

Digital Economy as a Determinant of Economic Growth and Its Impact on Gross Capital Formation: Indonesia and Thailand

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ABSTRACT

The economic growth of Indonesia and Thailand, as two large ASEAN member states, over the past 30 years (1994-2023) has tended to fluctuate, with a dominant upward trend since the early 2000s, both in terms of digital economy and economic performance. This study aims to verify the accuracy of the economic model proposed by Sahoo et al (2021) in formulating digital economic performance, comprising 8 variables: internet density, mobile density, per capita electricity power consumption, research and development, exports, expected years of schooling, foreign direct investment, and the consumer price index, as factors influencing economic growth and its impact on gross capital formation in both countries. Using the Two-Stage Least Squares (2SLS) model 1 and Ordinary Least Squares (OLS) model 2, better values were obtained, along with significant proof, of Sahoo's model.

INTRODUCTION

Indonesia and Thailand are two neighboring countries located in Southeast Asia. Both Southeast Asian countries are members of ASEAN (Association of Southeast Asian Nations). ASEAN plays a very important role in the global economy, contributing US\$1.73 trillion to the global economy in 2021 (Kominfo, 2023). This research is conducted to verify the model used by Sahoo regarding digital issues and economic performance in two major economies, India and China. This study focuses on two ASEAN member countries: Indonesia and Thailand. These two countries share similarities: similar but different directions of economic growth, rapid digital transformation, strategic positions within ASEAN, human resource potential and challenges, and policy relevance..

Economic growth, or per capita gross domestic product (PCGDP), influenced by many factors such as entrepreneurship and investment (Cornwall, 2023), is taken as the dependent variable (Y) in this study. Meanwhile, gross capital formation (GCF), where economic growth plays a crucial role as a driving force that can strengthen long-term production capacity (Khan, 2020), is included as the independent variable (Z) in this study. Several input variables (X), related to digitalization and economic performance, which can affect economic growth in this study are internet density (ID), mobile density (MD), per capita electricity power consumption (PCEPC), research and development (R&D), exports (EX), expected years of schooling (EYS), foreign direct investment (FDI), and the consumer price index (CPI) (Sahoo et al., 2021). Internet density and mobile density are digital factors representing the number of internet and mobile phone subscribers per 100 people.

Problems frequently arise with internet density (ID) when too many users access internet services in a single area or network simultaneously, resulting in various technical issues and decreased service quality, such as decreased internet speed, unstable connections, insufficient bandwidth, and others. Mobile density (MD) problems occur when too many users access cellular networks (GSM, 3G, 4G, 5G) in a given area simultaneously, leading to disruptions in communication and data services. Problems with per capita electricity power consumption (PCEPC) include suboptimal utilization for productive activities, a lack of electricity-based technological innovation, a failure to leverage digitalization reliant on electricity, unregulated operating hours for energy efficiency, a lack of utilization of energy subsidies or stimuli, minimal use of renewable energy for businesses, and inadequate energy education for improving competitiveness and profit. Research and development (R&D) problems include insufficient funding, a lack of qualified human resources, low collaboration between academia and industry, complex bureaucracy and regulations, a lack of focus on applied research, and others. Suboptimal utilization of exports (EX) such as a lack of understanding of export procedures, inadequate fulfillment of international product quality and standards, limited use of digital technologies and international e-commerce, a lack of information about foreign markets and trends, and other factors. Problems with expected years of schooling (EYS) relate to obstacles that cause a low number of years of formal education expected from someone from the age of school entry, including disparities in educational access,

poverty and economic pressure, early marriage and gender inequality, poor education quality, and a lack of awareness of the importance of education. Foreign direct investment (FDI) problems are obstacles that hinder the entry of foreign capital into a country, or that cause existing foreign investment to not run optimally, such as complex and inefficient bureaucracy, legal and regulatory uncertainty, inadequate infrastructure quality, and others. Uncontrolled consumer price index (CPI) leads to high inflation, which decreases purchasing power; it often does not represent the conditions of all segments of society; the impact of rising CPI on people's lives is not immediately apparent; rising CPI can encourage interest rate increases, and other issues.

In his research, Sahoo outlines the relationship between variable Y, or economic growth (PCGDP), along with several other variables in model 2 in defining its influence on variable Z. While model 1, which links variable X with Y, is not defined or modeled, because only PCGDP is described as its variable Y. This becomes a shortcoming of the research conducted by Sahoo, making it appear like a missing link when connecting model 1 with model 2.

THEORETICAL REVIEW

Economic Growth Theory

The classical theory of Adam Smith posits that economic growth is determined by labor specialization and increased productivity through the division of labor (Christian & Erreygers, 2020). Neoclassical theory, on the other hand, emphasizes the roles of capital accumulation, population growth, and technological progress in economic growth (Adams, 2019); (Christian & Erreygers, 2020); (Li et al., 2020). The following ten hypothesis are as follows:

First: There is a significant simultaneous effect between internet density (ID), mobile density (MD), per capita electricity power consumption (PCEPC), research and development (R&D), exports (EX), expected years of schooling (EYS), foreign direct investment (FDI), and consumer price index (CPI) on economic growth (EG) in Indonesia and Thailand.

High-Speed Cable Internet Theory

High-speed internet operates based on the principle of transmitting digital data using various transmission media, such as copper cables (DSL), coaxial cables (cable), fiber optics (fiber optic), radio waves (wireless/Wi-Fi), and cellular networks (4G/5G) (Esmailzadeh, 2016); (Lee & Leonard, 2023).

Second: There is a significant influence between internet density (ID) on economic growth (EG) in Indonesia and Thailand.

Cellular Phone Theory

Cellular phone technology works based on the principle of two-way radio communication connecting user devices to the cellular network via transmission towers (base transceiver station/BTS) (He et al., 2016); (Kang, 2020).

Third: There is a significant influence between mobile density (MD) and economic growth (EG) in Indonesia and Thailand.

Electricity Consumption Theory

Electricity consumption refers to the amount of electrical energy used by appliances, households, industries, or other sectors over a specific period, measured in kilowatt-hours (kWh) (Guo et al., 2018); (Xue et al., 2023).

Fourth: There is a significant effect between per capita electricity power consumption (PCEPC) on economic growth (EG) in Indonesia and Thailand.

Research and Development Theory

Research and Development (R&D) is a systematic scientific and technical activity aimed at gaining new knowledge, generating innovation, and creating more effective and efficient products, processes, or services (O'Connell et al., 2022); (Wu & Zhao, 2022).

Fifth: There is a significant influence between research and development (R&D) and economic growth (EG) in Indonesia and Thailand.

Export Theory

It is the activity of selling goods or services from one country to another, encompassing the mechanisms of comparative advantage, resource distribution, and international trade patterns (Heriqbaldi et al., 2023); (Negeri & Ji, 2023).

Sixth: There is a significant influence between exports (EX) and economic growth (EG) in Indonesia and Thailand.

Human Development Theory

Human development is a process aimed at improving the quality of individual lives in physical, social, emotional, intellectual, and spiritual aspects, focusing primarily on nurturing each individual's potential for growth, development, and achieving better well-being (Oosterlaken, 2015).

Seventh: There is a significant influence between expected years of schooling (EYS) on economic growth (EG) in Indonesia and Thailand.

Foreign Direct Investment Theory

Foreign Direct Investment (FDI) is a form of cross-border investment where companies or individuals from one country invest capital in the form of ownership of assets or companies in another country (Knoerich, 2019); (Levis et al., 2023).

Eighth: There is a significant influence between foreign direct investment (FDI) and economic growth (EG) in Indonesia and Thailand.

Consumer Price Index Theory

The Consumer Price Index (CPI) is one of the most important economic indicators used to measure the rate of inflation, which provides an overview of the purchasing power of the community and serves as a reference for economic policy decisions by the government and central bank (Qureshi et al., 2023); (Zulkifli et al., 2023).

Ninth: There is a significant effect between the consumer price index (CPI) and economic growth (EG) in Indonesia and Thailand.

Gross Capital Formation Theory

It is a macroeconomic indicator reflecting the total investment in an economy during a specific period, referring to the addition of fixed assets and changes in inventories used to support the production process (Al-Abdi et al., 2023); (Ogiangbe et al., 2023).

Tenth: There is a significant effect of economic growth (EG) on gross capital formation (GCF) in Indonesia and Thailand.

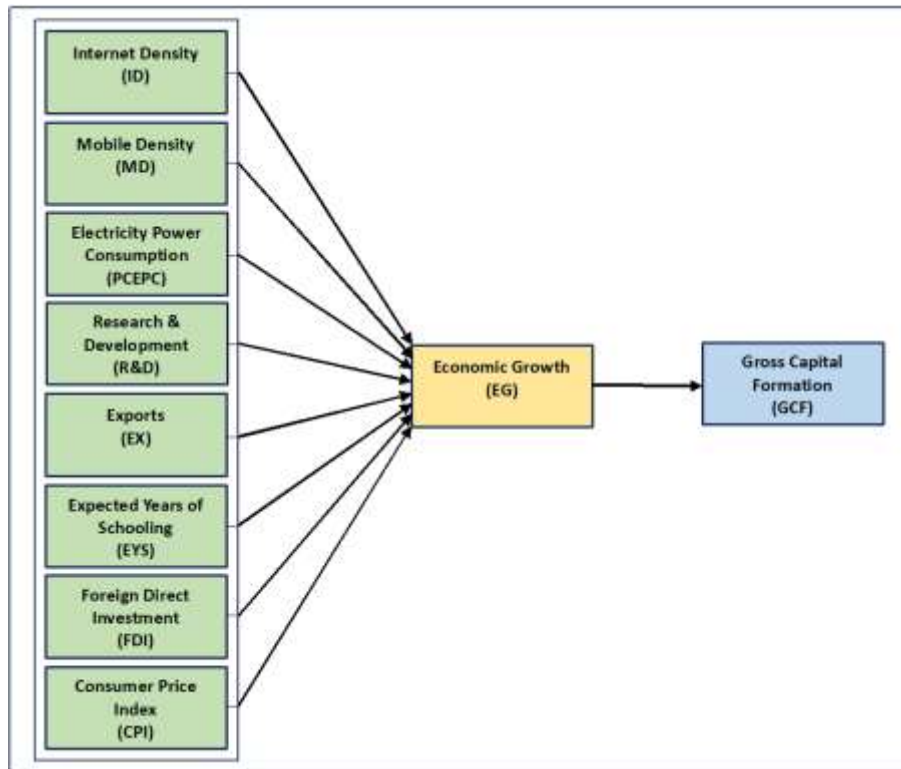


Figure 1. Conceptual Framework

The first image illustrates the influence of variable X, consisting of 8 items, on variable Y, which represents economic growth, both simultaneously and partially. The image also shows the effect of variable Y on variable Z, namely gross capital formation.

METHODOLOGY

To demonstrate the points made in Sahoo's article, this research employs two techniques: 2SLS (two-stage least squares) for Model 1 and OLS (ordinary least squares) for Model 2. The selection of Common Effect, Fixed Effect, and Random Effect models within the OLS category was based on Chow and Lagrange Multiplier tests. In contrast, the 2SLS technique used a direct selection process, choosing models with notably significant values.

RESULTS

Two models were used in this study: Model 1 (Equation 1), processed using the 2SLS method, and Model 2 (Equation 2), processed using the OLS method. The equations used to define both models are as follows:

$$\begin{aligned} \ln PCGDP_{i,t} = & \delta + \gamma_1 \ln ID_{i,t} + \gamma_2 \ln MD_{i,t} + \gamma_3 \ln PCEPC_{i,t} + \gamma_4 \ln R\&D_{i,t} + \gamma_5 \ln EX_{i,t} \\ & + \gamma_6 \ln EYS_{i,t} + \gamma_7 \ln FDI_{i,t} + \gamma_8 \ln CPI_{i,t} + \gamma_9 (\ln EYS * \ln R\&D)_{i,t} + \gamma_{10} (D_c \\ & * \ln EX)_{i,t} + \gamma_{11} (D_c * \ln EYS)_{i,t} + \gamma_{12} (D_c * \ln FDI)_{i,t} + \gamma_{13} (D_c * \ln ID)_{i,t} \\ & + \gamma_{14} (D_c * \ln MD)_{i,t} + \gamma_{15} (D_c * \ln PCEPC)_{i,t} + \gamma_{16} (D_c * \ln R\&D)_{i,t} + \gamma_{17} (D_c \\ & * \ln CPI)_{i,t} + \gamma_{18} (D_c * \ln EYS * \ln R\&D)_{i,t} + \varepsilon_{i,t} \end{aligned} \quad (1)$$

$$\ln GCF_{i,t+1} = \delta + \gamma \ln PCGDP_{i,t} + \varepsilon_{i,t} \quad (2)$$

where i = Cross-section, t = Time-series, δ = Constanta, γ = Coefisient, ε = Error Standard, D_c = Dummy of Country; 1 $\rightarrow$ Indonesia, 0 $\rightarrow$ Thailand.

Results of the stationarity test using the Augmented Dickey-Fuller (ADF) method. The criteria are that if the probability value from the ADF-Fisher Chi-Square is < 0.05 or $< 5\%$, the data is considered stationary; however, if the ADF-Fisher Chi-square value is > 0.05 or $> 5\%$, the data is considered non-stationary. For Model 1, all variables are stationary in the "level" category, except for $\ln PCGDP$, $\ln ID$, $\ln R\&D$, $\ln EX$, $\ln EYS$, $\ln EYS * \ln R\&D$, $D_c * \ln EX$, $D_c * \ln EYS$, $D_c * \ln ID$, $D_c * \ln R\&D$, and $D_c * \ln EYS * \ln R\&D$, which are all stationary in the first-differenced category. For Model 2, both $\ln GCF$ and $\ln PCGDP$ are stationary in the first-differenced category. A summary of these stationarity test results can be found in Tables 1 and 2.

Table 1. Results of the Stationarity Test for Model 1

Variabel	ADF	Category	Status
$\ln PCGDP$ - per capita gross domestic product	0.0000	first differenced	stationer
$\ln ID$ - internet density	0.0120	first differenced	stationer
$\ln MD$ - mobile density	0.0000	level	stationer
$\ln PCEPC$ - per capita electricity power consumption	0.0149	level	stationer
$\ln R\&D$ - research & development	0.0008	first differenced	stationer
$\ln EX$ - exports	0.0001	first differenced	stationer
$\ln EYS$ - expected years of schooling	0.0000	first differenced	stationer
$\ln FDI$ - foreign direct investment	0.0002	level	stationer
$\ln CPI$ - consumer price index	0.0000	level	stationer
$\ln EYS * \ln R\&D$	0.0008	first differenced	stationer
$D_c * \ln EX$	0.0008	first differenced	stationer
$D_c * \ln EYS$	0.0212	first differenced	stationer
$D_c * \ln FDI$	0.0001	level	stationer
$D_c * \ln ID$	0.0425	first differenced	stationer
$D_c * \ln MD$	0.0000	level	stationer
$D_c * \ln PCEPC$	0.0084	level	stationer
$D_c * \ln R\&D$	0.0142	first differenced	stationer
$D_c * \ln CPI$	0.0001	level	stationer
$D_c * \ln EYS * \ln R\&D$	0.0157	first differenced	stationer

Tabel 2. Results of the Stationarity Test for Model 2

Variabel	ADF	Category	Status
lnGCF - <i>gross capital formation</i>	0.0000	<i>first differenced</i>	stationer
lnPCGDP - <i>per capita gross domestic product</i>	0.0120	<i>first differenced</i>	stationer

Multiple linear regression was performed on Model 1 using the 2SLS method. Of the three regression categories examined, the Random Effects model was selected. The regression results can be seen in Table 3. From Table 3, it appears that Model 1 using the 2SLS method shows a significant simultaneous effect of all X variables on the Y variable, which is economic growth (PCGDP). This is indicated by the F-Statistic Simultaneous test's p-value of 0.0000 (62.10088). Similarly, the adjusted R-squared value of 0.971305 further supports the excellent fit of Model 1.

Of the 8 X variables that are objects in this study, 6 variables show significant values. As for the dummy variable and the combination of 10 variables, 6 of them are significant. The findings show a better or greater quantity than Sahoo's, which only found 2 significant variables and 2 dummy variables with the same value.

Table 3. Summary of Regression Testing of Panel Data Model 1 using Selected Random Effects

Variabel	Common Effect		Fixed Effect		Random Effect	
	Koef	Prob	Koef	Prob	Koef	Prob
lnID - <i>internet density</i>	-0.026323	0.8601	0.108466	0.5286	-0.024696	0.0958
lnMD - <i>mobile density</i>	0.129460	0.7486	-0.215520	0.5585	0.056479	0.0081
lnPCEPC - <i>electricity consumpt</i>	2.288666	0.7127	1.539095	0.3408	0.935372	0.0000
lnR&D - <i>research & develop</i>	5.991982	0.7302	0.304537	0.8950	2.720629	0.0011
lnEX - <i>exports</i>	0.866037	0.7901	-0.531768	0.5328	0.134773	0.0001
lnEYS - <i>exp years of schooling</i>	-1.249979	0.7476	0.333729	0.7688	-2.108037	0.0231
lnFDI - <i>foreign direct invest</i>	-0.022425	0.8365	0.013600	0.8134	0.013249	0.1028
lnCPI - <i>consumer price index</i>	-3.626677	0.7130	-0.279571	0.8413	-1.418084	0.0000
lnEYS*lnR&D	-2.227915	0.7300	-0.118224	0.8932	-1.066673	0.0014
Dc*lnEX	-1.565008	0.7929	0.622202	0.4960	-0.201652	0.0000
Dc*lnEYS	-3.379505	0.8425	0.405147	0.8907	1.137069	0.0021
Dc*lnFDI	0.257025	0.7887	-0.033246	0.7873	-0.002079	0.6642
Dc*lnID	-0.005906	0.9878	-0.066365	0.7724	0.072448	0.0062
Dc*lnMD	-1.131567	0.8016	0.355253	0.4660	-0.118432	0.1310
Dc*lnPCEPC	-5.040380	0.7809	-1.029317	0.6294	-0.906311	0.0094
Dc*lnR&D	15.913430	0.8394	-4.331586	0.6360	-1.286826	0.1446
Dc*lnCPI	8.770970	0.7795	-0.536486	0.8231	1.647233	0.0066
Dc*lnEYS*lnR&D	-6.189133	0.8390	1.676291	0.6375	0.533669	0.1014
R ² (Within)	-29.185352		-4.415871		0.983044	
R ² (Overall)	-50.082903		-8.531932		0.971305	
F-Statistic	2.959321		2.770432		62.10088	
Durbin Watson	1.055593		1.013119		0.705127	

* $\alpha = 5\%$

This can be seen in the summary of the comparison of values obtained from this study against Sahoo's study in Table 4.

Meanwhile, economic growth (PCGDP) is the Y variable affecting gross capital formation (GCF) in Indonesia and Thailand, as the Z variable, significantly in this study, with an F-Statistic value of 4.642864. The positive value of its coefficient indicates a direct relationship between economic growth and gross capital formation. Several factors may cause the significance between these two variables in Indonesia and Thailand. A summary of this multiple linear regression model 2 test can be seen in Table 5. This model is different from the one used by Sahoo, so it does not prove that economic growth significantly affects foreign direct investment in Indonesia and Thailand. In this study, gross capital formation is the significant Z variable.

Table 4. Comparison of the Significance and Determination of Sahoo et al.'s (2021) Research Results with This Research for Model 1

Variabel	Sahoo (2021)	This Research
	Random Effect	Random Effect
lnID - internet density	0.013	-0.096
lnMD - mobile density	0.161	0.008
lnPCEPC - per capita electricity power consumption	0.572	0.000
lnR&D - research & development	7.669	0.001
lnEX - exports	0.326	0.000
lnEYS - expected years of schooling	2.210	-0.023
lnFDI - foreign direct investment	0.108	0.103
lnCPI - consumer price index	0.046	-0.000
lnEYS*lnR&D	3.355	-0.001
Dc*lnEX	-0.591	-0.000
Dc*lnEYS	-0.678	0.002
Dc*lnFDI	0.012	-0.664
Dc*lnID	0.018	0.006
Dc*lnMD	-0.150	-0.131
Dc*lnPCEPC	0.260	-0.009
Dc*lnR&D	10.124	-0.145
Dc*lnCPI	0.335	0.007
Dc*lnEYS*lnR&D	-4.318	0.101
R ² (Within)	0.998	0.983
R ² (Overall)	0.998	0.971

Table 5. Summary of Regression Testing of Panel Data Model 2 with Selected Common Effects

Variabel	Common Effect		Fixed Effect		Random Effect	
	Koef	Prob	Koef	Prob	Koef	Prob
lnPCGDP - gross domestic product	0.868253	0.0355	0.843120	0.0433	0.868253	0.0366
R ² (Within)	0.076561		0.082263		0.076561	
R ² (Overall)	0.060071		0.048891		0.060071	
F-Statistic	4.642864		2.465017		4.642864	
Durbin Watson	2.075377		2.083298		2.075377	

DISCUSSION

In the first hypothesis, it was significantly proven that all X variables significantly influenced economic growth as variable Y, simultaneously in Indonesia and Thailand. Each variable simultaneously contributed to economic growth, in addition to the sensitivity of digital variables. The second hypothesis was not significantly proven to influence economic growth, due to the low coverage of services, a shift in preference in both countries from fixed to mobile, greater use in the entertainment aspect, and service quality issues.

Third hypothesis showed a significant value in both countries, but differed from the value obtained by Sahoo. Mobile phones provide fast, cheap, and flexible communication access nowadays, such as rural residents without access to traditional banks can utilize this service. Fourth hypothesis proved significant, although the results differed from Sahoo's. Both countries show that increased per capita electricity consumption is linked to the growth of strategic sectors supporting GDP. The fifth hypothesis proved significant, as R&D creates spillover effects for the entire economy, increasing efficiency and driving long-term growth.

Sixth hypothesis was found to be statistically significant, but with a different value than Sahoo's findings. Export impacts extend beyond increasing foreign exchange reserves, also expanding domestic demand. The seventh hypothesis was found to be statistically significant, but in the opposite direction and with a different value than Sahoo's findings. Although children in both countries are attending school longer, the quality of teaching, curriculum, and educational infrastructure has not always supported the development of skills relevant to the job market. Eight hypothesis was not found to be statistically significant. This is because the majority of foreign investment in Indonesia and Thailand goes towards sectors that are not productive in the long term.

The ninth hypothesis showed a significant effect in the opposite direction. This is due to the high inflation that both countries experienced. The tenth hypothesis yielded a significant result, but with different variables compared to Sahoo's findings. This is because growth increases domestic savings and capital expenditure, making GCF (Gross Capital Formation) dominant. Sahoo's study on India and China, however, found that growth increased foreign direct investment inflows, making FDI (Foreign Direct Investment) dominant.

The limitations of this research are that Model 1 can only provide results with good influence values if and only if the 2SLS method is used, as used by Sahoo. The calculation results will be different when using the OLS method in general.

CONCLUSIONS AND RECOMMENDATIONS

ID and FDI were not found to be statistically significant in the Indonesian and Thai cases. MD, PCEPC, R&D, EX, EYS, and CPI were found to be statistically significant and positively correlated with economic growth, except for EYS and CPI, which had an inverse relationship. Sahoo's model was found to be statistically significant simultaneously in Model 1, but not in Model 2. Partially, each variable X in this study yielded better results than Sahoo's research.

For ID, this variable can significantly affect growth, with strategies to improve quality, access, and utilization, such as expanding fiber optic networks to remote areas, making broadband subscription costs more affordable through fiscal incentives or subsidies for vulnerable groups, and the government should encourage the integration of broadband with the productive sector. Regarding FDI, strategies are needed to encourage the quality and utilization of investment, such as friendlier regulations, fiscal incentives should be directed towards investment in high-value-added sectors, and physical and digital infrastructure development should be strengthened to support smooth production and distribution.

FURTHER STUDY

Further study on the influence of the eight variables on economic growth is necessary. Especially regarding their impact in both the short and long term.

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