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The Influence of Foreign Investment, Information and Communication Technology, Human Resources, and Spatial Dependence on Productivity Convergence

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Abstract

The structural characteristics in the Eastern Indonesia Region, such as human capital, demographics, unemployment rates, and government policies, lead to regional polarization with varying growth levels. This study examines the influence of foreign investment, information and communication technology, human resources, and spatial dependence on productivity and its convergence from 2015 to 2022 using the Spatial Durbin Model. The findings show productivity divergence, with foreign investment positively impacting TFP divergence, while ICT and human resources do not affect TFP between regions. Spatially, foreign investment and ICT positively impact TFP, whereas human resources negatively impact TFP, influencing both the region and its neighbors.

Keywords : Convergence, Regional Productivity, Spatial Dependence

Introduction

The spatial aspect is considered in understanding the behavior of economic activity. According to Flores-Chamba et al., (2019) the spatial condition of a region is a factor that naturally through the ownership of natural resource wealth, labor capacity, and productive infrastructure can explain the differences in regional economic growth. On the other hand, there are also external factors in the form of technological developments and economic policies that influence differences in regional economic growth. According to Ladjin, (2019) and Farida Millias Tuty et al., (2022) regional inequality between regions can occur due to the diversity of resources and development implementation between regions. This creates the term developed regions and underdeveloped regions, where disparities between these regions will have implications for the welfare of the people in a region.

To reduce regional inequality that occurs between regions, a convergence process is needed Convergence is a situation where the economies of less developed regions grow faster than more developed regions so that differences in economic conditions between these regions are narrowed through the reduction of gaps in productivity, income, wages, and other indicators (Purwono et al., 2021; Susilo & Wicesa, 2021). Wibisono, (2005) in Kumara et al., (2021) conducted a study on convergence by taking into account growth rate, physical investment, human investment, government investment, changes in terms of trades, and infrastructure. The results showed that the main mechanism that triggers convergence between regions is the increase in Total Factor Productivity (TFP). Inequality in TFP levels is also an indication of inequality in the per capita income of a region where differences in productivity levels are the source of almost all disparities in per capita income between economies (Syverson, 2011 in Li et al., 2024). TFP is an indicator in evaluating the level of productivity and technological development in a region.

The increasing inequality in the Eastern Indonesia Region (KTI) is explained by differences in regional characteristics that create divergent economic and development dynamics. The phenomenon of polarized development that occurs between regions is determined by structural characteristics such as human capital, demographic conditions, unemployment rates, government policies, and others (Paas et al., 2007 in Ladjin, 2019).

According to (Baktirani and Amin, 2023), from 2010-2021 the disparity in GRDP per capita between provinces in the KTI was classified as moderate and fluctuated. During the same period, the development of the Williamson Index in the Eastern Indonesia Region decreased, indicating a moderate inequality status. This indicates that with the implementation of regional autonomy and fiscal decentralization policies, income inequality between provinces is decreasing. Fluctuations in the level of inequality also indicate the inconsistent impact of policy interventions to reduce inequality between regions. On the other hand, it is also interesting to examine the dynamics of regional inequality in terms of productivity inequality (TFP).

Other studies also evaluate the importance of foreign investment, information, and communication technology development index, labor education level, and spatial dependence on productivity with different findings and their contribution to encouraging the process of productivity convergence between regions (Cardona et al, 2013 in Rath & Hermawan, 2019; Carbonell and Werner, 2018 in Yasin & Sari, 2022). On the other hand, there are different findings from previous research that productivity divergence has occurred in some regions (Kutlar et al., 2017; Napolitano, 2018; Turganbayev, 2017). Divergence occurs due to heterogeneity in regional characteristics such as differences in natural resource conditions, geographical conditions, inter-regional movement of factors of production, and substandard economic activities. This heterogeneity causes too high diversification of economic activities in each region, which has an impact on per capita income and causes inequality between regions (Ladjin, 2019).

This study analyzes productivity convergence among provinces in KTI in 2015-2022 where the determinants used are foreign investment, information and communication technology development index, and labor education. In answering the objectives, this study uses panel model econometric estimation and the Spatial Durbin Model to calculate productivity convergence between regions. The findings contribute to improving the understanding of how the convergence process occurs and how foreign investment, information and communication technology, and labor education level affect it by considering spatial aspects. This is important to consider in the formulation of policies that can encourage TFP convergence between regions in Eastern Indonesia.

From the existing inequality especially in KTI and the various efforts made by the government to reduce the inequality, there are variations in research results on the TFP convergence process and its influencing factors, as well as the lack of research on this topic at the provincial level in Indonesia.

Theoretical Framework

Concept of Convergence According to Neoclassical and Endogenous Growth Theories

In general, convergence is the idea of decreasing inequality. There are two main approaches to explaining economic growth: the factor production-based approach and the institution-based approach to economic growth theory. Neoclassical growth theory, which assumes diminishing returns to factors of production, including capital, predicts that income inequality will decline over time. This is known as convergence optimism. On the other hand, endogenous growth theory projects that disparities will continue to increase due to increasing returns to scale, known as convergence pessimism. Therefore, the endogenous growth theory states that in the long run government policies will have an impact on the growth rate of the economy, whereas in the neoclassical model, long-run growth is only affected by the savings rate.

Productivity in each region may differ due to various factors, but the main thing is how to predict such differences over time. In the Neoclassical model, capital per labor growth as well as exogenous technological development affects productivity growth. Capital is more abundant in more prosperous regions, so the incremental rate of return on capital investment is lower, resulting in slower economic growth. Furthermore, the spread of technology and innovation leads to convergence, with rich regions becoming centers of innovation and poorer regions adopting them at a lower cost than innovating themselves (Paas et al., 2007 in Ladjin, (2019). Therefore, differences in productivity result from variations in the rate of technological development (which is exogenous) and variations in the growth of the capital-to-labor ratio. Nevertheless, the model presupposes consistent scalability, diminishing returns concerning both capital and labor, as well as factor substitution without hindrances to the spread of technology. In the short term, regional productivity differences are estimated so that low-productivity

regions can catch up with high-productivity regions. In contrast, the endogenous growth model includes human capital as a variable and technological development is considered an endogenous variable. By including human capital in the model, there is no longer an assumption that capital will experience diminishing returns. Therefore, the convergence of per capita income in different regions does not occur even though the regions have similar savings rates, preferences, and technology.

The Concept of Convergence According to the New Economic Geography Growth Theory

The New Economic Geography (NEG) model describes variations in economic clustering geographically. The variation in regional growth is caused by increasing returns from spatial clustering in specialized economic activities, external economies, and endogenous effects of local specialization that lead to growth in the accumulation of skilled labor and the spread of local knowledge. The NEG model also explains that increasing returns at the individual producer level, imperfect competition, transport costs, and the movement of production factors and consumers are necessary conditions for agglomeration and core-periphery structures to occur. The NEG model asserts that location plays an important role in the economic activity of a region. The economic condition of a region, in addition to other factors, is strongly influenced by the location of the region as well as its neighbors. Therefore, less developed regions have a high potential for growth if there are more prosperous regions around them.

Total Factor Productivity

In neoclassical growth theory, there is an exogenous variable which is a combination of capital and labor variables and other variables that affect production and produce productivity called TFP. TFP can be in the form of technology or worker knowledge, where technological advances can cause an increase in the production function so that it can produce more output at certain inputs (Kim and Park, 2017 in Wahyuningsih & Budyanra, 2022). Mankiw, (2016) states that TFP is a measure of productivity that explains the impact of technology on the production process. TFP can explain the size of production efficiency through the influence of capital goods, human resources, and technology in economic growth. From this explanation, it can be

concluded that TFP is a measure of productivity described through the impact of the use of technology attached to human resources in a production process. In addition to production factors in the form of capital and labor, the existence of TFP elements in economic growth allows for a rapid economic growth process. In this case, TFP causes an increase in productivity and output to encourage an increase in workers' income. TFP is related to qualitative factors that can optimize the use of resources so that more output is produced for each unit of input.

Foreign Direct Investment

Zainol ABIDIN et al., (2021) define FDI as the transfer of capital including ownership and control by foreign parties of production facilities that occur. FDI can have a positive impact on the receiving country, namely the provision of long-term financing sources and capital formation, better international market access, technology transfer, increased sectoral and regional development, and increased employment. Investment in the form of foreign direct investment (FDI) affects increasing production efficiency, where FDI is complementary to human capital investment factors and specific sub-sector characteristics. With the high quality of human resources, the benefits of FDI are achieved because there is an increase in absorption capacity so that technology diffusion occurs quickly. Meanwhile, differences in technology intensity in the sector will create different FDI effects (Carbonell and Werner, 2018 in Yasin & Sari, 2022). FDI affects the facilitation of productivity improvements and technology spillovers, especially in the fields of science and economic improvement, where most FDI will be used to increase efficiency and profits.

ICT Development Index

Cardona et al., (2013) in Rath & Hermawan, (2019) in their research stated that the PTIK Index revolution has provided many innovations such as increased productivity in several countries. Certain scholars contend that the advancement of ICT will propel productivity growth as novel innovations emerge. Enhanced productivity within both the user and producer realms of Information ICT, achieved through the computerization of business and the broader economy, has been pivotal. Investments in ICT and Research

and Development (R&D) have played a crucial role in global growth, with economists assessing their impact through production theory.

Some research findings indicate that the direct effects of accumulating ICT capital and engaging in R&D have bolstered the growth of labor productivity. On the other hand, the secondary influence, manifested in value addition and productivity enhancement, surpasses the primary impact stemming from capital accumulation. This suggests that both the ICT Index and R&D exert an influence on productivity by fostering more effective production processes and enhancing product standards. Consequently, the ICT Index has facilitated the computerization of businesses and the overall economy, resulting in heightened productivity across ICT user and producer domains (Cardona et al., 2013 in Rath & Hermawan, 2019).

Labor Education

Capello and Lenzi, (2015) in Männasoo et al., (2018) stated that there is an interaction between TFP growth, R&D investment, and human capital, where the investment has a positive impact on TFP growth. In some studies, education is used as an interpretation of human capital. But in reality, there is still much debate about the impact of education on productivity. Puskarovaa and Piribauer, (2015) in Ladjin, (2019) stated that only about one-fifth of TFP growth can be achieved due to changes in human capital. Krugman, (1994) in Ariansyah, (2021) states that investment in human resources is a major factor in development because this investment can increase technological progress which ultimately affects the increase in population productivity. The occurrence of differences in economic growth in a region is due to differences in the stock of human capital, as research by Aghion and Howitt in Puspasari, (2019) states that a more educated and skilled labor force can meet employment requirements, through its response to innovation which can indirectly increase economic growth in a region. It can be said that high-quality human capital can increase the economic growth of a region through increased productivity of educated labor. Human capital is in the form of knowledge and skills obtained from education that can increase productivity.

Research Methods

This study uses quantitative methods that include descriptive analysis to explain the characteristics of TFP as well as explanatory analysis to explain the role of foreign investment, ICT Development index, labor education level, and spatial dependence on TFP and its convergence. In this study, the data used are panel data of 13 provinces in the period 2013-2022. TFP is formed on input factors, namely capital proxied by gross fixed capital formation and labor proxied by the number of workers. The following are indicators of TFP forming factors.

Indicators of TFP

Variable	Unit	Indicator	Notation	Source
		Input Factors		
Labor	person	Employed labor force	TK	BPS
Modal	million rupiahs	Gross fixed capital formation	PMTB	BPS
		Output Factor		
GDP	million rupiahs	Gross Regional Domestic Product	PDRB	BPS

Source; Author's analysis, (2024)

The determination of TFP value is carried out using econometric methods, namely random effect regression analysis based on Solow growth theory, through the Cobb-Douglas production function as follows.$Qt = At\ f(Kt^a, Lt^b)$

Notes:

Q = output; K = Capital stock; L = Labor

a = output elasticity of capital

b = output elasticity of labor

A = solow growth residual which is also called TFPonential, i.e. Ae^{dt} so:$Qt = Ae^{dt}Kt^aLt^b$

inearized to:$Ln\ (PDRB_{it}) = \alpha + \beta_1 lnTK_{it} + \beta_2 lnModal_{it} + \varepsilon_{it}$

$$\alpha + \epsilon_{it}$$

ng the coefficient of each variable, the value is used to calculate the TFP value with the following equation.$Ln(TFP_{it}) = \alpha + \epsilon_{it} = Ln\ (PDRB_{it}) - \beta_1 lnTK_{it} - \beta_2 lnModal_{it}$

$TFP = e^{lnTFP}$

Notes:

TFP_{it} = TFP of province i in period t

$Ln\ (PDRB_{it})$ = natural log of GDRP at current prices of the province i in the period t

$lnModal_{it}$= natural log of total capital value of the province i in the period t

$lnTK_{it}$ = natural log of number of labor of the province i in the period t

ϵ_{it}= composite error component of the model in individuals i in the period t

Where:

$\epsilon_{it} = \mu_i + v_{it}$

i = 13 province in KTI

t = year of 2015-2022

Explanatory analysis to explain the process of TFP convergence between regions and the influence of its determinants. The variables used in this study are as follows.

Research Variables

Variable	Unit	Method/Indicator	Notation	Source
TFP	Point	Response Variable Multiple Linear Regression	TFP	Researcher calculation
Initial TFP	Point	Predictor Variable Multiple Linear Regression	TFP t-1	Researcher calculation
ICT	Point	ICT Development Index	TIK	BPS
Foreign Investment	Million Rupiahs	FDI Value	PMA	BPS
Human Resources	Person	Workers with at least a high school education	Pendidikan Tenaga Kerja	BPS

Source; Author's analysis, (2024)

Spatial Dependence Test

In this study, the existence of spatial linkages is tested through the Moran Index which is calculated by the following formula.

$$I = \frac{N \sum_{t=1}^{N} \sum_{j=1}^{N} W_{ij}(Y_i - \bar{Y})(Y_j - \bar{Y})}{\sum_{t}^{N} \sum_{j}^{N} W_{ij} \sum_{i=1}^{N} (Y_i - \bar{Y})^2}$$

Moran's index is used to calculate the relationship between one variable Y where Y_i is for region i and Y_j is for region j with N data points. $\bar{Y}$ is the average observed value and

W_{ij} is the standardized weight matrix element. The Moran Index has a value with a range between -1 and 1. To identify spatial linkage patterns, the Moran Index value criterion is used and compared with the E(I) value. E(I) is the expected value of the Moran Index which is calculated using the following formula.

$$E(I) = -\frac{I}{N-1}$$

If the value of I>E(I) means that the data has positive autocorrelation and has a clustered pattern with similar characteristics. If the value of I<E(I) means that the data has negative autocorrelation and has a spread pattern. Meanwhile, if the value of I=E(I) means that there is no autocorrelation between regions (Griffith, 2009).

The Role of Foreign Investment, ICT Development Index, Labor Education and Spatial Linkages on Beta Convergence

In analyzing the role of foreign investment, information and communication technology development index, and labor education on beta convergence spatially, this study uses the Spatial Durbin Model. So the conditional beta convergence model by including spatial effects is as follows.

$$ln\frac{y_{i,t}}{y_{i,t-1}} = \alpha + \beta_0 \ln(y_{i,t-1}) + \beta_1 PMA_{i,t} + \beta_2 TIK_{i,t} + \beta_3 PendTenagaKerja_{i,t} + \beta_4 \ln(SPy_{i,t-1}) + \beta_5 SPPMA_{i,t} + \beta_6 SPTIK_{i,t} + \beta_7 SPPendTenaga\ Kerja_{i,t} + u_{i,t}$$

Notes:

$subscriptionsy_{i,t}$ is a variable that represents the level of productivity by proxy TFP province *i* in year t

$y_{i,t-1}$ is the previous year's TFP

PMA is the value of a foreign investment

TIK is the value of the ICT development index

$PendTenagaKerja$ is the number of workers with at least high school education

$SPy_{i,t-1}$, $SPPMA_{i,t}$, $SPTIK_{i,t}$,$SPPendTenagaKerja_{i,t}$ is the spatial lag of the variable $y_{i,t-1}$, $PMA_{i,t}$, $TIK_{i,t}$, and $PendTenagaKerja_{i,t}$.

The choice of Spatial Durbin Model is due to its ability to explain that the productivity level of a region is not only influenced by internal factors and productivity

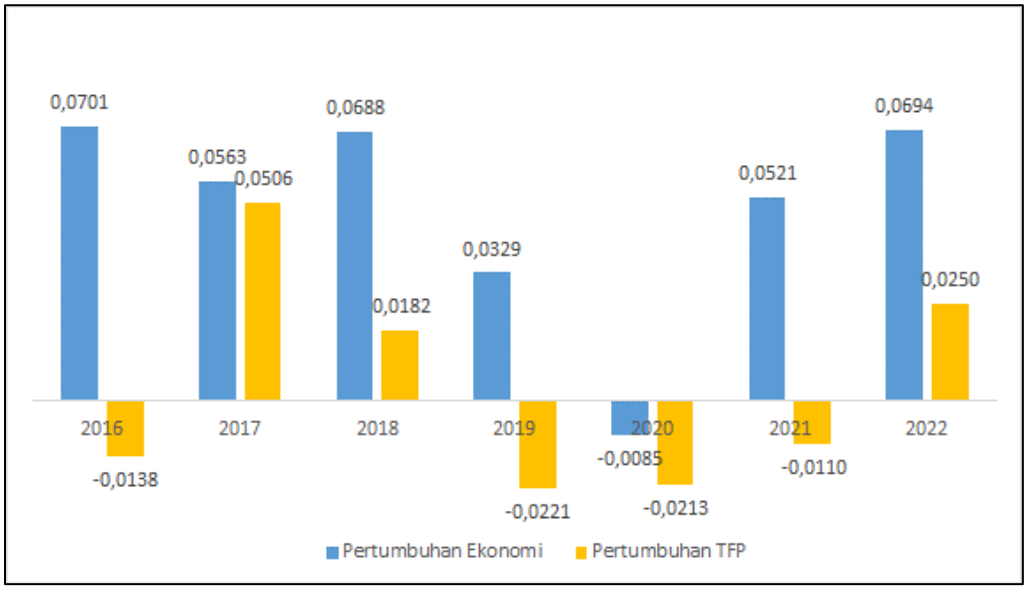
of the region but also by factors from other regions. In this model, productivity and production factors in neighboring region i are explained by the $SPy_{i,t-1}$, $SPPMA_{i,t}$, $SPTIK_{i,t}$, $SPPendTenagaKerja_{i,t}$.

Discussion of Research Results

Total Factor Productivity

TFP is a measure of productivity that explains the impact of technology on the production process (Mankiw, 2016). An overview of the average TFP growth in KTI in 2015-2022 is presented in the following figure.

Average TFP Growth in KTI 2015-2022



Source; Author's analysis, (2024)

According to the figure above, the average TFP growth in KTI during the 2015-2022 period was below the average economic growth in all provinces. This shows that economic productivity has not been optimized. During this period, TFP growth fluctuated, reaching its peak in 2017 with a value of 0.0506, while its lowest point occurred in 2019 with a value of -0.0221. This indicates that technological improvement had an impact on economic productivity in 2017, while technological decline affected economic productivity in 2019.

Beta Conditional Convergence

The parameter estimation results of the SDM modeling are presented in the following table.

Parameter Estimation Results of SDM Model

Parameter	Coefficient	p-value
Constanta	3,632447	0,007***
LNTFPt1	0,9800677	0,000***
LNPMA	0,0065491	0,067*
TIK	-0,0098117	0,198
LnPendTenagaKerja	-0,0150051	0,160
Lag. LNTFPt1	-0,498902	0,001***
Lag. LNPMA	0,030488	0,069*
Lag. TIK	0,0306375	0,035**
Lag. LnPendTenagaKerja	-0,1295086	0,003***
Rho	0,1760228	0,324
Lambda	-	-
AIC	-322,4659	
R^2	0,9983	

Notes: *** significant at the 1% level, ** significant at the 5% level, * significant at the 10% level
Source; Author's analysis, (2024)

Beta conditional convergence indicates the divergence process by including the initial TFP variable and foreign investment variable, information and communication technology development index, and labor education as independent variables. From the analysis using SDM, the coefficient of initial TFP is positive and significant at 1%. This indicates that there has been a conditional beta divergence with a speed of 8.54% per year.

The analysis shows that FDI has a positive and significant effect on TFP with a coefficient of 0.0065491 which means that for every 1% increase in FDI, TFP will grow by 0.0065491% (ceteris paribus) and divergence will increase by 0.0065491% assuming other variables are held constant. Spatially, FDI also has a positive and significant effect on TFP with a coefficient of 0.030488, which means that a 1% increase in FDI on TFP in a region results in an increase of 0.030488% in TFP in its neighboring regions. In addition, it is known that the ICT Development Index has no effect on TFP with a coefficient of -0.0098117, which means that for every 1% increase in the ICT

Development Index, TFP will decrease by 0.0098117% (ceteris paribus) and does not encourage divergence. Spatially, the ICT Development Index has a positive and significant effect on TFP with a coefficient of 0.0306375, indicating that a 1% increase in the ICT Development Index on TFP in a region results in an increase of 0.0306375% in TFP in its neighboring regions. Another finding of this study is that labor education has no effect on TFP with a coefficient of -0.0150051 which means that for every 1% increase in labor education, TFP will decrease by 0.0150051% (ceteris paribus) and does not encourage divergence. Spatially, labor education has a negative and significant effect on TFP with a coefficient of -0.1295086, meaning that a 1% increase in labor education on TFP in a region results in a decrease of 0.1295086% in TFP in its neighboring regions.

Beta conditional convergence implies that an economy grows faster than its steady state. The use of the conditional beta convergence measure occurs when the relationship between per capita income growth and initial per capita income is affected by other variables such as investment, savings, population growth, and other factors. Paas et al., (2007) in Ladjin, (2019) added that in conditional beta convergence, a negative relationship arises when regions have similar structural characteristics, such as human capital, demographic conditions, unemployment rates, government policies, and others. A negative relationship can also occur between growth rate and distance if income levels are not in equilibrium at the steady state. Therefore, a rich region does not necessarily have to grow slower than a poor region because the position of the rich region has already passed the steady state equilibrium point. Foreign investment, the PTIK Index, and labor education are some of the elements that form structural characteristics of regions that can trigger the convergence process or vice versa.

Latip, (2009) stated that FDI entering a country will bring technology and knowledge as well as increased managerial capabilities, thus triggering an increase in TFP and also an increase in TFP inequality. FDI has a significant influence on regional productivity with the construction of new factories that can absorb labor and increase demand for capital goods originating from a region. Increased employment opportunities in these new factories have a positive impact on the economy of a region. Putri & Idris, (2020) said that in the short term, the ICT Development Index has no effect on TFP

growth because the spread of ICT must be accompanied by sufficient knowledge and competence to adopt technology to achieve maximum results. Conversely, ICT development that is not accompanied by an increase in knowledge and competence will make the ICT Development Index not encourage productivity growth.

Akinlo and Adejumo, (2016) stated that TFP growth is not significantly affected by human capital, and even tends to have a negative impact. Human capital and TFP growth having a negative correlation indicates a low level of income in a country. This can also be caused by low education with a focus on skill development. Supporting this, Hia, (2009) in Sianturi et al., (2016) argues that a high number of labor does not always have a positive impact on productivity. On the contrary, the use of labor that is not balanced with the needs can have a negative impact on productivity. In the new economic geography model, it is stated that location plays an important role in economic activities in a region, where the economic conditions of a region depend on the region itself and the surrounding areas. In their research, Mossiet et al., (2003) stated that regions adjacent to richer regions have a greater opportunity to increase their income. This is because when a region borders a richer region, it will support its economic activities through strong trade relations between the two (Alvarez and Barbero, 2016).

Conclusions

There are several conclusions from this study. First, there has been a conditional beta divergence of TFP with a speed of 8.54% per year. Second, that FDI has a positive and significant influence on TFP and encourages the speed of TFP divergence. This is due to the uneven concentration of FDI in provinces in KTI. The ICT Development Index and the level of labor education do not have a significant effect on TFP and its divergence. This is because other factors outside the study are more influential on TFP and its convergence. Third, spatial dependence plays a role in TFP growth and encourages the divergence process in KTI. This is because regions that neighbor regions with higher TFP will have greater potential to increase the region's TFP.

Suggestions

The author can give suggestions from the research that has been done such as the need to determine development priorities in the aspects of foreign investment, ICT, and human resources that are more effective in encouraging TFP growth and accelerating TFP convergence between regions. In addition, the need for the effectiveness of development policies in the aspects of foreign investment, ICT, and human resources in each province played by the central government that can intervene in policies at the local government level (regional regulations) so as not to hinder the process of productivity convergence between provinces.

This study has not included other variables besides the current model and has not used other spatial regression models (e.g. Spatial Durbin Error Model) as an alternative comparison model where it is still possible for spatial effects to occur in the error variable. Future research needs to use the Spatial Durbin Error Model (SDEM) as an alternative model to the Spatial Durbin Model (SDM) where it is still possible for spatial effects to occur in error variables and use the Human Capital Index as a proxy for human capital indicators. In addition, future research also needs to use the elasticity coefficient values on the TFP-forming variables calculated in each province so that the estimation is more realistic.

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