

THE DYNAMICS MODEL OF CROSS-REGIONAL TO ENHANCE ECONOMIC GROWTH: NEW EMPIRICAL EVIDENCE FROM INDONESIA

Lilis Siti Badriah¹, Arintoko¹

Received 05.06.2024.

Sent to review 20.06.2024.

Accepted 28.09.2024.

Original article



¹ Universitas Jenderal Soedirman,
Faculty of Economics and Business,
Department of Economics, Indonesia

Corresponding Author:

Lilis Siti Badriah

Email: lilis.badriah@unsoed.ac.id

JEL Classification: O1, O3, O4

Doi: 10.2478/eoik-2024-0046

UDK: 330.35.01:336.1/.5(594)

ABSTRACT

Economic growth is crucial to improve community welfare in the long term. Although Indonesia's economic growth is on an upward trend, Indonesia must remain vigilant in its relationship with the global world due to the rapidly changing and highly uncertain dynamics. Indonesia's economic growth is also inseparable from the influence of various provinces' economic growth, which varies due to the economic dynamics between regions. These dynamics can influence the region's contribution to national economic growth. Therefore, identifying the important role of the determining factors of economic growth and appropriate policies in dealing with economic dynamics between regions is crucial because sustainable economic growth is also essential for improving community welfare. This study examines the determinants of Indonesia's economic growth from a regional economic perspective, using a Dynamic Panel Data analysis model with three estimation models. The first model focuses on the primary variables of technological progress, population, and investment. The second model adds the human capital variable, while the third model further incorporates the variables of open economy, economic structure changes, and income inequality. The study utilizes data from the Indonesian Central Statistics Agency, covering 27 provinces from 2015 to 2022. The results indicate that increased technological progress, population, investment, human resources, economic openness, and economic structure changes can increase economic growth, while inequality of income harms economic growth. This research has implications that in creating determinant conditions for conducive economic growth, it needs to be carried out evenly in all provinces in Indonesia.

Keywords: *economic growth, technological progress, population, investment, human capital, open economic, structural change, income inequality, Dynamic Model*

1. INTRODUCTION

Economic development remains a pivotal concern for nations globally, including Indonesia, which has demonstrated a growth trajectory while grappling with the complexities of sustainable development. Economic development aims to enhance the welfare of communities, with success often measured through economic growth (Ahmad et al., 2020; Ibn-Mohammed et al., 2021). According to Dinh et al. (2019), increasing economic growth can align with and improve people's quality of life.

For Indonesia, an archipelagic country with diverse regions and significant natural resources, pursuing economic growth is intertwined with addressing infrastructure challenges, poverty reduction, and equitable development. In Indonesia, economic growth has shown an upward trend from 4.88% in 2015 to 5.31% in 2022, with variations across provinces reflecting regional economic dynamics (Central Statistics Agency, 2023). Despite growth, Indonesia faces challenges adapting to global economic uncertainties and maintaining sustainable development.

In line with Indonesia's economic growth, structural changes are evident, with a shift from primary to non-primary sectors, particularly in manufacturing, which increased its GDP contribution from 25.9% in 2015 to 26.9% in 2022 (Central Statistics Agency, 2023). However, the adaptation of human resources to these changes remains uneven, as reflected in the Gini index, indicating persistent income inequality despite some improvement.

The foundation of economic growth theory is rooted in classical and Neo-classical economics, which highlight several determinants of growth: capital accumulation, population growth, land area, natural resources, and technology (Todaro & Smith, 2012).

Capital accumulation is critical for long-term economic growth (Huseynli & Huseynli, 2024). Investment can increase capital accumulation, technology diffusion, and productivity to drive economic growth (Zafar et al., 2019). Classical and Neo-classical theories emphasize investment's role in enhancing labor productivity and per capita output (Romer, 1990; Solow, 1956). It is supported by findings that increased investment accelerates economic growth (Alwakid et al., 2021). Economic growth can increase the level of financial development through increased savings, investment, and technological advancements (Omair et al., 2024). Regarding investment variables, the phenomenon of inter-provincial investment conditions in Indonesia, as measured by the ratio of capital to RGDP, varies widely. During 2017-2022, the highest investment value was in North Maluku Province, with a value of 50.21%, while the lowest was in Bali Province, at 18.23% (Central Statistics Agency, 2023).

Population growth and an expanding workforce are positive factors for economic growth. A larger workforce enhances productivity and market size, stimulating growth (Bekun et al., 2019; Brida et al., 2024; Chinoda & Kapingura, 2024). The quality of human capital, which improves labor productivity, is crucial for sustainable growth (Rahim et al., 2021; Yang et al., 2017). Regarding the population variable, the number of productive age populations between provinces in Indonesia also varies (Prasetyo et al., 2024). During 2017-2022, the highest population was in West Java Province, with 21,882,330 persons, while the lowest was in West Papua Province, with 453,608 persons (Central Statistics Agency, 2023).

In addition, technological progress is fundamental to economic growth, enhancing production efficiency and fostering innovation. Technological readiness drives economic efficiency and can increase productivity and competitiveness. Technological advancement is the key to growth (Škuflić et al., 2024; Yang et al., 2017; Zhou et al., 2021). The theory of endogenous growth underscores the role of technological change and investment in driving growth (Aghion & Howitt, 1992; Grossman & Helpman, 1991; Romer, 1990; Stanley et al., 2018; Yang et al., 2017; Zhou et al., 2021). Technological advances can be reflected in labor productivity indicators. Regarding the variable of technological progress, the phenomenon of technological progress between provinces in Indonesia, which is measured by the ratio of output to the number of workers, also varies greatly. During 2017-2022, the highest technological progress was in DKI Jakarta Province at 0.38%, while the lowest was in East Nusa Tenggara Province at 0.03% (Central Statistics Agency, 2023).

Todaro & Smith (2012) show that through export-led growth, economic openness can positively impact economic growth by expanding market reach and creating demand for labor and

capital. It aligns with endogenous growth theories that highlight the benefits of global market participation, including technology transfer and increased competitiveness (Acemoglu & Zilibotti, 1997; Intisar et al., 2020; Khan et al., 2022; Stojanović & Puška, (2021); Raghutla, 2020; Rodrik, 1998). Regarding the variable of economic openness, the level of economic openness between provinces in Indonesia, which is measured by the value of net exports to RGDP, also varies. During 2017-2022, the highest level of economic openness was in West Papua Province, reaching 37.61%, while the lowest level was in East Nusa Tenggara Province, with a value of 2.19% (Central Statistics Agency, 2023).

Another factor affecting economic growth is a change in the economic structure. Structural transformation towards more productive sectors can enhance development sustainability and economic growth (Zhou et al., 2021). The structural change theory shows that diverting inputs to more productive sectors will improve the quality of human resources, productivity, and economic diversification. It can ultimately encourage economic growth (Erumban et al., 2019; Hausmann, 2012; Lewis, 1954). However, mismatches in human resources' adaptation to these changes can lead to inequality (Bekun et al., 2019). Regarding the variables of changes in economic structure, the phenomenon of changes in the economic structure between provinces in Indonesia, as measured by the contribution of the industrial sector to the RGDP, also varies. During 2017-2022, the highest change in economic structure was in Riau Islands Province, reaching 58.85%, while the lowest change in economic structure was in Bengkulu Province by 10.91% (Central Statistics Agency, 2023).

The relationship between income inequality and economic growth is complex. The Equality Growth Theory posits that more equitable income distribution improves access to essential services, fostering human capital development and economic growth (Breunig & Majeed, 2020; Galor & Zeira, 1993; Milanovic, 2016). Regarding income inequality, conditions between provinces in Indonesia also vary. During 2017-2022, the highest inequality was in the Province of Yogyakarta at 0.436, while the lowest was in the Province of Bangka Belitung Islands at 0.263 (Central Statistics Agency, 2023).

Previous research has explored various factors affecting economic growth, including (1) human capital (Affandi et al., 2019a; Anetor, 2020; Azam, 2019; Dinh et al., 2019; Garza-Rodriguez et al., 2020; Intisar et al., 2020; U. Khan et al., 2022; Musibau et al., 2019; Zhang et al., 2020). (2) technological progress (Zhang et al., 2020). (3) Investment (Anetor, 2020; Azam, 2019; Dinh et al., 2019; Garza-Rodriguez et al., 2020; Intisar et al., 2020). (4) economic openness (Intisar et al., 2020; U. Khan et al., 2022; Raghutla, 2020). (5) income inequality (Azam, 2019; Breunig & Majeed, 2020; Younsi & Bechtini, 2020). (6) economic structural change (Erumban et al., 2019; S. Zhang et al., 2020). (7) population (Brida et al., 2024; Intisar et al., 2020).

However, there are inconsistencies between the previous research findings and the economic growth theory. It can be seen in the variables of economic structural change in the research of Aggarwal (2018), which shows that the changes harm economic growth in India because the sectoral shift towards high-productivity sectors cannot create jobs for a relatively large population. That result aligns with Zhang et al. (2020), who state that structural change harms economic growth in China. Theoretically, the economic structural change indicates a shift in sectoral roles from less productive to more productive sectors. When productivity increases, it should positively impact economic growth (Hausmann, 2012; Lewis, 1954).

Then, in the Investment variable, Intisar et al. (2020) show that investment harms economic growth in West Asia, while the research of Anetor (2020) shows that in Sub-Saharan Africa, investment has no impact on economic growth. Theoretically, when investment increases, it can impact increasing economic activities and expanding employment opportunities to increase labor productivity and per capita output. Increasing productivity can increase economic growth

(Romer, 1990; Solow, 1956).

Furthermore, there is inconsistency in the variable of income inequality. The research of Aiyar & Ebeke (2020), Blotevogel et al. (2022), and Marrero & Servén (2022) show that there is an unstable connection between economic growth and inequality. Theoretically, the Equality Growth Theory states that improving the quality of human resources can be encouraged through equitable income distribution. It aligns with several previous researchers (Berg et al., 2018; Breunig & Majeed, 2020; Ferreira et al., 2022; Milanovic, 2016; Younsi & Bechtini, 2020) who state that income inequality harms economic growth. Diverse results are shown by the research of Brueckner and Lederman (2018), which shows that inequality in poor countries has a detrimental impact on their economic growth, while inequality in wealthy countries has a beneficial impact on their economic growth.

It is then related to the variable of economic openness. The research of Huchet-Bourdon et al. (2018) shows the negative impact of economic openness on economic growth, while Intisar et al. (2020) shows that economic openness is an important driving factor affecting economic growth. It aligns with Sarigül & Apak (2024), which shows the connection between economic growth and long-term trade openness in nine countries that are the object of his research.

Based on the previous description, economic growth is a prerequisite for improving people's welfare. Varying economic growth between provinces can make its contribution to national economic growth suboptimal. The difference in the growth of the economy between provinces in Indonesia is inseparable from the dynamics of factors that influence economic growth in each province. Therefore, it is necessary to strengthen Indonesia's economic growth by identifying the determinants of economic growth as a reference for taking the necessary policies and strategies to increase economic growth.

Inconsistencies in findings across different contexts highlight the need for further investigation. Therefore, this study intends to analyze the factors that affect economic growth by paying attention to the dynamics of conditions between regions in Indonesia. The influence of human resources, technology, investment, economic openness, income inequality, structural changes, and population growth on economic growth is complex. Understanding these factors can help the government develop more effective policies and strategies to encourage sustainable economic growth.

This study has a novelty, namely the existence of determinants of economic growth that are used together in one study, namely technological advancement, investment, population growth, human capital, economic openness, changes in economic structure, and income inequality. The study was carried out by testing three estimation models, which were carried out by gradually adding free variables into the model, while in previous studies, no one has done this. This study was also carried out by paying attention to the dynamics of the economy between regions in a country, namely the dynamics of the economy between provinces in Indonesia. This study also has novelties not found in previous research, namely, using three estimation models to apply the dynamic data panel model. In modeling, support for the novelty of this study is the formulation of a dynamic model that comprehensively involves selected variables that theoretically and empirically influence growth and is applied to cross-regional growth.

2. RESEARCH METHODOLOGY

2. 1. DATA AND VARIABLES

The research uses secondary data from the Indonesian Central Statistics Agency, which is analyzed quantitatively. The research variables used consist of economic growth as a dependent variable and Technological Progress, Investment, Number of Population, Human Capital, Open

Economy, Structural Change, and Inequality as Independent Variables. The definition and measurement of variables are presented in Table 1. The data related to these variables comes from data from 27 provinces in Indonesia during the period 2015-2022. Panel data analysis involves diverse provinces in Indonesia, mainly in terms of area, population size, geographical location, and economic structure, so there are variations between provinces for the values of the variables analyzed in the model.

Table 1. Definition and measurement of variables

Variable	Abbreviation	Definition	Measurement
Gross Regional Domestic Product	RGDP	The value of actual output produced within the province during the year	Expressed in millions of rupiah and transformed into natural logarithm (ln)
Technological progress	TP	The use of more advanced production methods and techniques to increase labor productivity (effective labor)	The ratio between output to the number of workers, and expressed in decimal numbers
Investment	INV	The amount of physical capital used in the development process, both domestic and foreign capital	Ratio of capital to RGDP in percent
Population	POP	The number of productive populations in 27 provinces in Indonesia	The number of productive age workers in 27 provinces in Indonesia per year, expressed in people
Human Capital	HC	Quality of human resources	Human Development Index (HDI), expressed in index
Economic openness	OPEN	Economic participation in international trade as a result of the elimination of tariff and quota barriers	Net Export to GDP Ratio, expressed in percent
Economic Structural Change	SC	Changes in the proportion of dominant contribution to National Income from the Agricultural Sector to the Industrial Sector	The proportion of the industrial sector's contribution to RGDP, expressed in percent
Income inequality	INEQ	Differences in income received between community income groups	Gini ratio, expressed in index numbers

Source: Indonesian Central Statistics Agency and author's formulation

3. MODEL

The model in this study uses Dynamic Panel Data Models. The estimation technique used is a first-difference estimator, which eliminates fixed effects and time invariance. The general form of dynamic linear panel data is as follows:

$$y_{it} = \phi y_{it-1} + x'_{it} \beta + u_{it} \quad (1)$$

Where:

$$u_{it} = \mu_i + \varepsilon_{it} \text{ and } \varepsilon_{it} \sim N\left(0, \sigma^2_{\varepsilon}\right)$$

ϕ is the parameter of autoregressive

y_{it-1} is the lagged dependent variable

x_{it} is the independent variable vector

The model in this study is developed into three equations From the general form of the dynamic panel in Equation (1). Equation (2) is the baseline model. This Equation includes regional output (LNRGDP) as the dependent variable and technological progress (TP), investment (INV), and population (LNPOP) as explanatory variables. Equation (3) extends the baseline model by adding human capital (HC) as an explanatory variable. Equation (4) is an extension model of Equation (3) by adding openness (OPEN), structural change (SC), and inequality (INEQ) as explanatory variables.

$$LNRGDP_{it} = \alpha_1 LNRGDP_{i,t-1} + \alpha_2 TP_{i,t} + \alpha_3 INV_{i,t} + \alpha_4 LNPOP_{i,t} + u_{1i,t} \quad (2)$$

With expected parameters: $\alpha_1 > 0$, $\alpha_2 > 0$, $\alpha_3 > 0$, $\alpha_4 > 0$

$$LNRGDP_{it} = \beta_1 LNRGDP_{i,t-1} + \beta_2 TP_{i,t} + \beta_3 INV_{i,t} + \beta_4 LNPOP_{i,t} + \beta_5 HC_{i,t} + u_{2i,t} \quad (3)$$

With expected parameters: $\beta_1 > 0$, $\beta_2 > 0$, $\beta_3 > 0$, $\beta_4 > 0$, $\beta_5 > 0$

$$LNRGDP_{it} = \gamma_1 LNRGDP_{i,t-1} + \gamma_2 TP_{i,t} + \gamma_3 INV_{i,t} + \gamma_4 LNPOP_{i,t} + \gamma_5 HC_{i,t} + \gamma_6 OPEN_{i,t} + \gamma_7 SC_{i,t} + \gamma_8 INEQ_{i,t} + U_{3i,t} \quad (4)$$

With expected parameters: $\gamma_1 > 0$, $\gamma_2 > 0$, $\gamma_3 > 0$, $\gamma_4 > 0$, $\gamma_5 > 0$, $\gamma_6 > 0$, $\gamma_7 > 0$, $\gamma_8 < 0$

The application of panel data considers that panel data can model the behavior of joint and individual groups. The benefits of panel data are that it can provide more variability, information, and efficiency than pure time series or cross-sectional data. In addition, statistical impacts that cannot be obtained from pure time series or cross-sectional data can be identified using panel data. This study uses the Generalized Method of Moments (GMM) to estimate the dynamic panel regression model. GMM has advantages in cases of endogeneity, measurement error, and momentum constraints. In addition, models with the method can perform better in cases with non-linearities, heteroscedasticity problems, and autocorrelation in the data. A dynamic panel model with the GMM method was used in previous studies on economic growth analysis, among others, by [Khan et al. \(2019\)](#), [Sebki \(2021\)](#), and [Sumaira & Bibi \(2022\)](#).

4. RESULTS

Table 2 until Table 5 show the results of data analysis from the model used in this study. Table 2 presents a statistical summary of the variables in the model. Because it is a panel data that combines province and time, the statistical description shows high variation compared to pure time-series and cross-sectional data. In addition to variations between provinces, there are also variations between years. The variable with the most significant value data is Regional Gross Domestic Product (RGDP), while the variable with the most minor value data is technological progress (TP). Judging from the statistical summary, RGDP has statistical characteristics that show the highest variation compared to other variables. The wide gap between the mean and median and the extensive range and standard deviation marks the high variation of RGDP between provinces in Indonesia. However, the population between provinces also varies highly. The stark difference in population size between Javanese and non-Java provinces shows the variation in population size between provinces in Indonesia. The variation in economic openness (OPEN) between provinces is also significant because of its positive and negative values. Some provinces with negative net exports have negative economic openness, while others with positive net exports have positive economic openness. If exports exceed imports, a province will have positive net exports, and vice versa. Meanwhile, human capital (HC), structural change (SC), and income inequality (INEQ) have relatively low variations because the three variables are indices and proportions between 0 – 100. The difference in human capital, structural changes, and income inequality be-

tween provinces is also insignificant compared to the difference between RGDP and population.

Table 2. Summary statistics

Variable	Mean	Median	Maximum	Minimum	Std. Dev.
RGDP	3.35E+08	1.35E+08	1.95E+09	20380304	4.80E+08
TP	0.0847	0.0687	0.4007	0.0249	0.0671
INV	33.1956	31.7401	74.5160	16.4056	7.8236
POP	4243229	2244309	23099397	384629.5	5799154
HC	70.2439	70.2700	81.6500	57.2500	4.3932
OPEN	-1.9152	2.1927	40.6882	-57.4645	17.9624
SC	27.2864	24.2961	61.3692	10.5831	12.6795
INEQ	0.3566	0.3592	0.4490	0.2455	0.0402

Source: Author's calculation

Table 3 summarizes the correlation between the explanatory variables and RGDP (in ln) with two lags and two leads. This correlation summary supports the analysis of the panel dynamics model for interprovincial economic growth in Indonesia. The correlation coefficient between the LNRGDP and each explanatory variable decreases as the lag and lead increase. The explanatory variable that has the strongest correlation with LNRGDP is population (LNPOP), while the smallest correlation coefficient is between LNRGDP and investment (INV).

Table 3. Correlation between variables in the model

Correlation		i	Lag	Lead
With Lag	With Lead			
LNRGDP,TP(-i)	LNRGDP,TP(+i)	0	0.3994	0.3994
		1	0.3397	0.3516
		2	0.2825	0.2997
LNRGDP,INV(-i)	LNRGDP,INV(+i)	0	-0.1115	-0.1115
		1	-0.0708	-0.1221
		2	-0.0429	-0.1235
LNRGDP,LNPOP(-i)	LNRGDP,LNPOP(+i)	0	0.9152	0.9152
		1	0.8003	0.7995
		2	0.6855	0.6849
LNRGDP,HC(-i)	LNRGDP,HC(+i)	0	0.4219	0.4219
		1	0.3638	0.3628
		2	0.3082	0.3041
LNRGDP,OPEN(-i)	LNRGDP,OPEN(+i)	0	0.2914	0.2914
		1	0.2506	0.2555
		2	0.2120	0.2159
LNRGDP,SC(-i)	LNRGDP,SC(+i)	0	0.5642	0.5642
		1	0.5002	0.4876
		2	0.4327	0.4127
LNRGDP,INEQ(-i)	LNRGDP,INEQ(+i)	0	0.2881	0.2881
		1	0.2460	0.2418
		2	0.2061	0.2090

Source: Author's calculation

The GMM dynamic panel model estimation results are presented in Table 4 and Table 5. Table 4 shows the estimated result of the basic model (Model 1) as in Equation (2). With a p-value of 0.01, technological progress (TP), investment (INV), and population (POP) significantly affect the Regional Gross Domestic Product (RGDP) positively. Meanwhile, the one-year lag of RGDP significantly increases RGDP, so there is a tendency for RGDP to increase in the long term. An increase in last year's RGDP of one percent would increase the RGDP by 0.4272 percent.

Table 4. Model estimation results with dynamic panel GMM (cross-section fixed)

Variable	Model 1	Model 2	Model 3
LNRGDP(-1)	0.4272***	0.1212***	-0.1508***
TP	0.6710***	1.0285***	0.4332***
INV	0.0068***	0.0075***	0.0133***
LNPOP	0.8328***	0.4470***	0.2797***
HC		0.0431***	0.0562***
OPEN			0.0103***
SC			0.0060***
INEQ			-0.6153***
J-Statistic	26.447	25.2323	20.799
Arellano-Bond SC Test	AR(2): -0.8669	AR(2): -1.45867	AR(2): 0.0282

*** significant at $\alpha = 0.01$

Source: Author's calculation

In the results of model 2 estimation, adding the variable control human capital (HC) improves the model's performance with a significant influence of four explanatory variables together on the RGDP. RGDP lag, technological advancement, investment, and population consistently significantly benefit the economy's growth at the p-value of 0.01. In model 2, human capital also significantly benefits RGDP. Technological progress has the most significant regression coefficients, which show the dominance of influence on RGDP.

Based on model 3 with a cross-section fixed in Table 4, the addition of economic openness (OPEN), structural changes (SC), and income inequality (INEQ) contributed to the determinants of inter-provincial growth in Indonesia. Economic openness and structural changes positively affect the RGDP, while income inequality harms the GRDP at a p-value of 0.001. Economic openness and structural change from less productive sectors to more productive sectors have an impact on increasing economic growth, while income inequality has an impact on reducing economic growth. Model 3 shows that all the independent variables used are suitable predictors for explaining economic growth between regions. Overall, the explanatory variables in model 3 have a significant effect according to the hypothesis expectations. Meanwhile, all models generated from the GMM Dynamic Panel analysis by paying attention to cross-section and fixed periods can be seen in Table 5.

Table 5. Model estimation results with dynamic panel GMM (cross-section and period fixed)

Variable	Model 1	Model 2	Model 3
LNRGDP(-1)	0.5669***	0.7973***	0.0605
TP	0.5397***	0.3450***	0.2484***
INV	0.0041***	0.0018***	0.0134***
LNPOP	0.2191***	0.0947***	0.1084**
HC		-0.1566***	-0.0187
OPEN			0.0126***
SC			0.0039***
INEQ			-0.3031
Period fixed:			
2017	0.0145***	0.0955***	0.0471***
2018	0.0152***	0.1065***	0.0480***
2019	0.0071***	0.1002***	0.0499***
2020	-0.0382***	-0.0409***	-0.0345***
2021	0.0440***	0.0904***	0.0196***
2022	0.0211***	0.1126***	0.0437***
J-Statistic	20.3927	16.4439	11.1746

*** significant at $\alpha = 0.01$; ** significant at $\alpha = 0.05$

Source: Author's calculation

Table 5 summarizes the results of the model estimates by including the fixed period for 2017 to 2022 in all models. The estimation results show that the core variables, namely technological progress (TP), investment (INV), and population (LNPOP), robustly have a positive effect on RGDP. The parameters of the estimation results show the average variation of RGDP between years during the study period. 2020 was the year with the lower average RGDP during the study period. The year 2020 was when the economy was affected by the COVID-19 pandemic, which caused the average RGDP to fall and triggered a decline in growth between regions.

5. DISCUSSION

The analysis of dynamic data panels in the basic model (model 1) shows that technological advancement, investment, and population growth significantly positively affect economic growth in Indonesia. It shows that increasing technological advances can increase labor productivity in producing output. It follows previous research results (Aghion & Howitt, 1992; Grossman & Helpman, 1991; Romer, 1990; Stanley et al., 2018; Yang et al., 2017; Zhou et al., 2021).

According to Sima et al. (2020), Technological advances have been a driver of human capital development since the beginning of civilization. Technological advances can increase efficiency and increase innovation. Technological advances can also improve product quality, encourage productivity, and create new jobs so that, ultimately, technological advances can have an impact on increasing economic growth (Ma et al., 2022; Ren et al., 2021; Sima et al., 2020).

Likewise, if investment in a region increases, economic growth will increase by increasing infrastructure availability and job opportunities. New investment can increase a country's physical capital supply, allowing efforts to increase output to be achieved. Productive direct investment is made by investing in economic and social infrastructure that facilitates and integrates various economic activities (Rareş Bircea & Kardos, 2024). Investment is usually allocated to

economic sectors that provide high investment returns (*rate of return*). Investment can increase productive activities (Neumann, 2022; Zafar et al., 2019). It aligns with Neo-classical and Classical theories, which state that investment is essential for sustainability in economic growth through increased worker productivity and per capita output. Increased investment will increase capital acquisition. An increase in capital accumulation will increase capital per worker so that output per worker can increase, which means that total output will increase with a certain number of workers (Romer, 1990; Solow, 1956).

Furthermore, increasing population growth can expand market share and encourage real sector development. If the real sector increases, it will increase employment so that the demand side and economic growth will increase. Jones (2022) states that the number of people is essential to the economic growth model. However, there are two points of view related to the number of population. The first model views that negative population growth has a disadvantageous impact because it can lead to a lack of improvement in knowledge and standard of living, and the population will eventually disappear and vice versa (Puška et al., 2023). It is in line with Romer (1990) that a large population is needed to achieve rapid economic growth. The limited population will impact the limitation in the market share of the output produced by a country. According to Pfister (2022), the negative relationship between population and well-being is a characteristic of the Malthusian economy.

Meanwhile, the second model views that low population growth will impact increasing economic growth because it can increase per capita income due to increased per capita capital (Sasaki & Hoshida, 2017). The second model is in line with Kremer (1993), which states that a relatively constant number of people will create various ideas where they learn while working so that the standard of living increases as the population's productivity increases. This model 1 analysis results follow Solow's and new growth theories.

The analysis results of model 2, which is a development of model 1 by adding human capital variables, show that when human capital variables are added to the main variables that affect economic growth, it can also be seen that all of these variables significantly affect economic growth positively. Human capital is crucial in optimizing technological advancement, investment, and population growth.

Human capital can encourage increased productivity through an efficient production process because of its readiness to use production technology (Zafar et al., 2019). Efforts to encourage the improvement of human resources are critical (Affandi et al., 2019b; Hanushek, 2013; Ma et al., 2022; Rahim et al., 2021; Teixeira & Queirós, 2016; C. Zhang & Zhuang, 2011).

Human capital supports a more efficient production process (Bano et al., 2018). Efficient production will have an impact on increasing productivity. Therefore, human capital development must continue providing significant economic growth benefits. Lin et al. (2021) show that the R&D of a workforce directly related to innovation and the development of better technology will result in innovative human capital.

The analysis results of model 2 show that the value of the coefficient of technological progress is a more significant magnitude. It shows that increasingly qualified human capital will encourage the effectiveness of technological progress.

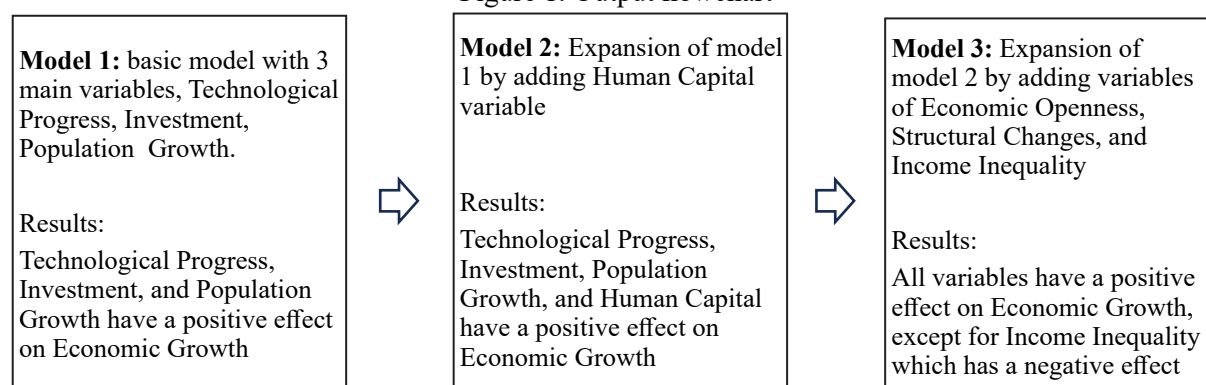
Based on the dynamic data panel analysis in model 3, by adding variables of economic openness, changes in economic structure, and income distribution inequality, it can also be seen that these variables significantly affect economic growth and follow the specified hypothesis. Six variables positively affect economic growth: technological progress, investment, population growth, human capital, economic openness, and changes in economic structure. It means that an increase in these six variables can encourage economic growth. Meanwhile, income

distribution inequality has a negative effect. It means that the lower the income distribution inequality, the higher the economic growth. Economic growth can be accelerated through an open economy model through export and import activities (Ibrahim et al., 2022; Nguyen, 2022; Al-Wasity et al., 2023). For example, Argentina benefits from multilateral cooperation and an open economic system (Pinilla & Rayes, 2019). Quality of human resources and trade openness are essential factors for economic growth (Intisar et al., 2020).

Economic structural changes can accelerate the growth of the economy. This condition is in line with Erumban et al.(2019), who explained that the the shift in the economic structure from the agricultural sector to the manufacturing sector has contributed positively to economic growth in India.

The Equality Growth Theory states that an equal income distribution will encourage improving human resources' quality and productivity through increased access to health, education, and various available economic opportunities. It aligns with several previous researchers (Berg et al., 2018; Breunig & Majeed, 2020; Ferreira et al., 2022; Milanovic, 2016; Younsi & Bechtini, 2020), which state that income inequality harms economic growth. Based on the three models used to identify the determinants of economic growth in Indonesia, it show that all the variables used support the economic growth theory. Gradually adding variables to the main variables provides consistent results in all three models. The estimation results show that the main variables, namely technological progress (TP), investment (INV), and population growth (LNPOP), robustly have a positive effect on RGDP. The use of these three models in analyzing the determinants of economic growth by paying attention to regional dynamics in Indonesia is a novelty of this study. The flow of the relationship between the three models can be seen in Figure 1.

Figure 1. Output flowchart



Source: Research results

6. CONCLUSION

Understanding Indonesia's economic growth dynamics is crucial for formulating effective policies that promote sustainable development. By analyzing the determinants of growth within the Indonesian context, this study seeks to provide insights that can guide future economic strategies, addressing regional disparities and national objectives.

It is necessary to increase technological advancement, investment, population growth, human capital, economic openness, change in economic structure towards more productive sectors, and reduce income distribution inequality to strengthen economic growth in Indonesia. Efforts to create conducive conditions in determining economic growth need to be carried out evenly in all provinces of Indonesia.

The findings of this study reinforce Solow and Romer's theory of the importance of investment,

population growth, and technological advances for sustainable economic growth. This research also supports the hypothesis of export-led growth that an open economy will increase economic growth through increased exports. It can further impact the development of the demand and supply sides simultaneously. It is also consistent with the theory of endogenous growth, which underlines that the ability of a country to participate in the global market can encourage the creation of technology transfer, market expansion, and increased efficiency and competitiveness. The study's results also support the Chenery and Syrquin model, which states that shifting the economic sector towards a more productive sector can boost economic productivity.

The policy implications of this study are: (1) There is a need to increase budget allocation to innovate in creating technological advancements through R&D so that economic growth can be sustainable in the long term; (2) There is a need to simplify licensing procedures, improve infrastructure, and maintain regional security to attract domestic and foreign investors so that investment increases; (3) It is necessary to control population growth so that it does not exceed economic growth and to increase labor productivity through improving the quality of human capital so that the demographic bonus in Indonesia can provide significant benefits for sustainable economic growth; (4) It is necessary to increase adequate education and health budget allocation in all provinces in Indonesia to improve the quality of human capital; (5) It is necessary to increase participation in the global economy through export and import activities so that it can optimally utilize comparative advantages and support the development of domestic industries; (6) To get more significant benefits from structural change, it is necessary to improve the technical ability of labor to create efficiency, and also need the support of appropriate downstream policies in resources using; (7) Policies are needed to reduce income inequality continuously through the provision of jobs and socialization of available jobs to bring together job seekers who are suitable for their jobs so that productive workers increase and they can become a market for the output produced.

The study explored three models, focusing on different sets of variables. Future research could consider adding other variables, such as institutional quality, infrastructure development, and the role of the government, to gain a more holistic understanding of the factors influencing economic growth. In addition, the study examined the economic dynamics between regions, but future research could delve deeper into the spatial interdependence and spillover effects among provinces or regions, which may have significant implications for policy formulation.

This study's limitations include potential endogeneity issues, such as the Dynamic Panel Data analysis approach used in the study not fully addressing potential endogeneity issues, which could arise from the complex relationships between the variables. Future research could explore alternative econometric techniques to mitigate these concerns. In addition, regional heterogeneity issues that Indonesia is a diverse country with significant variations in economic, social, and institutional characteristics across provinces. The study may not yet pay attention to these regional heterogeneities in detail, and future research could delve deeper into the unique dynamics of provinces or regions by grouping regions based on the similarity of regional characteristics.

REFERENCES

- Acemoglu, D., & Zilibotti, F. (1997). Was Prometheus unbound by chance? Risk, diversification, and growth. *Journal of Political Economy*, 105(4), 709–751. <https://doi.org/10.1086/262091>
- Affandi, Y., Anugrah, D. F., & Bary, P. (2019a). Human capital and economic growth across regions: a case study in Indonesia. *Eurasian Economic Review*, 9(3), 331–347. <https://doi.org/10.1007/s40822-018-0114-4>
- Affandi, Y., Anugrah, D. F., & Bary, P. (2019b). Human capital and economic growth across regions: a case study in Indonesia. *Eurasian Economic Review*, 9(3), 331–347. <https://doi.org/10.1007/s40822-018-0114-4>
- Aggarwal, A. (2018). Economic Growth, Structural Change and Productive Employment Linkages in India: Did Market Transition Matter? *South Asia Economic Journal*, 19(1), 64–85. <https://doi.org/10.1177/1391561418761074>
- Aghion, P., & Howitt, P. (1992). A Model of Growth Through Creative Destruction. *Econometrica*, 60(2), 323. <https://doi.org/10.2307/2951599>
- Ahmad, M., Jiang, P., Majeed, A., Umar, M., Khan, Z., & Muhammad, S. (2020). The dynamic impact of natural resources, technological innovations and economic growth on ecological footprint: An advanced panel data estimation. *Resources Policy*, 69(September), 101817. <https://doi.org/10.1016/j.resourpol.2020.101817>
- Aiyar, S., & Ebeke, C. (2020). Inequality of opportunity, inequality of income and economic growth. *World Development*, 136, 105115. <https://doi.org/10.1016/j.worlddev.2020.105115>
- Al-Wasity, R. T., Ahmed, A. F., & Albadawi, S. A. (2023). an Economic Analysis of the Competitiveness of Dates and Their Role in International Agricultural Marketing in Iraq for the Period 2005-2019. *Iraqi Journal of Agricultural Sciences*, 54(1), 205–215. <https://doi.org/10.36103/ijas.v54i1.1691>
- Alwakid, W., Aparicio, S., & Urbano, D. (2021). The influence of green entrepreneurship on sustainable development in Saudi Arabia: The role of formal institutions. *International Journal of Environmental Research and Public Health*, 18(10). <https://doi.org/10.3390/ijerph18105433>
- Anetor, F. O. (2020). Human capital threshold, foreign direct investment and economic growth: evidence from sub-Saharan Africa. *International Journal of Development Issues*, 19(3), 323–337. <https://doi.org/10.1108/IJDI-01-2020-0014>
- Azam, M. (2019). Relationship between energy, investment, human capital, environment, and economic growth in four BRICS countries. *Environmental Science and Pollution Research*, 26(33), 34388–34400. <https://doi.org/10.1007/s11356-019-06533-9>
- Bano, S., Zhao, Y., Ahmad, A., Wang, S., & Liu, Y. (2018). Identifying the impacts of human capital on carbon emissions in Pakistan. *Journal of Cleaner Production*, 183, 1082–1092. <https://doi.org/10.1016/j.jclepro.2018.02.008>
- Bekun, F. V., Emir, F., & Sarkodie, S. A. (2019). Another look at the relationship between energy consumption, carbon dioxide emissions, and economic growth in South Africa. *Science of the Total Environment*, 655, 759–765. <https://doi.org/10.1016/j.scitotenv.2018.11.271>
- Berg, A., Ostry, J. D., Tsangarides, C. G., & Yakhshilikhov, Y. (2018). Redistribution, inequality, and growth: new evidence. *Journal of Economic Growth*, 23(3), 259–305. <https://doi.org/10.1007/s10887-017-9150-2>
- Blotevogel, R., Imamoglu, E., Moriyama, K., & Sarr, B. (2022). Income inequality measures and economic growth channels. *Journal of Macroeconomics*, 72, 103413. <https://doi.org/10.1016/j.jmacro.2022.103413>
- Breunig, R., & Majeed, O. (2020). Inequality, poverty and economic growth. *International Economics*, 161, 83–99. <https://doi.org/10.1016/j.inteco.2019.11.005>
- Brida, J. G., Alvarez, E., Cayssials, G., & Mednik, M. (2024). How does population growth affect economic growth and vice versa? An empirical analysis. *Review of Economics and Political Science*, 9(3), 265–297. <https://doi.org/10.1108/REPS-11-2022-0093>

- Brueckner, M., & Lederman, D. (2018). Inequality and economic growth: the role of initial income. *Journal of Economic Growth*, 23(3), 341–366. <https://doi.org/10.1007/s10887-018-9156-4>
- Central Statistics Agency. (2023). *Indonesian Statistics*. Central Statistics Agency. <https://www.bps.go.id/id>
- Chinoda, T., & Kapingura, F. M. (2024). Digital financial inclusion and economic growth in Sub-Saharan Africa: the role of institutions and governance. *African Journal of Economic and Management Studies*, 15(1), 15–30. <https://doi.org/10.1108/AJEMS-09-2022-0372>
- Dinh, T. T. H., Vo, D. H., The Vo, A., & Nguyen, T. C. (2019). Foreign Direct Investment and Economic Growth in the Short Run and Long Run: Empirical Evidence from Developing Countries. *Journal of Risk and Financial Management*, 12(4). <https://doi.org/10.3390/jrfm12040176>
- Erumban, A. A., Das, D. K., Aggarwal, S., & Das, P. C. (2019). Structural change and economic growth in India. *Structural Change and Economic Dynamics*, 51, 186–202. <https://doi.org/10.1016/j.strueco.2019.07.006>
- Ferreira, I. A., Gisselquist, R. M., & Tarp, F. (2022). On the Impact of Inequality on Growth, Human Development, and Governance. *International Studies Review*, 24(1). <https://doi.org/10.1093/isr/viab058>
- Galor, O., & Zeira, J. (1993). Income Distribution and Macroeconomics. *The Review of Economic Studies*, 60(1), 35. <https://doi.org/10.2307/2297811>
- Garza-Rodriguez, J., Almeida-Velasco, N., Gonzalez-Morales, S., & Leal-Ornelas, A. P. (2020). The Impact of Human Capital on Economic Growth: the Case of Mexico. *Journal of the Knowledge Economy*, 11(2), 660–675. <https://doi.org/10.1007/s13132-018-0564-7>
- Grossman, G. M., & Helpman, E. (1991). The Review of Economic Studies, Ltd. Quality Ladders in the Theory of Growth Quality Ladders i n the Theory of Growth. *Source: The Review of Economic Studies Review of Economic Studies*, 58(58), 43–61. <http://www.jstor.org/stable/2298044>
<http://www.jstor.org/page/info/about/policies/terms.jsp>
- Hanushek, E. A. (2013). Economic growth in developing countries: The role of human capital. *Economics of Education Review*, 37, 204–212. <https://doi.org/10.1016/j.econedurev.2013.04.005>
- Hausmann, R. (2012). Structural Transformation and Economic Growth in Latin America. In *The Oxford Handbook of Latin American Economics*. <https://doi.org/10.1093/oxfordhb/9780199571048.013.0021>
- Huchet-Bourdon, M., Le Mouél, C., & Vijil, M. (2018). The relationship between trade openness and economic growth: Some new insights on the openness measurement issue. *The World Economy*, 41(1), 59–76. <https://doi.org/10.1111/twec.12586>
- Huseynli, B. & Huseynli, N. (2024). The Dynamics of R&D Expenditure, Renewable Electricity Production, and Economic Growth: A Comparative Analysis of Norway and Brazil. *Journal of Sustainability for Energy*, 3(2), 75-86. <https://doi.org/10.56578/jse030202>
- Ibn-Mohammed, T., Mustapha, K. B., Godsell, J., Adamu, Z., Babatunde, K. A., Akintade, D. D., Acquaye, A., Fujii, H., Ndiaye, M. M., Yamoah, F. A., & Koh, S. C. L. (2021). A critical review of the impacts of COVID-19 on the global economy and ecosystems and opportunities for circular economy strategies. *Resources, Conservation and Recycling*, 164(May 2020), 105169. <https://doi.org/10.1016/j.resconrec.2020.105169>
- Ibrahim, O. A., Devesh, S., & Shaukat, M. (2022). Institutional determinants of FDI in Oman: Causality analysis framework. *International Journal of Finance and Economics*, 27(4), 4183–4195. <https://doi.org/10.1002/ijfe.2366>
- Intisar, R. A., Yaseen, M. R., Kousar, R., Usman, M., & Amjad Makhdum, M. S. (2020). Impact of trade openness and human capital on economic growth: A comparative investigation of asian countries. *Sustainability (Switzerland)*, 12(7). <https://doi.org/10.3390/su12072930>
- Khan, S., Peng, Z., & Li, Y. (2019). Energy consumption, environmental degradation, economic growth and financial development in globe: Dynamic simultaneous equations panel analysis. *Energy Reports*, 5, 1089–1102. <https://doi.org/10.1016/j.egyr.2019.08.004>

- Khan, U., Khan, A. M., Alam, M. S., & Alkatheery, N. (2022). Causation between Consumption, Export, Import, and Economic Growth of Oman. *Etikonomi*, 21(1), 67–78. <https://doi.org/10.15408/etk.v21i1.20034>
- Kremer, M. (1993). Population Growth and Technological Change: One Million B.C. to 1990. *The Quarterly Journal of Economics*, 108(3), 681–716. <https://doi.org/10.2307/2118405>
- Lewis, W. A. (1954). Economic Development with Unlimited Supplies of Labour. *The Manchester School*, 22(2), 139–191. <https://doi.org/10.1111/j.1467-9957.1954.tb00021.x>
- Lin, X., Zhao, Y., Ahmad, M., Ahmed, Z., Rjoub, H., & Adebayo, T. S. (2021). Linking innovative human capital, economic growth, and Co2 emissions: An empirical study based on Chinese provincial panel data. *International Journal of Environmental Research and Public Health*, 18(16). <https://doi.org/10.3390/ijerph18168503>
- Ma, D., Zhang, J., Wang, Z., & Sun, D. (2022). Spatio-Temporal Evolution and Influencing Factors of Open Economy Development in the Yangtze River Delta Area. *Land*, 11(10). <https://doi.org/10.3390/land11101813>
- Marrero, G. A., & Servén, L. (2022). Growth, inequality and poverty: a robust relationship? *Empirical Economics*, 63(2), 725–791. <https://doi.org/10.1007/s00181-021-02152-x>
- Milanovic, B. (2016). *Global Inequality*. Harvard University Press. <https://doi.org/10.2307/j.ctvjghwk4>
- Musibau, H. O., Mahmood, S., Ismail, S., Haruna, M. A., & Khan, M. U. (2019). Electricity availability, human capital investment and sustainable economic growth causality in Sub Sahara Africa: Revisited evidences. *International Journal of Energy Economics and Policy*, 9(6), 222–233. <https://doi.org/10.32479/ijeep.8201>
- Neumann, T. (2022). Impact of green entrepreneurship on sustainable development: An ex-post empirical analysis. *Journal of Cleaner Production*, 377(September), 134317. <https://doi.org/10.1016/j.jclepro.2022.134317>
- Nguyen, P. T. (2022). Carbon emissions versus value-added in export-driven countries: case of Vietnam. *Journal of Economic Structures*, 11(1). <https://doi.org/10.1186/s40008-022-00272-w>
- Omir, A., Adambekova, A., Khishauyeva, Z., Zhanibekova, G., & Amankeldi, N. (2024). the Influence of the Capital Market (Financial Instruments) on Economic Growth in Kazakhstan and Cis Countries. *ECONOMICS - Innovative and Economics Research Journal*, 12(1), 227–239. <https://doi.org/10.2478/eoik-2024-0010>
- Pfister, U. (2022). Economic Growth in Germany, 1500-1850. *Journal of Economic History*, 82(4), 1071–1107. <https://doi.org/10.1017/S002205072200033X>
- Pinilla, V., & Rayes, A. (2019). How Argentina became a super-exporter of agricultural and food products during the First Globalisation (1880–1929). *Cliometrica*, 13(3), 443–469. <https://doi.org/10.1007/s11698-018-0178-0>
- Prasetyo, S. D., Rizandy, A. N., Birawa, A. R., Regannanta, F. J., Arifin, Z., Mauludin, M. S., & Sukarman (2024). Design and Economic Analysis of a Solar-Powered Charging Station for Personal Electric Vehicles in Indonesia. *Journal of Sustainability for Energy*, 3(2), 65-74. <https://doi.org/10.56578/jse030201>
- Puška, A., Hodžić, I., & Štilić, A. (2023). Evaluating the Knowledge Economies within the European Union: A Global Knowledge Index Ranking via Entropy and CRADIS Methodologies. *International Journal of Knowledge and Innovation Studies*, 1(2), 103-115. <https://doi.org/10.56578/ijkis010203>
- Raghutla, C. (2020). The effect of trade openness on economic growth: Some empirical evidence from emerging market economies. *Journal of Public Affairs*, 20(3). <https://doi.org/10.1002/pa.2081>
- Rahim, S., Murshed, M., Umarbeyli, S., Kirikkaleli, D., Ahmad, M., Tufail, M., & Wahab, S. (2021). Do natural resources abundance and human capital development promote economic growth? A study on the resource curse hypothesis in Next Eleven countries. *Resources, Environment and Sustainability*, 4(December 2020), 100018. <https://doi.org/10.1016/j.resenv.2021.100018>

- Rareș Bircea, M., & Kardos, M. (2024). Emigration and its Impact on the Sending Country. Social and Economic Effects for Romania. *Collection of papers new economy* 2(1), 79-96.
<https://doi.org/10.61432/CPNE0201079r>
- Ren, S., Hao, Y., Xu, L., Wu, H., & Ba, N. (2021). Digitalization and energy: How does internet development affect China's energy consumption? *Energy Economics*, 98.
<https://doi.org/10.1016/j.eneco.2021.105220>
- Rodrik, D. (1998). Why do more open economies have bigger governments? *Journal of Political Economy*, 106(5), 997–1032. <https://doi.org/10.1086/250038>
- Romer, P. M. (1990). Endogenous technological change. *Journal of Political Economy*, 98(5), S71–S102. <https://doi.org/10.3386/w3210>
- Sarıgül, H., & Apak, S. (2024). Economic growth, energy consumption, and trade openness nexus: Evidence from net energy importing middle-income countries. *Panoeconomicus*, 71(3), 345–371.
<https://doi.org/10.2298/PAN211102024S>
- Sasaki, H., & Hoshida, K. (2017). The effects of negative population growth: An analysis using a semien-dogenous r&d growth model. *Macroeconomic Dynamics*, 21(7), 1545–1560.
<https://doi.org/10.1017/S1365100515000991>
- Sebki, W. (2021). Education and Economic Growth in Developing Countries: Empirical Evidence from GMM Estimators for Dynamic Panel Data. *Economics and Business*, 35(1), 14–29.
<https://doi.org/10.2478/eb-2021-0002>
- Sima, V., Gheorghe, I. G., Subić, J., & Nancu, D. (2020). Influences of the industry 4.0 revolution on the human capital development and consumer behavior: A systematic review. *Sustainability (Switzerland)*, 12(10). <https://doi.org/10.3390/SU12104035>
- Škuflić, L., Šokčević, S., & Bašić, M. (2024). Sustainable Development and Competitiveness: Is There a Need for Gci Reconstruction? *ECONOMICS - Innovative and Economics Research Journal*, 12(1), 153–173. <https://doi.org/10.2478/eoik-2024-0001>
- Solow, R. M. (1956). A Contribution to the Theory of Economic Growth Author (s): Robert M . Solow Source. *The Quartely Journal of Economics*, 70(1), 65–94. <http://www.jstor.org/stable/1884513>
- Stanley, T. D., Doucouliagos, H., & Steel, P. (2018). Does Ict Generate Economic Growth? a Meta-Re-gression Analysis. *Journal of Economic Surveys*, 32(3), 705–726.
<https://doi.org/10.1111/joes.12211>
- Stojanović, I., Puška, A., (2021). Logistics performances of Gulf Cooperation Council's countries in global supply chains. *Decision Making Applications in Management and Engineering*, 4(1), 174-193. <https://doi.org/10.31181/dmame2104174s>
- Sumaira, & Bibi, R. (2022). Banking sector development and Economic growth in south Asian coun-tries: Dynamic Panel data analysis. *Journal of Environmental Science and Economics*, 1(1), 52–57. <https://doi.org/10.56556/jescae.v1i1.10>
- Teixeira, A. A. C., & Queirós, A. S. S. (2016). Economic growth, human capital and structural change: A dynamic panel data analysis. *Research Policy*, 45(8), 1636–1648.
<https://doi.org/10.1016/j.respol.2016.04.006>
- Todaro, M. P., & Smith, S. C. (2012). Economic Developement. In *Pearson (11th ed.)*. *Pearson Educa-tion Limited*.
- Yang, L., Wang, J., & Shi, J. (2017). Can China meet its 2020 economic growth and carbon emissions reduction targets? *Journal of Cleaner Production*, 142(2016), 993–1001.
<https://doi.org/10.1016/j.jclepro.2016.08.018>
- Younsi, M., & Bechtini, M. (2020). Economic Growth, Financial Development, and Income Inequality in BRICS Countries: Does Kuznets' Inverted U-Shaped Curve Exist? *Journal of the Knowledge Economy*, 11(2), 721–742. <https://doi.org/10.1007/s13132-018-0569-2>

- Zafar, M. W., Zaidi, S. A. H., Khan, N. R., Mirza, F. M., Hou, F., & Kirmani, S. A. A. (2019). The impact of natural resources, human capital, and foreign direct investment on the ecological footprint: The case of the United States. *Resources Policy*, 63(May), 101428.
<https://doi.org/10.1016/j.resourpol.2019.101428>
- Zhang, C., & Zhuang, L. (2011). The composition of human capital and economic growth: Evidence from China using dynamic panel data analysis. *China Economic Review*, 22(1), 165–171.
<https://doi.org/10.1016/j.chieco.2010.11.001>
- Zhang, S., Liu, Y., & Huang, D.-H. (2020). Contribution of factor structure change to China's economic growth: evidence from the time-varying elastic production function model. *Economic Research-Ekonomska Istraživanja*, 33(1), 2919–2942.
<https://doi.org/10.1080/1331677X.2019.1697722>
- Zhou, X., Cai, Z., Tan, K. H., Zhang, L., Du, J., & Song, M. (2021). Technological innovation and structural change for economic development in China as an emerging market. *Technological Forecasting and Social Change*, 167(January 2020), 120671.
<https://doi.org/10.1016/j.techfore.2021.120671>