Multiplier Effect of Science and Technology on Economic Growth in ASEAN Countries

Muhammad Khoirul Fuddina), Rahmad Hidayatb), Wahyu Hidayat Riyantoc), and Zainal Arifind)

Faculty of Economics and Business, University of Muhammadiyah Malang, Malang, Indonesia

a) Corresponding author: [khoirulfuddin@umm.ac.id](mailto:khoirulfuddin@umm.ac.id)

b)[rahmadhidayat@umm.ac.id](mailto:rahmadhidayat@umm.ac.id)

c) [wahyuhidayat@umm.ac.id](mailto:wahyuhidayat@umm.ac.id)

d)[zainalarifin@umm.ac.id](mailto:zainalarifin@umm.ac.id)

**Abstract.**  Science and technology in the modern era play an important role in economic growth. However, the impact of both is different when viewed based on the time. Some can have an immediate impact in the short term but some need time so that the impact is only seen in the long term. The research will aim to see how much effect the use and utilization of technology and science have on mobile phone ownership, the cost of using intellectual property, and the number of patents on ASEAN economic growth in the long and short term. The methodology used is to use vector error-correction models (VECM). Ownership of mobile phones in ASEAN in the long term or short term can influence economic growth. Meanwhile, the costs of using intellectual property and the number of patents have yet to be able to contribute to the economic growth of ASEAN countries in the long and short term. Using mobile phones with reasonably high intensity, whether used for productive or consumptive activities, significantly influences the economic growth of ASEAN countries. However, the impact on intellectual property, reflected in the cost of use and the amount of patented intellectual property, has yet to be able to contribute maximally to the country's economic growth.

**Keywords:** Economic Growth, Technology and Science

# INTRODUCTION

The availability of capital, natural resources, and human resources strongly influences economic growth in a classical economy. Classical economics focuses on understanding capital, natural resources, and human resources and their role in economic growth. Classical writers believed that economics should deal with objective, measurable data and that social tastes were a given, at least briefly. They also emphasize the importance of capital accumulation and growth, which depends on the creation of savings and investment, the proportionality of different forms of capital, the institutional environment, scientific and technological progress, public policy, and globalization. Additionally, natural resource economics treats resources as capital and highlights the need for forward-looking behavior in dynamic settings [1]. Additionally, the distribution of natural resource rents can impact incentives to invest in higher education [2]. Classical economics provides theoretical and methodological explanations for economic growth and the factors that influence it, including capital, natural resources, and human resources.

In the era of development towards the modern and global era, other fundamental variables influence the growth and acceleration of a country's economic growth, namely the availability and use of technology. Technology has a vital role in accelerating a country's economic growth. Countries that do not have abundant capital, natural resources, and human resources can still develop better and faster if they can utilize technology well and optimally. Technological innovation significantly impacts economic growth; This drives productivity and output growth, leading to overall economic development [3]. New technologies drive the creation of new products and services and higher productivity, which leads to economic growth. Studies consistently show a strong positive relationship between R&D investment and productivity and output growth [4]. However, the impact of technology on economic growth can vary across countries and sectors. For example, in the case of tourism countries and industrialized countries, technology has been found to hurt economic growth [5]. In addition, the effectiveness of technological innovation in stimulating economic growth can be influenced by factors such as institutions, human resource development, and the ability to formulate and implement policies that promote innovation [6]. While technology is vital in driving economic growth, its impact can be influenced by various factors and contexts.

ASEAN is a region where several countries, such as Indonesia, Malaysia, Philippines, and Thailand, have abundant availability of capital, natural resources, and human resources. According to the classical school, the country should have a potential level of economic growth when talking about economic growth. Singapore is one of the countries in the ASEAN region that has much less availability of human resources and natural resources compared to other countries, but when it comes to economic growth, Singapore is an ASEAN country that has relatively good economic growth; this is due, in part, to the use of technology and sound research.

Singapore's success in maintaining economic growth and high per capita income by utilizing science and technology has made other ASEAN countries also begin to concentrate on using technology to increase economic growth; this is why ASEAN was chosen as the object of research: Most countries in the ASEAN region have abundant natural and human resources and are starting to concentrate on using technology to support economic growth.

Various levels of society must refrain from using mobile phones in the era of globalization. The existence of a mobile phone is a primary need for the lifestyle of modern society. Mobile phones are more than to facilitate communication; in the modern era, mobile phones also determine the course of economic activities in a country. The ease, security, and effectiveness of transactions in the modern era are also determined by the people of a country's use of mobile phones.

The costs of using intellectual property rights provide a dilemma in their implementation, especially in developing countries. On the one hand, these costs will cause additional costs from the use of goods or services that are being consumed by the public so that it is not uncommon for people's consumption interest to decrease or even give rise to imitation products to serve the public's needs for goods or services. On the other hand, the cost of using intellectual property rights stimulates someone to conduct necessary research and discoveries where the results can increase the country's economic growth, directly or indirectly.

Patents are an inseparable part of a researcher continuing to develop their expertise. Technology and discoveries produced by a person or business entity are expected to accelerate economic growth in a country.

Various kinds of research have comprehensively discussed the causes or impacts of economic growth through several economic perspectives ranging from macroeconomics, microeconomics, geopolitics, financial instruments, and monetary or fiscal. However, it is still rare to find research that specifically discusses technology and science related to economic growth from a short-term and long-term perspective. This research will be even more interesting, considering that technology and science are variables that can accelerate economic growth in several developed countries. Meanwhile, in this research, the object discussed in developing countries, namely ASEAN, which in the last few decades has experienced quite significant economic growth. The research will look at how much effect the use and utilization of technology and science have on mobile phone ownership, the cost of using intellectual property, and the number of patents on ASEAN economic growth in the long and short term.

# METHODS

Assume Is the k-dimensional stochastic time series data with for each And each k is influenced by a dimensionless exogenous variable . Based on these assumptions, the VAR model can be constructed following the equation (1). When Not influenced by time series variables VAR model that has been constructed in Eq (1) can be formulated like an equation (2). Next, with the cointegration transformation carried out in formula 2, equation (3) is obtained. If has cointegration, then Moreover, equation (3) can be written like equation (5).

(1)

(2)

(3)

with

(4)

(5)

(6.1)

(6.2)

Engle and Granger combined cointegration and error correction models to form a vector error correction model (VECM). As long as variables have a cointegration relationship, the error correction model can be derived from the vector auto-regressive (VAR) model. Therefore, VECM is a VAR model with cointegration constraints. Equation (6) is a formal mathematical VECM model that will be used as the basic model in this study.

We apply the best practices in building the VECM model to get a robust model. First, we performed a Stationarity test using the Augmented Dickey-Fuller (AF) and Phillips-Perron (PP) Tests. Second, determine the lag length for the endogenous variable. The wider the Lag Interval, the more it reflects the dynamic nature and endogeneity, but on the other hand, a lag that is too wide will reduce the degree of freedom of the model. This study uses Lag Length Criteria and Ar Roots to obtain the optimal lag. Third, we carried out a cointegration test between variables in the model using the Johnsen method by assuming the linear trend, which has cointegration with an intercept. In the third stage, a Granger causality test is carried out to see the causal relationship between the variables in the model. Next, the VECM model analysis is carried out in the fourth stage.

After the VECM model is obtained, the Impulse Response function (IRF) helps explain the dynamic system of the VECM model by showing the existence of impulses between endogenous variables and the variables themselves when a shock occurs. Suppose the impulse response is adopted to reflect the shock effect of the system on the internal variables. In that case, variance decomposition refers to the decomposition of the mean squared error whose contribution comes from each variable. Therefore, variance decomposition can be applied to analyze the effect of changes in each variable on other variables.

The nature of VECM, a simultaneous equation, also provides the advantage that each variable can be placed as a dependent variable. Based on equation (6) and the nine variables included in the model, this study constructs eight models such as equations (7.1)-(7.4). The eight models formed will provide a perspective on the dynamic relationship between economic growth, welfare, the environment, and the role of government.

(7.1)

(7.2)

(7.3)

(7.4)

Description: EG is economic growth; MP is mobile phone ownership; CI is the cost of using intellectual property; IPR is the number of patents; i is the ith lag, and p is the optimal lag length.

# RESULTS AND DISCUSSION

## TEST STATIONARITY PANEL

The results of the panel unit root test stationarity test show that the data used in this research is not stationary at the level and stationary at the first different degree as displayed in **TABLE 1**. Thus, it can be said that it can be continued to carry out testing using the VECM test to be able to see the influence between variables in the short term and long.

**TABLE 1.** Unit Root Test Stationarity Panel

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Panel unit root test (Level) | | | | | |
| Variabel | Levin, Lin & Chu t\* | Im, Pesaran and Shin W-stat | ADF - Fisher Chi-square | PP - Fisher Chi-square | Annotation |
| EG | 0.0000 | 0.0000 | 0.0000 | 0.0000 | Stationery |
| MP | 0.0000 | 0.0393 | 0.0492 | 0.0001 | Non-Stationery |
| CI | 0.0309 | 0.5030 | 0.1136 | 0.8700 | Non-Stationery |
| IPR | 0.5366 | 0.2105 | 0.0276 | 0.2704 | Non-Stationery |
| Panel unit root test (First Different level) | | | | | |
| Variabel | Levin, Lin & Chu t\* | Im, Pesaran and Shin W-stat | ADF - Fisher Chi-square | PP - Fisher Chi-square | Annotation |
| EG | 0.0000 | 0.0000 | 0.0000 | 0.0000 | Stationery |
| MP | 0.0000 | 0.0000 | 0.0002 | 0.0000 | Stationery |
| CI | 0.0000 | 0.0000 | 0.0000 | 0.0000 | Stationery |
| IPR | 0.0000 | 0.0000 | 0.0000 | 0.0000 | Stationery |

## LAG OPTIMUM TEST

The lag length used in this research is 2, based on the smallest Akaike Information Criterion (AIC) value of 71.51528 as shown in **TABLE 2**. This optimum lag length 2 will later be used in estimating the VECM model.

**TABLE 2.** Lag Optimum Test

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Lag | LogL | LR | FPE | AIC | SC | HQ |
| 0 | -1810.131 | NA | 3.84e+26 | 72.56524 | 72.71820 | 72.62348 |
| 1 | -1772.310 | 68.07819 | 1.61e+26 | 71.69239 | 72.45720\* | 71.98363\* |
| 2 | -1751.882 | 33.50123\* | 1.37e+26\* | 71.51528\* | 72.89194 | 72.03952 |
| 3 | -1742.540 | 13.82639 | 1.84e+26 | 71.78160 | 73.77010 | 72.53883 |
| 4 | -1735.812 | 8.880309 | 2.85e+26 | 72.15250 | 74.75285 | 73.14273 |
| 5 | -1715.979 | 23.00670 | 2.72e+26 | 71.99916 | 75.21136 | 73.22239 |
| 6 | -1697.796 | 18.18322 | 2.97e+26 | 71.91183 | 75.73588 | 73.36805 |
| 7 | -1686.926 | 9.130370 | 4.75e+26 | 72.11705 | 76.55295 | 73.80627 |

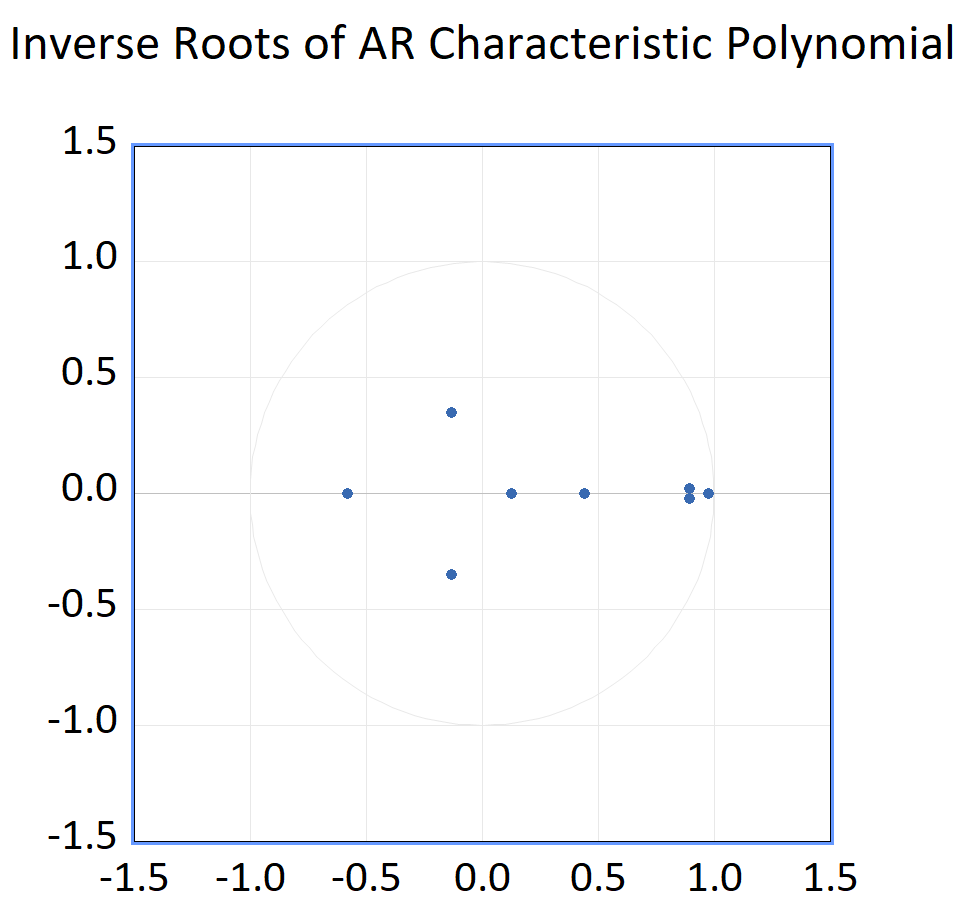
## STABILITY TEST

To analyze the short and long-term using VECM correctly, a stable model is needed. Model stability testing in VECM can be done using Roots of Characteristic polynomials as presented in **TABLE 3**. The model is said to be stable if the value is no more than one.

**TABLE 3.** Roots of Characteristic Polynomial

|  |  |
| --- | --- |
| Root | Modulus |
| 0.974376 | 0.974376 |
| 0.895200 - 0.022095i | 0.895473 |
| 0.895200 + 0.022095i | 0.895473 |
| -0.581080 | 0.581080 |
| 0.441130 | 0.441130 |
| -0.132700 - 0.350950i | 0.375200 |
| -0.132700 + 0.350950i | 0.375200 |
| 0.127617 | 0.127617 |
| No root lies outside the unit circle. | |
| VAR satisfies the stability condition. | |

In the inverse root of the AR characteristic polynomial image, it can be seen that each point is inside the circle. This proves that the variables used are stable, so the results of the Variance Decomposition (VD) and Functional Response Impulse (IRF) analysis carried out through VECM estimation can be used to predict the observed variables. From **FIGURE 1** it shows that each coordinate is inside the circle. This shows that the VAR model in this study is stable.

****

**FIGURE 1.** Inverse Roots of AR Characteristic Polynomial

## GRANGER CASUALITY TEST

Mobile phone ownership influences economic growth. Mobile phone ownership has significantly impacted economic growth in ASEAN countries. Research has shown that penetration of mobile subscriptions, including fixed lines and mobile-mobile subscriptions, has a positive effect on GDP growth in the region [7-9]. The digital economy, which includes the use of mobile phones, has transformed the economic growth of ASEAN countries, leading to improvements in their economic performance [10]. Additionally, investment in ICT infrastructure, including mobile phone penetration, has been identified as a critical driver of economic growth in Asian countries [11]. Therefore, mobile phone ownership drives economic growth in ASEAN countries. While economic growth does not influence cellphone ownership, as shown in **TABLE 4**.

**TABLE 4.** Pairwise Granger Causality Tests

|  |  |  |  |
| --- | --- | --- | --- |
| Null Hypothesis: | Obs | F-Statistic | Prob. |
| MP does not Granger Cause EG | 80 | 6.20916 | 0.0032 |
| EG does not Granger Cause MP | | 0.21907 | 0.8038 |
| CI does not Granger Cause EG | 80 | 0.06749 | 0.9348 |
| EG does not Granger Cause CI | | 0.34136 | 0.7119 |
| IPR does not Granger Cause EG | 80 | 3.03856 | 0.0538 |
| EG does not Granger Cause IPR | | 0.77676 | 0.4636 |
| CI does not Granger Cause MP | 80 | 0.68217 | 0.5086 |
| MP does not Granger Cause CI | | 0.09587 | 0.9087 |
| IPR does not Granger Cause MP | 80 | 1.23561 | 0.2965 |
| MP does not Granger Cause IPR | | 3.37272 | 0.0396 |
| IPR does not Granger Cause CI | 80 | 0.53065 | 0.5904 |
| CI does not Granger Cause IPR | | 1.86691 | 0.1617 |

The cost of intellectual use does not influence economic growth and vice versa. The number of intellectual property rights does not influence economic growth and vice versa. Intellectual usage costs do not influence mobile phone ownership and vice versa.

The number of intellectual property rights does not influence mobile phone ownership, but mobile phone ownership influences the amount of intellectual property. Mobile phone ownership significantly influences the amount of intellectual property (IP) in ASEAN. China's rise has balanced trade differences between China and other countries, including ASEAN member countries such as Indonesia and Thailand [12]. These countries have been shown to have high rates of illegal software downloads, indicating a strong presence of digital copyright infringement [13]. Additionally, developing an IP market model based on mobile location-aware computing in Indonesia has shown the potential to commercialize IP and provide contextual IP information to smartphone users based on location [14].

The differences between corporate development and IP creation in ASEAN highlight the need for further research on the nature and characteristics of technological progress at the corporate level and the adaptation of formal IP registration systems to encourage companies to register their technological innovations [15]. Overall, mobile phone ownership and the digital landscape in ASEAN have implications for the region's amount and protection of intellectual property. The amount of intellectual property does not influence the cost of using intellectual property and vice versa.

## COINTEGRATION TEST

To see whether the research between variables can be analyzed in the long term, it can be seen using the cointegration test. The test results found that the probability value from the PP-Statistics Panel and the ADF-Statistics Panel was less than 0.05; thus, it can be concluded that the variables in this study influence the long term, see **TABLE 5**.

**TABLE 5.** Pedroni Residual Cointegration Test

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Alternative hypothesis: common AR chefs. (within-dimension) | | | | | |
|  | | Statistic | Prob. | Weighted | |
| Statistic | Prob. |
| Panel v-Statistic | | 1.004919 | 0.1575 | -0.757011 | 0.7755 |
| Panel rho-Statistic | | 0.243344 | 0.5961 | 0.312160 | 0.6225 |
| Panel PP-Statistic | | -7.276848 | 0.0000 | -9.657645 | 0.0000 |
| Panel ADF-Statistic | | -5.976187 | 0.0000 | -6.452484 | 0.0000 |
| Alternative hypothesis: individual AR chefs. (between-dimension) | | | | | |
|  | | Statistic | Prob. |  |  |
| Group rho-Statistic | | 1.048445 | 0.8528 |  |  |
| Group PP-Statistic | | -11.48225 | 0.0000 |  |  |
| Group ADF-Statistic | | -6.940289 | 0.0000 |  |  |
| Cross-section-specific results | | | | |  |
| Phillips-Peron results (non-parametric) | | | | | |
| Cross ID | AR(1) | Variance | HAC | Bandwidth | Obs |
| 1 | -0.298 | 1.520994 | 0.253398 | 16.00 | 17 |
| 2 | -0.203 | 6.405906 | 2.221233 | 7.00 | 17 |
| 3 | -0.300 | 8.041389 | 8.347632 | 1.00 | 17 |
| 4 | -0.238 | 11.73633 | 1.452861 | 14.00 | 17 |
| 5 | -0.231 | 4.949689 | 1.597196 | 4.00 | 17 |
| Augmented Dickey-Fuller results (parametric) | | | | | |
| Cross ID | AR(1) | Variance | Lag | Max lag | Obs |
| 1 | -1.371 | 0.934348 | 1 | 2 | 16 |
| 2 | -0.203 | 6.405906 | 0 | 2 | 17 |
| 3 | -0.300 | 8.041389 | 0 | 2 | 17 |
| 4 | -0.932 | 8.561395 | 1 | 2 | 16 |
| 5 | -0.231 | 4.949689 | 0 | 2 | 17 |

## VECM ESTIMATION

The long-term VECM estimation results show that mobile phone ownership in ASEAN countries influences economic growth as seen in **TABLE 6**. The costs of using intellectual property and the number of patents in the long term do not affect the economic growth of ASEAN countries. Mobile phone ownership significantly impacts the economic growth of ASEAN countries. Research has shown that increased mobile penetration leads to increased economic growth, with a one percent increase in mobile penetration resulting in a 1.0-2.6 per cent increase in economic growth [8]. Mobile phone penetration is considered a critical factor in increasing economic growth, along with investment in human and physical capital [9]. Additionally, the embrace of the digital economy, including innovation and the use of ICT, has been found to improve a country's economic performance and GDP growth [10]. Therefore, the governments of ASEAN countries can increase their economic growth by exploiting the potential of mobile phone penetration and investing in ICT infrastructure [7].

**TABLE 6.** Vector Error Correction Estimates

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Cointegrating Eq: | CointEq1 |  |  |  |
| EG(-1) | 1.000000 |  |  |  |
| MP(-1) | 0.095295 |  |  |  |
|  | (0.02063) |  |  |  |
|  | [ 4.61999] |  |  |  |
| CI(-1) | -3.61E-12 |  |  |  |
|  | (9.5E-11) |  |  |  |
|  | [-0.03803] |  |  |  |
| IPR(-1) | 0.000509 |  |  |  |
|  | (0.00163) |  |  |  |
|  | [ 0.31238] |  |  |  |
| C | -16.13858 |  |  |  |
| Error Correction: | D(EG) | D(MP) | D(CI) | D(IPR) |
| CointEq1 | -0.435101 | -1.652123 | -16635382 | 5.895944 |
|  | (0.13970) | (0.33758) | (4.1E+07) | (10.6606) |
|  | [-3.11457] | [-4.89396] | [-0.40621] | [ 0.55306] |
|  |  |  |  |  |
| D(EG(-1)) | -0.370815 | 1.181622 | 48590712 | 19.81268 |
|  | (0.16126) | (0.38970) | (4.7E+07) | (12.3064) |
|  | [-2.29942] | [ 3.03214] | [ 1.02783] | [ 1.60995] |
|  |  |  |  |  |
| D(EG(-2)) | -0.261758 | 0.523545 | 17774374 | 2.432768 |
|  | (0.15252) | (0.36857) | (4.5E+07) | (11.6391) |
|  | [-1.71621] | [ 1.42048] | [ 0.39753] | [ 0.20902] |
|  |  |  |  |  |
| D(MP(-1)) | -0.128369 | -0.022446 | -7151498. | -10.03689 |
|  | (0.04615) | (0.11152) | (1.4E+07) | (3.52163) |
|  | [-2.78169] | [-0.20128] | [-0.52863] | [-2.85007] |
|  |  |  |  |  |
| D(MP(-2)) | 0.043431 | -0.148689 | 11238344 | 12.70399 |
|  | (0.05194) | (0.12552) | (1.5E+07) | (3.96366) |
|  | [ 0.83618] | [-1.18463] | [ 0.73808] | [ 3.20511] |
|  |  |  |  |  |
| D(CI(-1)) | -2.32E-10 | 2.09E-09 | 0.243912 | -3.05E-08 |
|  | (4.5E-10) | (1.1E-09) | (0.13109) | (3.4E-08) |
|  | [-0.51947] | [ 1.93208] | [ 1.86067] | [-0.89336] |
|  |  |  |  |  |
| D(CI(-2)) | 2.36E-10 | -1.90E-10 | 0.134484 | 1.98E-08 |
|  | (4.5E-10) | (1.1E-09) | (0.13195) | (3.4E-08) |
|  | [ 0.52376] | [-0.17461] | [ 1.01922] | [ 0.57745] |
|  |  |  |  |  |
| D(IPR(-1)) | 0.000886 | -0.011005 | -249511.8 | -0.450396 |
|  | (0.00181) | (0.00437) | (530499.) | (0.13810) |
|  | [ 0.48954] | [-2.51662] | [-0.47033] | [-3.26148] |
|  |  |  |  |  |
| D(IPR(-2)) | 0.000710 | -0.010031 | -146412.6 | -0.013603 |
|  | (0.00218) | (0.00527) | (639251.) | (0.16641) |
|  | [ 0.32540] | [-1.90360] | [-0.22904] | [-0.08174] |
|  |  |  |  |  |
| C | -0.091485 | 8.501507 | 1.38E+08 | 44.00679 |
|  | (0.61975) | (1.49763) | (1.8E+08) | (47.2938) |
|  | [-0.14762] | [ 5.67665] | [ 0.75811] | [ 0.93050] |
| R-squared | 0.549283 | 0.369161 | 0.123937 | 0.506600 |
| Adj. R-squared | 0.486877 | 0.281814 | 0.002637 | 0.438283 |
| Sum sq. resides | 814.9556 | 4758.995 | 7.00E+19 | 4745869. |
| S.E. equation | 3.540873 | 8.556594 | 1.04E+09 | 270.2099 |
| F-statistic | 8.801647 | 4.226382 | 1.021735 | 7.415429 |
| Log-likelihood | -195.8821 | -262.0568 | -1658.098 | -520.9940 |
| Akaike AIC | 5.490189 | 7.254847 | 44.48260 | 14.15984 |
| Schwarz SC | 5.799188 | 7.563846 | 44.79160 | 14.46884 |
| Mean dependent | -0.097333 | 5.559867 | 1.72E+08 | 39.37333 |
| S.D. dependent | 4.943100 | 10.09677 | 1.04E+09 | 360.5307 |
| Determinant resid covariance (of adj.) | | 5.25E+25 |  |  |
| Determinant resid covariance | | 2.96E+25 |  |  |
| Log-likelihood | | -2625.056 |  |  |
| Akaike information criterion | | 71.17482 |  |  |
| Schwarz criterion | | 72.53441 |  |  |
| Number of coefficients | | 44 |  |  |

Meanwhile, in the short term, in this research, economic growth at lag two and mobile phone ownership at lag one can influence the economic growth of ASEAN countries. At the same time, the cost of using intellectual property and the number of patents do not affect the economic growth of ASEAN countries.

Mobile phone ownership in ASEAN in the short term is influenced by economic growth in Lag 2; the cost of using intellectual property influences Lag 1, while the number of patents influences Lags 1 and 2

The costs of using intellectual property in the short term in ASEAN countries are not influenced by economic growth, mobile phone ownership, or the number of patents. The number of patents in ASEAN in the short term is influenced by mobile phone ownership and the variable itself at lag 2

## IMPULS RESPON FUNCTION

The impulse response function is shown by economic growth when there is a shock to mobile phone ownership, the cost of using intellectual property, and the number of patents fluctuates from the first year to the eighth year. After the eighth year, economic growth showed fluctuating movements in the fourteenth year. This is shown by the figure response of EG to innovations.

The response caused by economic growth, the cost of using mobile phones, and the number of patents to mobile phone ownership tends to decrease until the first year, then stagnates in the fifth to fourteenth years. This is shown by the figure response of MP to innovations.

Meanwhile, the response generated by the cost of using intellectual property rights when there are fluctuations in economic growth, mobile phone ownership, and the number of patents from the first year to the last year has little impact and tends to show no fluctuating movements. This is shown by the figure response of CI to innovations.

Meanwhile, when there was a shock to economic growth, mobile phone ownership, and the cost of using intellectual property, the number of patents fluctuated quite a bit in the early years until the eighth year, then returned to stability until the fourteenth year. This is shown by the **FIGURE 2**, response of IPR to innovations.



**FIGURE 2.** Impuls Respons Function

## VARIANCE DECOMPOSITION

The economic growth of ASEAN's five regional countries over 14 periods can be seen to be influenced by the variables themselves; then, in the following period, mobile phone ownership contributed to the economic growth of ASEAN countries. Thus, mobile phone ownership contributes to economic growth in ASEAN countries 5. Mobile phone penetration has a positive effect on economic growth in ASEAN countries [9, 16]. Research has shown that the use of mobile phones and other information and communications technologies (ICT) can contribute to economic development and innovation, improve decision-making, and create demand for goods and services [17]. In particular, a cointegration relationship between mobile phone penetration and economic growth has been found in Asian countries [10]. Additionally, the study reveals that high-income Asian countries have achieved significant economic development through high Internet penetration, while middle-income countries have also begun to benefit from ICT [18]. Therefore, policymakers should focus on building better quality ICT services and infrastructure to support economic growth in middle-income Asian countries]. Overall, mobile phone penetration positively impacts economic growth in ASEAN countries, and governments can increase their economic growth by exploiting the potential of mobile phone penetration, see **FIGURE 3**.



**FIGURE 3.** Variance Decomposition

Mobile phone ownership in ASEAN 5 countries is greatly influenced by economic growth in a country. A country's higher economic growth level will increase mobile phone ownership among the public. The increase in cellphone ownership still needs to be related to its use, whether for productive activities or only to fulfill consumer needs. The benefits of having a mobile phone in ASEAN are mainly used for consumption rather than productivity for economic growth [19]. Studies show that while Information and Communication Technology (ICT) has a vital role in enhancing economic growth in ASEAN countries, it is not the main factor that causally motivates economic expansion [9].

The costs of intellectual use are influenced by the variables themselves and are influenced by economic growth. Intellectual property rights (IPR) can influence economic growth in the ASEAN region. IPR protection can encourage economic growth through technology transfer and positive spillovers, leading to increased productivity and technological innovation [20]. Additionally, stricter enforcement of intellectual property laws has been found to have a positive relationship with economic growth [21, 22]. The costs of using intellectual property in the ASEAN region are likely to be influenced by economic growth and the implementation and enforcement of intellectual property laws and regulations.

# CONCLUSIONS

Ownership of mobile phones in ASEAN in the long term or short term can influence economic growth. Meanwhile, the costs of using intellectual property and the number of patents have yet to be able to contribute to the economic growth of ASEAN countries in the long and short term. Using mobile phones with reasonably high intensity, whether used for productive or consumptive activities, significantly influences the economic growth of ASEAN countries. However, the impact on intellectual property reflected in the cost of use and the amount of patented intellectual property has not been able to contribute maximally to the country's economic growth in ASEAN.

# References

1. Araji, S.M. and H. Mohtadi, Natural resources, incentives and human capital: reinterpreting the curse. Middle East Development Journal, 2018. 10(1): p. 1-30.

2. Karp, L.S. and M. Chen, Environmental indices for the Chinese grain sector. Available at SSRN 293691, 2001.

3. Naeruz, M., et al. The impact of economic growth on technological developments, emoneys and fluctuations interest rates and exchange rates in Indonesia. EDP Sciences.

4. Yılmaz, E.G., S.İ. Bıyıklı, and C. Demir, Impacts of Technology on Economic Growth: With Difference Between Tourism Countries and Industry Countries Aspect Based on Extended Solow Growth Model. Scientific Papers of the University of Pardubice. Series D, Faculty of Economics & Administration, 2023. 31(1).

5. Jammeh, I.Y., The effect of technological innovation on economic growth: Evidence from ECOWAS countries. International Journal of Social Sciences Perspectives, 2022. 11(1): p. 1-10.

6. Jin-Xiu, Z. An Empirical Study on the Impact of Technological Innovation on Economic Growth—Taking Shandong Province as an Example. Atlantis Press.

7. Lee, H.S., et al. Does Neo-Schumpeterian economics matter? An analysis of information and communication technology and international trade in ASEAN-5.

8. Jing, A.H.Y. and R. Ab-Rahim, Information and communication technology (ICT) and economic growth in ASEAN-5 countries. Journal of Public Administration and Governance, 2020. 10(2): p. 20-33.

9. Thoyibah, Q.A.y.P. and L. Sugiharti, The Effect of telecommunication infrastructure on economic growth in the Six ASEAN Countries. Media Trend, 2022. 17(1): p. 156-167.

10. Dutta, U.P., A. Gupta, and P.P. Sengupta. Exploring the nexus between mobile phone penetration and economic growth in 13 Asian countries: evidence from panel cointegration analysis. Springer.

11. Tran, L.Q.T. and M.T. Nguyen, Digital Economy: A Comparative Study in ASEAN. Theory, Methodology, Practice-Review of Business and Management, 2022. 18(02): p. 83-92.

12. Prihastomo, Y. and A.A. Ningtyas. Mobile Intellectual Property Marketplace Model for Commercialization of Intellectual Property Rights. IEEE.

13. Lu, B.-Y., et al., EXPLORATION OF MOBILE MARKET: POPULATION DISTRIBUTION AND EMOTIONAL BEHAVIOR CHANGES IN SOUTHEAST AND SOUTH ASIAN COUNTRIES. International Journal of Neuropsychopharmacology, 2022. 25(Supplement\_1): p. A100-A101.

14. Lim, H.Y.-F., The battle against digital copyright infringements in ASEAN, in Intellectual Property Law in South East Asia. 2023, Edward Elgar Publishing. p. 297-317.

15. Antons, C. and M. Blakeney, Intellectual property, farmers' rights and agriculture in the ASEAN countries, in Intellectual Property Law in South East Asia. 2023, Edward Elgar Publishing. p. 318-357.

16. Nipo, D.T., et al., Information and Communication Technology (ICT) on Economic Growth in Asia: A Panel Data Analysis. International Journal of Business and Management, 2022. 17(12): p. 18-23.

17. Das, A., S. Khan, and M. Chowdhury, Effects of ICT development on economic growth in emerging Asian countries, in ICTs in Developing Countries: Research, Practices and Policy Implications. 2016, Springer. p. 141-159.

18. Kurniawati, M.A., Analysis of the impact of information communication technology on economic growth: empirical evidence from Asian countries. Journal of Asian Business and Economic Studies, 2022. 29(1): p. 2-18.

19. Lim, Y.A.L. and V. Nissapatorn, Transmission of waterborne parasites in the Association of Southeast Asian Nations (ASEAN): Overview and direction forward. Food and Waterborne Parasitology, 2017. 8: p. 75-83.

20. Yang, X. and Y. Qi, Simulation of intellectual property management on evolution driving of regional economic growth. Applied Sciences, 2022. 12(18): p. 9011.

21. Janjua, P.Z. and G. Samad, Intellectual property rights and economic growth: The case of middle income developing countries. The Pakistan Development Review, 2007: p. 711-722.

22. Antons, C. and M. Blakeney, Intellectual property, creativity and innovation in ASEAN, in Intellectual Property Law in South East Asia. 2023, Edward Elgar Publishing. p. 1-16.