revolution 4.0 and even towards the industrial revolution 5.0. This is supported by government and private efforts in building and expanding network-based telecommunications infrastructure. With the increasing penetration of technology into various

aspects of life, the utilization of information technology is now changing traditional trade patterns into electronic transactions or what is known as E-commerce. E-commerce as a type of electronic business mechanism that focuses on individual-based business transactions using the Internet as a medium for exchanging goods or services either between two institutions or between institutions and direct consumers (Edwin Kiky Aprianto, 2021).

Initially, the use of the Internet in an economic context was limited to securities transactions. However, with the rapid development of computers and the internet, it has become easier for people to communicate and access information. This convenience offers unlimited, fast, and interactive access, so consumers can easily get the products they want. This opportunity is then utilized by business people, both producers and distributors, to market products online. The use of the Internet as a marketing medium and sales channel provides advantages, among others; 1). Certain products are more suitable to be offered through the Internet, 2). The internet is the most appropriate media for company and product promotion at a relatively cheaper price, 3). Purchases via the Internet will always be followed by delivery services to the place of order. This is different from ordinary trade transactions (Edwin Kiky Aprianto, 2021).

Changes in community transactions are influenced by internet penetration in various aspects of life. At first, the development of ICT began with sign language until Alexander Graham Bell sent the first letter by telephone in 1876. Since then, ICT has continued to develop until the internet appeared in 1969 which was formed by the U.S. Defense Advance Research (DARPA) for military purposes in connecting vital areas or regions (Panagariya, 2000). While in Indonesia itself, the use of the Internet first began in 1994 through Indonet as an Internet Service Provider (ISP). Its presence opened up great opportunities in the utilization of telecommunications and information technology in various sectors, including trade.

E-commerce is evidence of technological advancement in the global economy, particularly through the utilization of the Internet in the production process. It can increase the economic productivity of countries that adopt it, as the internet allows faster and more efficient access to information and new ideas. As a result, there is an increase in the dissemination of ideas and information that can encourage innovation. Therefore, the implementation of e-commerce is considered an important source of economic growth, as it provides a boost of ideas and innovation for those who can make good use of the internet for profit (Dianari, 2018). (Ilmakunnas and Miyakoshi, 2013), said in their research that Information, Communication & Technology (ICT) has a major contribution to economic growth. The use of ICT is more widely

used in various business sectors to increase productivity so its existence is important for the economy of a country. The community's economy will not run without the support of ICT and infrastructure development because its existence has become an enabler in all sectors of life (Andini, 2019). This opportunity is considered one of the strategic factors in improving business processes and human resource productivity (Aryani *et al.*, 2020).

Meanwhile (Georgiou, 2009), his research said that E-commerce increases economic growth by stimulating the consumer side. According to him, E-commerce increases sales (and then consumption), which in turn increases the performance of companies, thus leading to economic growth. E-commerce is evidence of technological development in the world economy, namely through the use of the Internet in production activities, so that it can bring about an increase in the economic productivity of the country that implements it. According to data from Databox sourced from Activate Consulting, the global E-commerce business reached a GMV of US$5.1 trillion in 2021. China dominates the market with 51% of the total GMV followed by the United States with a total of 19% and other countries. This shows that E-commerce dominates China in the global market, while its development in developing countries is still limited (https://databoks.katadata.co.id/, 2022).

Developing countries also have a great opportunity to utilize the internet to advance their economy. So, the internet can create opportunities for developing countries to become shippers of goods to other countries. For example, through E-commerce platforms, or even becoming a provider of goods to governments or companies abroad. Now there are so many developed and developing countries that use the Internet as a platform for tender auctions. This gives suppliers from developing countries the opportunity to compete more fairly and win contracts (Panagariya and Mukim, 2014).

The use of E-commerce can also provide regional economic growth is no longer limited to attracting tourists to come to an area to spend money brought from outside an area, with the existence of E-commerce can fold the space and time that limits the transaction process because the use of E-commerce does not require physical space to market a product so that buyers can access it from various regions and spend their money indirectly money circulation in an area can increase. According to data released by Bank Indonesia (BI), during the first semester of 2022, E-commerce transactions increased 22.1 percent on an annual basis and reached a total of Rp227.8 trillion in nominal terms (Ibrahim, 2023).

Indonesia ranks third in the number of internet users in the Asian region, where as many as 76.5 percent of the total population are internet users. This fact can be interpreted as a

considerable opportunity to optimize the utilization of the digital economy. According to the "E-Conomy SEA 2022" report compiled by Google, Temasek, and Bain & Company, the E-commerce sector is the largest contributor to Gross Sales Value (GMV) in the digital economy in Indonesia, with an estimated value of US$59 billion (Hasyim, 2016).

With Indonesia's geographical characteristics as an archipelago, the development of telecommunications network infrastructure such as the Palapa Ring project is very important. This project aims to provide quality broadband access evenly throughout Indonesia to meet the RPJMN 2015-2019 target. It is expected that this project can create equity and ease of access to telecommunications-information, open business opportunities (E-commerce), improve work efficiency, and increase competence to compete in the global market (KPPIP., 2019).

The results of an E-commerce survey conducted by the Central Bureau of Statistics in 2021 showed a gap in E-commerce adoption between regions. Of the total 2,361,423 E-commerce businesses in Indonesia, 1,774,589 businesses (around 75.15 percent) are spread across Java Island. This phenomenon is not surprising, given that the value of Indonesia's Information and Communication Technology Development Index (IP-ICT) is also highest in Java.

Based on data released by the Central Bureau of Statistics 2022, DKI Jakarta is still the province with the highest ICT Development Index value in Indonesia, namely 7.66 in 2021, which increased from 7.46 in 2020. Meanwhile, the province with the lowest ICT Development Index is Papua, which is 3.35 in 2021 and 2020. Thus, the ICT development gap still tends to increase, as indicated by the widening gap between the highest and lowest ICT Development Index values. In 2020, the gap between the highest and lowest ICT Development Index was 4.11 and this gap widened further in 2021 to 4.31 (BPS., 2022).

This study aims to determine the effect of the information and communication technology development index and e-commerce on economic growth in Indonesia. Indonesia's economic growth in 2020 contracted due to the rapid spread of Covid-19. Especially in the economic sector, Indonesia experienced a contraction in 2020 with a rate of -2.07%. Previously, in 2018 and 2019, the economy grew by 5.17% and 5.02% respectively. On the other hand, the digital economy sector is experiencing growth where E-commerce is one of its components, with policies that limit people's activities in public spaces as a form of tackling the spread of the virus, it is proven that during the pandemic there was an increase in E-commerce sales volume by 26% with new consumers reaching 51%. Digital payments have also increased, where more than 70% of Kredivo transactions come from E-commerce so that

economic activity in E-commerce has also increased to 40.6% (Handayanti, Agachi and Fadillah, 2022).

Based on the background of this description, one of the causes of economic growth has experienced a significant shift in terms of technology adoption, namely due to the influence of COVID-19. However, on the other hand, the use of E-commerce has increased which certainly cannot be separated from the existence of technological facilities and infrastructure. The purpose of this study is to show the impact of the relationship between the information and communication technology (ICT) development index and e-commerce on economic growth and to deepen the understanding of how the advancement of the ICT sector and e-commerce can affect economic growth in Indonesia.

This study has significant potential to provide game-changing insights into Indonesia's economic landscape by examining the complex interplay between the development of information and communication technology (ICT), e-commerce, and economic growth. By uncovering the dynamics of this nuanced relationship, this report offers actionable intelligence for policymakers, businesses, and stakeholders to strategically leverage ICT and e-commerce advancements as engines of sustainable economic development. Moreover, by focusing specifically on Indonesia, this research addresses important gaps in the literature, providing contextually relevant findings that can inform targeted policy interventions and industry strategies tailored to Indonesia's unique socioeconomic context. Ultimately, this research is poised to not only enrich scholarly discourse but also drive tangible positive outcomes by empowering Indonesia to harness the full potential of ICT and e-commerce to drive inclusive and resilient economic growth.

LITERATURE REVIEW

Economic growth is a key indicator that reflects a country's progress in various aspects of life. In Indonesia, economic growth is not only influenced by traditional factors such as natural resources and labor, but also by the development of technology, information, communication, and e-commerce. In recent decades, the Information and Communication Technology Development Index (IP-ICT) and e-commerce penetration have become key elements driving economic transformation.

According to Todaro, economic growth as a process of increasing output over time is an important indicator to measure the success of a country's development. A country's economy that is integrated with the global economy has more opportunities to expand markets and increase competitiveness so that efficiency is achieved. A country's economy that is integrated

with the global economy has more opportunities to expand markets and increase competitiveness so that efficiency is achieved. The economic growth of a nation has three main determining components, namely: (i) capital accumulation which includes all forms or types of new investment invested in land, physical equipment, and human resources; (ii) population growth which increases the size of the labor force in the coming years; (iii) technological progress.

An equally important factor in supporting economic growth is technological development. According to (Wardhana, Kharisma and Lisdiyanti, 2020), the rapid development of science and technology is able to accelerate the development process, changing work patterns that originally used human hands to be replaced by sophisticated machines has an impact on the efficiency, quality and quantity of a series of economic development activities carried out and will ultimately have an impact on accelerating the rate of economic growth.

E-Commerce is evidence of technological development in the world economy, namely through the use of the internet in production activities, so that it can bring an increase in the economic productivity of the country that implements it. In Indonesia, the digital economy is now being echoed by the government, which is none other than the application of the new economy concept that specifically leads to the transaction of goods and services through the internet media. Quoted from ASEAN, the application of E-commerce can reduce barriers to entry and reduce production costs. In addition, the contribution of E-Commerce to economic growth also needs to be supported by infrastructure, policies and markets that are able to accept and adapt to the new transaction system.

IP-ICT is a measure that reflects the extent to which information and communication technologies have developed and been adopted within a country. The index covers various aspects, such as technology infrastructure, accessibility, and the use of technology by society and the business sector. A high IP-ICT indicates that a country has a good technology infrastructure and its people are able to utilize the technology optimally. In Indonesia, an increase in IP-ICT is expected to accelerate the digitalization process, which in turn will boost economic productivity and efficiency.

Technology and information play an important role in driving innovation, improving efficiency and creating new opportunities in various sectors of the economy. With the right technology adoption, sectors such as agriculture, manufacturing, and services can increase their productivity. In Indonesia, increased access to information and technology has helped MSMEs (Micro, Small, and Medium Enterprises) expand their markets and improve competitiveness. In

addition, the digitization of government services and education also contributes to improving the quality of human resources, which in turn supports economic growth. Effective communication is the foundation for efficient economic interaction. In the digital era, the development of communication technologies such as the internet and mobile phones has changed the way people and businesses interact. In Indonesia, improved accessibility and quality of communication networks have expanded market reach and accelerated the flow of information. This not only strengthens the business sector, but also enables better economic integration between regions, reducing regional economic disparities (Nursari, 2020).

Information and Communication Technology in English is commonly referred to as information and communication technology (ICT). Information and communication technology is defined as the application of knowledge and skills used by humans in flowing information or messages to help to solve human problems (social activities) to achieve communication goals (Setiawan., 2018). ICT also includes aspects consisting of technology, engineering, and management techniques used in controlling and processing information and its use, computers and the relationship between machines (computers) and humans, and matters relating to social, economic and cultural.

Information and communication technology (ICT) combines two important elements: information technology and communication technology. Information technology covers all matters relating to the processing, use, manipulation, and management of information. Meanwhile, communication technology focuses on the tools and processes for processing and transferring data between devices.

The development of information and communication technology continues, which is reflected in the increase of IP-ICT (Information and Communication Technology Development Index) as one of the indicators of ICT progress. IP-ICT was first introduced by the International Telecommunication Union (ITU) in 2008. As an index consisting of several components, IP-ICT is used to evaluate the level of development of information and communication technology. The index is useful for comparing ICT progress in different regions and in human social activities, to achieve better progress in communication as a whole (Setiawan, 2018). The ICT Development Index is a composite of three sub-indices, each of which consists of the indicators that make it up; the Access and Infrastructure Subindex which assesses ICT readiness in terms of access and infrastructure, as measured by five indicators, the ICT Usage Subindex which reflects how intensive the use of ICT is, with three indicators, the ICT Expertise Subindex shows the level of capability required in ICT, with three indicators as well.

Thus, the higher the index value indicates the faster the development of information and communication technology in a region. Conversely, the lower index value indicates that ICT development in the region tends to be slow. According to (Xing, 2018), in general, information technology can be divided into two main components: software and hardware. Hardware refers to physical equipment such as memory, printers, and keyboards, while software consists of instructions that organize how the hardware works to suit the desired needs.

E-commerce is one of the tangible manifestations of technological and information development that has a significant impact on the economy. In Indonesia, e-commerce has become a new driving force for economic growth, especially in the context of a large domestic market and a young, tech-savvy population. Through e-commerce, MSMEs gain a platform to reach a wider range of consumers without geographical restrictions. In addition, e-commerce also encourages the creation of new jobs, both directly through e-commerce companies themselves and indirectly through supporting ecosystems such as logistics and digital payments (Suprihanti, Kafiya and Pratiwi, 2021).

E-commerce is a subset of E-business, which includes more than just trading activities. E-business has a broader scope, including collaboration with business partners, service to customers, distribution of job vacancies, and so on (Rehatalanit., 2021). E-commerce is not just about services or goods, but a combination of services and goods. E-commerce and related activities over the Internet can act as a catalyst in boosting the domestic economy by facilitating the liberalization of domestic services and supporting faster integration with global production activities. According to (Indrajit, 2002), e-commerce is a form of electronic business mechanism that primarily focuses on individual business transactions, involving the exchange of goods or services over the internet. These transactions can occur between two institutions (B-to-B) or between institutions and direct consumers (B-to-C).

The E-commerce model according to Romindo et al., (2019), is divided into several types, including; business-to-business (B2B), which is E-commerce activities conducted between companies with transactions through EDI (Electronic Data Interchange) and email. Some experts predict the growth of B2B E-commerce will be faster than B2C, examples of B2B companies include Alibaba, Garuda Indonesia, and PT Avesta Continental Pack. Business-to-consumer (B2C), which means trade between companies and consumers, involves consumers in gathering information and purchasing physical goods or information goods. These information goods are received through electronic networks. Examples of B2C companies are amazon.com (http://www.amazon.com/), Bhinneka and Hartono, and business-to-government

(B2G), which is trade between companies and the public sector or government. Such as the use of the Internet in procurement, licensing procedures, and other activities that involve the government but with predetermined conditions. Examples of B2G include IBM Center for the Business of Government and consumer-to-consumer (C2C), which is trade between individuals (private sector) and consumers. C2C is characterized by an increase in electronic markets and online auctions, especially in industries where companies offer what they want from several suppliers.

The advantages of E-commerce according to namely changing the way of working from manual to automatic, integration increasing the way of working to be more efficient and effective, publication providing promotion and communication services for marketed products and services, interaction allows the exchange of data or information between various parties so as to reduce errors, and transactions are agreements between two parties involving other institutions (Rehatalanit, 2021).

Although online transactions (E-commerce) are a profitable system because they can reduce business transaction costs and can improve the quality of service to customers, the E-commerce system and its supporting infrastructure are easily misused by irresponsible people and can also be exposed to errors that may arise through various ways. According to (Riswandi, 2019), e-commerce activities also have disadvantages such as; the potential for hackers to take over a consumer's E-commerce account to retrieve data or use the account for bad things that harm consumers, theft of valuable confidential information, loss of business opportunities due to service disruption, loss of trust from consumers caused by various factors, in addition, there is the potential for fraudulent goods from irresponsible individuals and unexpected losses.

In actual economic activity, economic growth means the physical development of the production of goods and services in a country, such as the increase and production of industrial goods, infrastructure development, increase in the number of schools, increase in the number of service sector production and increase in the production of capital goods (Sukirno, 2015).

Economic growth is also used as an indicator to measure the level of progress of a region. Internal and external factors greatly influence whether economic growth will be high or low. Economic growth occurs when there is an increase in income caused by increased production of goods and services. Thus, economic growth reflects the extent to which economic activity can increase additional income or community welfare in a certain period. This means that economic growth that continues to increase shows the economic progress of the country or region (Sriwahyuni, 2020).

Economic growth is a process that involves various aspects of production that are closely related to the achievement of social justice. Growth is not only about economic development but also a human activity that focuses on progress both materially and spiritually. Gross Domestic Product (GDP) or Economic Growth, is a clear reflection of the progress in the production of goods and services in a country, such as increasing the quantity and quality of industrial products and infrastructure development. The growth rate of real national income achieved is an indicator that is often used to describe the achievement of a country's economic growth (Choi, 2010).

Economists are concerned with the causes of prosperity and economic progress in each country. From their thoughts, the concept and theory of economic growth was born. Classical growth theory states that when there is a shortage of products, marginal production is higher than per capita income. Therefore, population growth will increase per capita income. However, as the population increases, the law of diminishing returns will affect the production function, i.e. marginal production will start to decline. Therefore, national income and per capita income grows more slowly (Hai-Ninh, Ngoc Hoang and Do, 2024).

The Neo-Classical theory looks at the supply side from a different perspective. According to the theory developed by Abramovist and Solow, economic growth depends on the development of factors of production. The most important factors that bring about economic growth are not capital increases and labor increases. The most important factors are technological progress and improvement in the skills and expertise of the labor force. The most important contribution of Neo-Classical growth theory is not in pointing out the factors that affect economic growth, but its contribution in using the theory to conduct empirical investigations in determining the actual role of various factors of production in realizing economic growth (Alhassan, Adamu and Safiyanu, 2023).

According to (Hasyim, 2016), there are basically three factors that affect economic growth, namely; a). supply factor. From the supply side, economic growth can be influenced by five main factors, namely human resources, natural resources, capital, entrepreneurship, and science and technology. All of these factors are forms of goods and services available to encourage economic growth, b). Demand factor. With a high demand for goods and services, there will be an increase in productivity. A high and optimal level of productivity will contribute to significant economic growth for a country, c). Non-economic factors, namely culture, religion, and tradition. These three things can affect the economy, such as cultures that can encourage development, including hard work and smart work, honesty, tenacity and so on.

Information and communication technology (ICT) continues to experience renewal from time to time. Until now, its existence has taken an important role in supporting the development of society, government, and nation. This condition encourages changes in the way humans work, characterized by one of which ICT becomes the main facilitator in various activities (Lin, 2015). The community's economy will not run without the support of ICT and infrastructure development because its existence has become an enabler in all sectors of life (Andini, 2019). This opportunity is considered one of the strategic factors in improving business processes and human resource productivity (Aryani *et al.*, 2020).

E-commerce is one of the new factors in increasing economic growth. (Xing, 2018) said that e-commerce entered into the Cobb-Douglas production function and concluded that E-commerce is a new economic growth point and a turning point in economic development. (Nopiah *et al.*, 2024), said the commercial E-commerce index became a Cobb-Douglas production function, formed a Cobb-Douglas production function with the E-commerce index, and concluded that E-commerce is a new driver of economic growth (Andini, 2019).

With internet technology, transactions between producers or sellers and consumers can be done quickly and efficiently. The use of the internet also increases the flow of information and ideas, encourages innovation, and makes it easier for business people (entrepreneurs). Therefore, the application of E-commerce is not only a source of economic growth, but also a driving factor for ideas and innovation for users who are able to utilize the internet to their advantage (Nopiah *et al.*, 2024).

The rapid development of science and technology today creates and encourages changes in people's lifestyles to be more practical and efficient. In Indonesia, online shopping has become a trend. There are many platforms gathering sellers online in one place like BukaLapak, Lazada, Tokopedia, Shopee, JD.ID, Blibli.com and others. Google Trends illustrated that Shopee led the search until the end of November 2019 compared to other e-commerce platforms (Saputri *et al.*, 2021). Overall, the Information and Communication Technology Development Index (IP-ICT), as well as the development of technology, information, communication, and e-commerce have a very significant role in driving economic growth in Indonesia. The ongoing digital transformation not only improves efficiency and productivity in various sectors, but also opens up new opportunities that can be optimized to achieve sustainable economic growth. Therefore, investing in the development of communication technology and infrastructure, as well as supporting the e-commerce ecosystem, are important strategic steps for Indonesia's economic future.

METHOD

The research location used in this study is the territory of Indonesia which consists of 34 provinces. The source of the data is obtained from the Central Statistics Agency (BPS) in the form of secondary data. The variables in this study are the information and communication technology development index as an independent variable and economic growth as the dependent variable. The type of research used is quantitative research with panel data analysis using the Fixed Effect Model (FEM) method. The population and sample in this study are time series data for 3 years and cross section data for 34 provinces in Indonesia. In using panel data regression, there are several assumption models that must be examined first. In this study, the Fixed Effect Model (FEM) model was used. This model has an intercept that can change for each individual and time, where each cross-sectional unit is specified in a time series the model equation is as follows.

This research data includes data on the percentage of E-Commerce businesses, and data on the Information and Communication Technology Development Index and as independent variable data, and GRDP at current prices (ADHB) for economic growth data as the dependent variable, which will be collected in 34 provinces for 3 years starting from 2019-2021 which are obtained from relevant agencies such as statistical agencies and sources that provide the required data, which are cross-section and time series (Panel Data).

The data analysis obtained in this study used the Eviews statistical data processing program. This study uses the panel data regression analysis method using the Ordinary Least Square (OLS) method. This analysis model uses panel data, namely a combination of time series and cross section data with the following basic equation:

$$Y = f(X1, X2) \quad \text{.....} \quad \text{(I)}$$

$$Yit = \alpha + \beta 1X1it + \beta 2\ X2itu + \varepsilon it \quad \text{.....} \quad \text{(II)}$$

In which, Y = Economic Growth; X1 = Information and Communication Technology Development Index; X2 = percentage of E-Commerce businesses; a: constant/intercept of Y; β 1 , β 2 : Regression coefficient on each independent variable e: Error term; I : Cross section (number of objects); t : Time series (time period).

Proving the hypothesis formulated in this research is carried out t test and f test. T testing is carried out to determine whether the independent variable individually has a significant effect or not on the dependent variable. The hypothesis used is as follows:

H0 : β = 0, there is no significant influence between E-Commerce and IP-ICT variables on

economic growth.

Ha : β ≠ 0, there is a significant influence between E-Commerce and IP-ICT variables on economic growth.

The test criteria used are if the t-test is greater than the t-Table value (t-test> t-Table, for example at a significant level of Level Of Significancy) 5%, it can be concluded that H0 is rejected, meaning that the independent variables individually have a significant effect on the dependent variable. Conversely, if the t-test value is smaller than the t-Table value (t-test < t-Table), for example at a significant level of 5%, it can be concluded that there is no partial (individual) influence of all independent variables on the dependent.

The F test is conducted to determine whether the independent variables in the model jointly affect the dependent variable used. The hypothesis formulation in the F-test is:

H0 : β = 0, there is no significant influence between E-Commerce and IP-ICT variables on economic growth and IP-ICT on economic growth.

Ha: β ≠ 0, there is a significant influence between E-Commerce and IP-ICT variables on economic growth.

The test criterion is if Fcount > FTabel, for example at a significant level of 10%, it can be concluded that Ho is rejected, meaning that the independent variables together have a significant effect on the dependent variable. Conversely, if the value of Fcount < FTabel for example at a significant level of 10%, it can be concluded that Ho is not rejected, meaning that the independent variables together do not have a significant effect on the dependent variable.

This study did not use classical assumption tests because the panel data allowed for more complex behavioral studies in the model. With the advantages of panel data regression, the implication is that classical assumption testing does not have to be done, where the advantages are that the data used become more informative, have greater variability, and low collinearity. So that it will produce a greater and more efficient degree of freedom (Gujarati., 2013).

RESULTS AND DISCUSSION

Indonesia consists of 5 major islands, namely Java, Sumatra, Kalimantan, Sulawesi and Papua. Indonesia is located between two continents and two oceans, allowing it to become a crossroads of world traffic, both air and sea traffic. Indonesia is a crossing point of world economic activities, between the trade of industrialized countries and developing countries. For example, between Japan, Korea, and the PRC with countries in Asia, Africa, and Europe. In addition, the influence of the seasons can also cause Indonesia to become a leading agricultural

country. Agriculture in Indonesia is advancing rapidly and produces many foodstuffs such as rice, corn, vegetables, fruits, rubber, coffee, sugar, tobacco, and others that are very useful for the prosperity and sustainability of the Indonesian population, economically it is also an opportunity to participate in international trade.

In panel data regression, there are three models that determine the research results, namely the Common Effect Model (CEM), Fixed Effect Model (FEM), and Random Effect Model (REM). Model estimation tests are needed to see and choose the best model used in econometric analysis. The model specification test is carried out through two tests, namely the Chow Test and the Hausman Test. From the results of the chow test, there is a probability value of 0.0000 which is smaller than alpha 0.05 with the conclusion that H0 is rejected and H1 is accepted and from the results of the Hausman test, there is a Cross Section Random probability value of 0.0011 which is smaller than alpha 0.05, so it can be ascertained that H0 is rejected and H1 is accepted, so the best model used in this study is the Fixed Effect Model.

Table 2. Panel data regression results table

Variable	Coefficient	Std. Error	t-Statistic	Prob.	Support for Hypotesis
C	5.482972	0.105020	52.20884	0.0000	
X1	0.149144	0.019046	7.830855	0.0000	Yes
X2	-0.000654	0.000126	-5.172781	0.0000	Yes
Prob(F-statistic)	0.000000				

Effects Specification

Cross-section fixed (dummy variables)

R-squared	0.999881	Mean dependent var	6.282460
Adjusted R-squared	0.999818	S.D. dependent var	3.141425
S.E. of regression	0.042357	Akaike info criterion	-3.214802
Sum squared resid	0.118412	Schwarz criterion	-2.288341
Log likelihood	199.9549	Hannan-Quinn criter.	-2.839646
F-statistic	15871.01	Durbin-Watson stat	1.954483

Source: Secondary data output after processing, 2024; (Kayyum., 2024)

1. Analysis of the effect of the information and communication technology development index (IP-ICT) on economic growth

The regression test results of the Fixed Effect Model are: (1) The constant value is

5.482972, which indicates that if the value of the independent variables of the communication information technology development index (IP-ICT) and E-commerce is equal to 0 or constant, the economic growth rate is 5.482972; (2) The regression coefficient of the communication information technology development index variable (X1) is 0. 149144 which indicates that every 1% increase in IP-ICT will increase economic growth (Y) by 0.149144% assuming other independent variables remain; and (3) The regression coefficient of the E-Commerce variable (X2) which shows a negative direction of influence of -0.000654 which indicates that every 1% increase in E-commerce businesses will reduce Economic Growth (Y) by 0.000654% assuming other independent variables remain.

It can be seen in the table, where the results of hypothesis testing using the Fixed Effect Model of each research variable with a significance level of alpha 0.05 (a = 5%). It can be explained that the variable Information communication technology development index (X1) has a significant effect on economic growth which has a probability value of 0.0000 which is smaller than the 5% significance level. The coefficient value of the IP-ICT variable is positive, which is 0.149144, which means that every 1% increase in IP-ICT will be accompanied by an increase in economic growth of 0.149144%.

Where the results of data processing that have been carried out show that IP-ICT has a positive and significant effect on economic growth which has a probability value of 0.0000 or less than the 5% significance level. The coefficient value of the IP-ICT variable is 0.149144, which means that every 1% increase in IP-ICT will be followed by an increase in economic growth of 0.149144%. This shows that the information and communication technology sector in Indonesia has enhanced economic growth. First, the sector has contributed to improving operational efficiency and productivity in various industries by enabling process automation, improved communications, and better data management, resulting in faster production and distribution of goods, which in turn has accelerated economic growth in Indonesia. Second, the sector creates new job opportunities and encourages innovation, which in turn stimulates the growth of related industries and entrepreneurship in Indonesia. Third, access to technology and the internet expands markets for products and services, both locally and globally, by reducing geographic barriers and transaction costs. Fourth, the sector has played a key role in improving education and training through e-learning and digital platforms, thereby improving the skills of the workforce. Thus, through increased efficiency, innovation, market access, and skills development, the information and communication technology sector significantly drives overall economic growth in Indonesia. The results of this study are in line with the results of

research previously conducted by Aini., (2020) which shows the influence of telecommunications infrastructure variables has a positive and significant effect on Indonesia's economic growth during 2001-2018. This is also in line with the Solow growth theory which states that the most important factor that realizes economic growth is not the increase in capital and increase in labor. The most important factors are technological progress and the increase in labor skills and expertise (Sukirno., 2015).

The coefficient value of each province shows different results, where there are 8 provinces that show positive coefficient values and there are 26 provinces with negative coefficient values. It can be seen that there are still many regions that show a negative direction of influence, this phenomenon is inseparable from the ICT disparities that still occur between regions in Indonesia. As with the data released by BPS 2022, where DKI Jakarta is still the province with the highest ICT Development Index value in Indonesia, which amounted to 7.66 in 2021, which increased from 7.46 in 2020. Meanwhile, the province with the lowest ICT Development Index is Papua, which amounted to 3.35 both in 2021 and 2020. Thus, ICT development disparities still tend to increase, as indicated by the widening distance between the highest and lowest ICT Development Index values. In 2020, the distance between the highest and lowest ICT Development Index was 4.11 and this distance widened in 2021 to 4.31 (BPS., 2022).

The disparity in the development of information and communication technology that occurs can be seen from various regions in Indonesia, this condition can be seen in terms of regional division between eastern and western Indonesia, as well as the results of previous research by Wardhana et al., (2020), which states in the results of his research that information and communication technology has a positive effect on economic growth. Also in Agustina et al., (2017), said that, ICT development and government spending in the ICT sector have a positive and significant effect on economic growth. In this study, it was found that there was a very large gap in ICT development between provinces in Indonesia.

2. The effect of E-Commerce on Indonesia's economic growth

The table shows the results of the regression, it can be seen that the E-commerce variable (X2) has a probability of 0.0000, which is smaller than the 5% significance level, with this E-commerce variable showing a significant effect on economic growth. The coefficient value of the E-commerce variable shows a negative direction of influence, namely -0.000654, which means that every 1% increase in E-commerce (percentage of businesses doing e-commerce) can reduce the level of economic growth by 0.000654%. The f test or simultaneous

significance test is conducted to see the extent of the relationship between the independent variables, namely the information communication technology development index (IP-ICT) and E-Commerce on the dependent variable, namely economic growth simultaneously or as a whole. In decision-making, if the probability (F-statistic) is smaller than 0.5 (<a = 5%) then the null hypothesis (H0) is rejected, meaning that it can be indicated that there is a significant effect (H1). It can be seen in the table where the results of the F statistical hypothesis test, obtained a probability value (Prob. F-statistic) of 0.000000 or smaller than the alpha significance level of 0.05 (5%). So it can be concluded that the variables of the development index of communication information technology (IP-ICT) and E-Commerce simultaneously (together) affect economic growth.

Based on the results of data processing that has been carried out, the results show that E-commerce has an influence, with a negative direction of influence on economic growth, with a probability value of 0.0000 which is smaller than the 5% significance level. The coefficient value of the E-commerce variable is -0.000654, which means that every 1% increase in E-commerce will be accompanied by a decrease in economic growth by 0.000654%. The results of this study show that the e-commerce sector in Indonesia faces various challenges that hinder its potential to significantly boost economic growth. Uneven digital infrastructure across Indonesia leads to gaps in internet access, which limits e-commerce penetration in remote areas. In addition, logistics and distribution constraints in the archipelago nation increase shipping costs and delivery times, reducing the attractiveness and efficiency of e-commerce. The low level of digital literacy in a large section of the population also hinders the adoption and full utilization of e-commerce platforms. In addition, regulations that do not fully support the e-commerce ecosystem create uncertainty for businesses and investors. As a result, despite e-commerce's great potential, various structural and socio-economic constraints hinder its contribution to Indonesia's overall economic growth. Although Indonesia's information and communication technology sector continues to grow, there are still many weaknesses that need to be corrected, in order to boost e-commerce growth and economic growth. This is in line with the results of research conducted by Puji Lestari et al., (2021), where the findings are the regression coefficient value of the E-commerce business variable of -3.109031 which also shows a negative direction of influence on Indonesia's economic growth 2018-1019, meaning that if the E-commerce business variable increases by 1%, Indonesia's economic growth will decrease by 3.109031%.

From these findings, it can be concluded that the presence of E-commerce has not been

able to provide a good and equitable contribution to Indonesia's economic growth, while in theory, the presence of E-commerce should be able to make a good contribution to the economy of a country. In line with that Panagariya., (2000), maps two things that can maximize the adoption of E-commerce, namely access to the Internet and access to trade services, where access to the Internet includes the feasibility of supporting infrastructure for Technology, Information, and Communication (ICT), as well as knowledge that can encourage the amount of internet usage.

Wardhana et al., (2020), introduced the E-commerce factor into the Cobb-Douglas production function and concluded that E-commerce is a new economic growth point and a turning point in economic development. Panagariya & Mukim., (2014), also introduced the E-commerce Index into the Cobb-Douglas production function, formed a Cobb-Douglas production function with the E-commerce index, and concluded that E-commerce is a new impetus for economic growth (Aini, 2020). However, to achieve this, it is necessary to maximize the adoption of E-commerce. In line with that, Panagariya., (2000), maps two things that can maximize the adoption of E-commerce, namely access to the Internet and access to trade services, where access to the Internet includes the feasibility of supporting infrastructure for Technology, Information and Communication (ICT), as well as knowledge that can encourage the amount of internet usage. Rosiyana et al., (2021) say the e-commerce features offered are able to have a big influence on the new digital marketing area for business people and consumers who like to shop online to be able to get their respective benefits. Attractive marketing features, easy use, simple appearance, performance and other advantages are able to attract people to try shopping online at this e-commerce site.

From the results of the E-commerce Survey of the Central Bureau of Statistics, it can be seen that the disparity in E-commerce adoption between regions, where 1,774,589 E-commerce businesses (75.15%) of the total E-commerce businesses in Indonesia (2,361,423 businesses) the distribution of their businesses is still centered on Java Island. This is not surprising, given that Indonesia's IP-ICT score is also highest in Java. In line with that Panagariya & Mukim (2014), mapped out two things that can maximize the adoption of E-commerce, namely access to the internet and access to trade services, where access to the internet includes the feasibility of infrastructure supporting Technology, Information and Communication (ICT), as well as the knowledge that can encourage the amount of internet usage.

From the results of the F statistical hypothesis test, the probability value (Prob. F-

statistic) is 0.000000 or smaller than the alpha 0.05 (5%) significance level. So it can be concluded that the variables of the Development Index of Communication Information Technology and E-Commerce together have an effect on economic growth. In line with this, economics views it as a transformation that cannot be avoided but must be accommodated. Starting from classical economic theory which places natural resources and population growth as sources of economic growth, to neo-classical theory and endogenous theory which begin to take into account elements of technology and knowledge as sources of economic growth (Dianari., 2018). To be able to make technology a new axis in economic activity, of course, infrastructure equality is needed as well as the quality of human resources capable of operating information and communication technology as an inseparable part of E-commerce. with the lack of various digital literacy and infrastructure for the people of Indonesia, especially in the eastern region.

CONCLUSION

Based on the results of data processing and analysis that have been carried out in this study, the following conclusions can be drawn. The Information Communication Technology (ICT) Development Index has a significant effect on Indonesia's economic growth in 2019-2021 which shows a positive direction of influence, where when the information technology development index increases, it will be followed by an increase in economic growth. E-Commerce has a significant effect on economic growth but shows a negative direction of influence, where when the percentage of E-Commerce businesses increases, it will be accompanied by a decrease in the level of economic growth. Where the results showed that the Information Communication Technology Development Index (IP-ICT) and E-Commerce simultaneously or together had an effect on Indonesia's economic growth.

The implication of this research, includes; the importance of prioritizing investments and policies aimed at fostering ICT development. Governments and policymakers may need to allocate resources towards initiatives such as infrastructure development, digital literacy programs, and regulatory frameworks that support ICT advancement. A positive relationship between ICT development and economic growth suggests the potential for more inclusive development outcomes. Access to ICT tools and platforms can empower marginalized communities and bridge digital divides, contributing to more equitable economic growth in Indonesia. Policymakers may need to reassess existing regulations and policies related to e-commerce to identify barriers or inefficiencies that hinder economic growth. This could involve addressing issues such as taxation, logistics infrastructure, consumer protection, and

cybersecurity to create a more conducive environment for e-commerce growth in Indonesia. This study has several limitations that need to be considered. One of the main limitations is that this study only uses two main variables, namely the Information and Communication Technology Development Index (IP-ICT) and E-Commerce on Indonesia's Economic Growth. This study does not include other variables that may have an effect on Indonesia's economic growth. Factors such as government policies, infrastructure, and labor market conditions may also play an important role in economic growth but were not analyzed in this study. Future research should consider incorporating a broader range of variables. Government policies, infrastructure development, educational attainment, labor market conditions, and foreign direct investment are just a few examples of factors that could significantly impact economic growth. By including these variables, future studies can provide a more holistic view of the economic landscape.

REFERENCE

Aini, F. (2020) *Pengaruh Perkembangan E-Commerce dan InfrastrukturTelekomunikasi Terhadap Pertumbuhan Ekonomi Indonesia Tahun2001-2018*.

Alhassan, A., Adamu, M. S. and Safiyanu, S. S. (2023) 'Finance-led growth hypothesis for Asia: an insight from new data', *Journal of the Asia Pacific Economy*, 28(2), pp. 599–618.

Andini (2019) *Pengaruh Foreign Direct Investment dan Pembangunan Teknologi Informasi dan Komunikasi (TIK) Terhadap PDB Per Kapita di Beberapa Negara ASEAN Tahun 2008-2017*.

Aryani, Y. *et al.* (2020) 'Pengaruh Teknologi Informasi dan E-Commerce terhadap Perdagangan Indonesia ke Negara ASEAN', *Jurnal Ekonomi Indonesia •*, 9, pp. 53–66.

Awan, A. G. and Yaqoob, R. (2023) 'Economic value of introducing technology to improve productivity: An ARDL approach', *Innovation and Green Development*, 2(3), p. 100069.

Choi, C. (2010) 'The effect of the Internet on service trade', *Economics Letters*, 109(2), pp. 102–104. doi: 10.1016/j.econlet.2010.08.005.

de Clercq, M., D'Haese, M. and Buysse, J. (2023) 'Economic growth and broadband access: The European urban-rural digital divide', *Telecommunications Policy*, 47(6), p. 102579.

Dianari, G. . (2018) 'The Impact of E-Commerce on Indonesia Economic Growth', *Bina Ekonomi*, 22(1), p. 43.

Edwin Kiky Aprianto, N. (2021) 'Peran Teknologi Informasi dan Komunikasi dalam Bisnis', *International Journal Administration, Business and Organization (IJABO)* /, 2(1), pp. 1–7. Available at: https://ijabo.a3i.or.id.

Georgiou, M. N. (2009) 'E-Commerce Has a Positive Impact on Economic Growth: A Panel Data Analysis for Western Europe', *SSRN Electronic Journal*. doi: 10.2139/ssrn.1484687.

Hai-Ninh, D., Ngoc Hoang, N. Y. and Do, N. B. (2024) 'Improving Business Performance for Smes: The Power of Co-Innovation and Business Networks Resilience in The Covid-19 Pandemic', *International Journal of Electronic Commerce Studies*, 15(1), pp. 1–23. doi: 10.7903/ijecs.2290.

Handayanti, A., Agachi, D. S. and Fadillah, W. (2022) 'Peran E-Commerce di Masa Pandemi Covid-19', *Jurnal Ilmu Komunikasi*, 7(1), pp. 27–34.

Hasyim, A. I. (2016) *Ekonomi Makro*. 1st edn. Jakarta: Kencana.

https://databoks.katadata.co.id/ (2022) *Global E-Commerce*.

Ibrahim, M. (2023) 'Transaksi Belanja Online Tembus Rp227,8 Triliun di 2022'. Available at: https://infobanknews.com/transaksi-belanja-online-tembus-rp2278-triliun-di-2022/#google_vignette.

Ilmakunnas, P. and Miyakoshi, T. (2013) 'What are the drivers of TFP in the Aging Economy? Aging labor and ICT capital', *Journal of Comparative Economics*, 41(1), pp. 201–211. doi: 10.1016/j.jce.2012.04.003.

Indrajit, R. . (2002) *Electronic Commerce Strategi dan Konsep Bisnis di Dunia Maya*. Jakarta: Aptikom.

Irfanudin, A. M. *et al.* (2020) 'Strategi Berbisnis Online Ditengah Pandemi Corona Virus Disease 2019 Covid-19', *Dedikasi Pkm*, 1(2), p. 63. doi: 10.32493/dedikasipkm.v1i2.6394.

Lin, F. (2015) 'Estimating the effect of the Internet on international trade', *The Journal of International Trade & Economic Development*, 24(3), pp. 409–428. doi: 10.1080/09638199.2014.881906.

Nopiah, R. *et al.* (2024) 'The Impact of E-Commerce Jurnal REP (Riset Ekonomi Pembangunan)'. doi: 10.31002/rep.v9i1.1216.

Nursari, A. (2020) 'The Influence Of Technology On Economic Growth In Indonesia IN 2010-2020', *Jurnal Jejama Manajemen Malahayati*, 3(1).

Panagariya, A. (2000) 'E-Commerce, Wto And Developing Countries', *Journal Ideas*, 2.

Panagariya, A. and Mukim, M. (2014) 'A Comprehensive Analysis of Poverty in India', *Asian Development Review*, 31(1), pp. 1–52.

Rehatalanit, Y. L. R. (2021) 'PERAN E-COMMERCE DALAM PENGEMBANGAN BISNIS', *Jurnal Pengabdian Kolaborasi dan Inovasi IPTEKS*, 1.

Riswandi, D. (2019) 'Transaksi On-Line (E-Commerce): Peluang dan Tantangan Dalam Perspektif Ekonomi Islam', *Jurnal Econetica*, 1(1).

Saputri, R. *et al.* (2021) 'Penetration Of Imported Products On E-Commerce Platform In Indonesia And Strategies For Improving Local Product Competitiveness', *Business, and Accounting Research (IJEBAR) Peer Reviewed-International Journal*, 5. Available at: https://jurnal.stie-aas.ac.id/index.php/IJEBAR.

Setiawan, D. (2018) 'Dampak Perkembangan Teknologi Informasi dan Komunikasi Terhadap Budaya Impact of Information Technology Development and Communication on Culture', *SIMBOLIKA*, 4(1). Available at: http://ojs.uma.ac.id/index.php/simbolika.

Skare, M., Gavurova, B. and Rigelsky, M. (2023) 'Innovation activity and the outcomes of B2C, B2B, and B2G E-Commerce in EU countries', *Journal of Business Research*, 163, p. 113874.

Sriwahyuni, A. (2020) *Pengaruh Pertumbuhan Ekonomi, Kemiskinan dan Pengangguran Terhadap Ketimpangan Pendapatan di Provinsi Riau Tahun 2005- 2019*.

Sudiantini, D. *et al.* (2023) 'Transformasi Digital : Dampak , Tantangan , Dan Peluang Untuk Pertumbuhan Ekonomi Digital', 1(3).

Sukirno, S. (2015) 'Makroekonomi: Teori Pengantar 399', *Article*, 3.

Suprihanti, A., Kafiya, M. and Pratiwi, L. F. L. (2021) 'Model Kolaborasi Pentahelix Dalam Pembentukan Inkubator Bisnis Di Perguruan Tinggi', pp. 410–417. Available at: http://eprints.upnyk.ac.id/24329/.

Tian, X. and Lu, H. (2023) 'Digital infrastructure and cross-regional collaborative innovation in enterprises', *Finance Research Letters*, 58, p. 104635.

Wardhana, A., Kharisma, B. and Lisdiyanti, T. (2020) 'Teknologi Informasi Komunikasi dan Pertumbuhan Ekonomi Wilayah Barat dan Timur Indonesia Periode 2014-2018', *E-Jurnal Ekonomi dan Bisnis Universitas Udayana*, 9(11), pp. 1103–1116.

Xing, Z. (2018) 'The impacts of Information and Communications Technology (ICT) and E-commerce on bilateral trade flows', *International Economics and Economic Policy*, 15(3), pp. 565–586. doi: 10.1007/s10368-017-0375-5.