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AN ANALYSIS OF THE FACTORS AFFECTING DEINDUSTRIALIZATION IN FOUR COUNTRIES

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Abstract: The phenomenon of premature deindustrialization is increasingly prevalent in developing countries, where the manufacturing sector experiences a decline in its contribution to GDP before reaching the stage of industrial maturity. Indonesia, India, Colombia, and South Africa are examples of countries that have shown this tendency in recent decades. This study aims to analyze the simultaneous and partial effects of Gross Domestic Product (GDP) per capita, exchange rate, and trade openness on deindustrialization in these four countries during the period 1995–2023. This research utilizes secondary data obtained from the World Bank and applies panel data regression analysis. The Chow and Hausman tests indicate that the most appropriate model to use is the Fixed Effect Model (FEM). The results reveal that, simultaneously, the three independent variables have a significant effect on the contribution of the manufacturing sector. Partially, GDP per capita and exchange rate have a negative and significant effect, while trade openness has a positive and significant effect on the contribution of the manufacturing sector. These findings highlight the need for adaptive industrial development policies, particularly in maintaining exchange rate stability and promoting open trade that can enhance the competitiveness of the manufacturing sector in these four countries.
Keywords: Deindustrialization, GDP per capita, Exchange Rate, Trade Openness,

INTRODUCTION

The modern world, in many respects, is the result of industrialization. The Industrial Revolution marked the beginning of sustained productivity growth in Europe and the United States, which eventually divided the global economy into rich and poor nations. Industrialization also enabled several non-Western countries to catch up and match Western nations—such as Japan in the late 19th century, and South Korea, Taiwan, and a number of other countries since the 1960s. Meanwhile, in countries still trapped in poverty—particularly in sub-Saharan Africa, Latin America, and parts of Asia—many observers and policymakers believe that future economic growth prospects rely heavily on the development of new manufacturing industries (Rodrik, 2015). This view aligns with Kaldor's first law of growth, proposed in 1996, which asserts that the manufacturing sector functions as the engine of economic growth in a country (Dasgupta & Singh, 2006).

The manufacturing sector generally follows an inverted U-shaped pattern throughout the development process. While this pattern is also observed in developing countries, the turning point occurs earlier and at significantly lower income levels. In many developing nations, the manufacturing sector has begun to shrink—or is on the path toward decline—while their income levels remain far below those of advanced economies when they first began deindustrializing (Amirapu & Subramanian, 2015). These countries are transitioning into service-based economies without having undergone a mature process of industrialization. This phenomenon is referred to as premature deindustrialization (Dasgupta & Singh, 2006).

Various systems have been developed to classify countries based on per capita income, since the term "developing countries" stems from the outdated and now considered offensive Cold War-era concept of the "Third World." Institutions such as the World Bank prefer to classify countries by per capita income levels. The World Bank regularly categorizes countries based on Gross National Income (GNI) per capita. This classification is widely used in economic research to differentiate the level of a country's development and serves as the basis for development policy analysis, aid allocation, and cross-country comparisons. The income classification, updated annually by the World Bank using the Atlas method, accounts for exchange rate fluctuations and global inflation to ensure more stable comparisons. The latest classification divides countries into four groups based on GNI per capita in U.S. dollars.

Low-income economies are defined as countries with GNI per capita below US$1,135 per year. These countries typically face major challenges such as extreme poverty, inequality, and limited access to basic services like education and healthcare. Lower-middle-income economies have GNI per capita between US$1,136 and US$4,465, and are generally undergoing early stages of industrialization with relatively high growth potential. Upper-middle-income economies have per capita incomes between US$4,466 and US$13,845, while high-income economies exceed US$13,846. These countries have typically achieved high levels of welfare, supported by modern service sectors, high labor productivity, and more established institutions.

There are two main perspectives for understanding why the decline of manufacturing in low- and middle-income countries may be categorized as premature deindustrialization. First, descriptively, this phenomenon reflects that these countries are experiencing a decline in their manufacturing sectors much earlier than the historical patterns observed in early-industrializing nations. Late industrializers fail to develop their manufacturing sectors to the extent seen in pioneering industrial economies, and instead, begin to deindustrialize at significantly lower per capita income levels (Rodrik, 2015).

Second, premature deindustrialization can have adverse implications for economic growth. The manufacturing sector has several characteristics that make it crucial to growth. First, it is typically a technologically dynamic sector. The formal manufacturing sector exhibits unconditional labor productivity convergence—unlike other sectors. Second, manufacturing has historically absorbed large numbers of low-skilled workers, a feature that distinguishes it from other productive sectors such as mining or finance.

Third, as a tradable sector, manufacturing growth is not solely dependent on domestic demand—which is often limited in developing countries. This means the sector can expand through access to global markets even when domestic consumption is low or stagnant. Furthermore, the manufacturing sector has strong capacity to absorb labor and facilitate technology diffusion, even when other sectors experience stagnation or limited productivity gains. Taken together, these features make manufacturing a critical pathway for accelerating economic development in developing countries. Premature deindustrialization thus risks removing one of the most effective channels for increasing income, generating employment, and driving structural transformation (Rodrik, 2015).

Additionally, indications of premature deindustrialization can be seen in the degree of industrial maturity achieved. This maturity level reflects how far the manufacturing sector has developed and significantly contributed to the national economic structure. A study by the McKinsey Global Institute (MGI) in 2012 stated that a country can be considered to have reached industrial maturity if the manufacturing sector contributes approximately 30–40 percent to GDP, with per capita GDP exceeding US$7,000 to US$10,000.

Beyond exchange rates, analyzing the processes of industrialization or deindustrialization in an open economy requires more than just considering domestic conditions. External economic relations and interactions must also be taken into account, as global dynamics significantly influence the industrial sector of a country. External parties play key roles, both as sources of raw materials through imports and as target markets for expanding the distribution of domestic manufactured goods (Singh, 1977). This reliance on international markets makes the industrial sector vulnerable to global shocks such as changes in world demand, trade policies of partner countries, and competition from imported products. Hence, understanding industrialization processes must emphasize not only internal strategies but also a country's position and responsiveness within the global trade network.

South Africa demonstrates a relatively high and stable level of trade openness, especially after 2000, with its openness index surpassing 65 percent in 2009. This can be attributed to South Africa's role as a key trading partner in the African region and its involvement in international trade blocs such as BRICS and SACU. Meanwhile, Colombia has shown a more moderate and stagnant level of trade openness, ranging between 32–40 percent over the past three decades. This reflects Colombia's economic structure, which is more focused on domestic consumption and dependent on primary exports such as oil and coffee. Given these phenomena, this study is motivated to examine the factors influencing deindustrialization in four countries.

METHOD

This study adopts a quantitative associative approach to analyze the influence of Gross Domestic Product (GDP) per capita, exchange rate, and trade openness on deindustrialization in four countries: Indonesia, India, Colombia, and South Africa. The object of this research is the phenomenon of deindustrialization, as indicated by the declining contribution of the manufacturing sector to GDP. The data used are annual panel data spanning the period 1995–2023, offering advantages in terms of data variation, broader observation capacity, and improved model estimation efficiency (Sugiyono, 2017; Widarjono, 2009; Baltagi, 2005).

The dependent variable in this study is the contribution of the manufacturing sector to GDP, while the independent variables include GDP per capita, exchange rate, and trade openness. Data were obtained from secondary sources such as the World Bank using documentation methods and non-participant observation. The analysis technique employed is panel data regression using three estimation approaches: the Common Effect Model (CEM), the Fixed Effect Model (FEM), and the Random Effect Model (REM). The selection of the most appropriate model was determined using the Chow test, Hausman test, and Lagrange Multiplier test, each of which assesses data characteristics and model fit (Winarno, 2007; Rosadi, 2012; Verbeek, 2004).

To ensure the validity of the model, classical assumption tests were conducted, including tests for normality, heteroscedasticity, and multicollinearity. Hypothesis testing was performed both simultaneously (F-test) and partially (t-test), along with the calculation of the coefficient of determination (R^2 and Adjusted R^2) to determine the contribution of independent variables to the variation in the dependent variable. This analysis provides a comprehensive overview of the dynamics of deindustrialization faced by developing countries and the macroeconomic factors influencing it over time (Ghozali, 2011; Suliyanto, 2011; Sujarweni, 2014).

RESULTS AND DISCUSSION

Data Analysis Results

Panel Data Regression

The panel data regression analysis in this study was carried out using several estimation approaches.

1. Selection of Panel Data Regression Estimation Techniques

In panel data regression analysis, there are three main estimation techniques that can be employed: the Common Effect Model (CEM), the Fixed Effect Model (FEM), and the Random Effect Model (REM). To determine the most appropriate estimation method for this study, a series of statistical tests were conducted, including the Chow test, Hausman test, and Lagrange Multiplier (LM) test. These tests assist in selecting the model that best fits the characteristics of the data used.

a) Chow Test

The Chow test aims to determine whether the Common Effect Model (CEM) or the Fixed Effect Model (FEM) is more appropriate. If the probability value of the cross-section chi-square is greater than the significance level of 0.05, the Common Effect Model is preferred. Conversely, if the probability value is less than 0.05, the Fixed Effect Model is deemed more suitable for the analysis.

Table 1. Results of the Chow Test

Redundant Fixed Effects Tests
Equation: Untitled
Test cross-section fixed effects

Effects Test	Statistic	d.f.	Prob.
Cross-section F	92.643711	(3,109)	0.0000
Cross-section Chi-square	146.960266	3	0.0000

Source: Data attached to the author's thesis

Based on the results of the Redundant Fixed Effects Test, the probability values obtained for both the Cross-section F test and the Cross-section Chi-square test were 0.0000. Since these probability values are smaller than the 5 percent significance level (0.05), the null hypothesis—which states that the Common Effect Model is more appropriate—is rejected. This indicates a significant difference across cross-sectional units (countries), thus making the Fixed Effect Model (FEM) more suitable for this study than the Common Effect Model (CEM). Therefore, FEM is chosen to capture the individual effects of each country on the dependent variable.

b) Hausman test

The Hausman Test is used to determine the more appropriate model between the Fixed Effect Model (FEM) and the Random Effect Model (REM). If the probability value of the cross-section random effect is less than 0.05, the Fixed Effect Model is considered more appropriate, indicating a correlation between the individual effects and the independent variables. Conversely, if the probability is greater than 0.05, the Random Effect Model is preferred, as it assumes no correlation between individual effects and the explanatory variables.

Table 2. Hausman Test Results

Correlated Random Effects - Hausman Test
Equation: Untitled
Test cross-section random effects

Test Summary	Chi-Sq. Statistic	Chi-Sq. d.f.	Prob.
Cross-section random	277.931133	3	0.0000

Source: Data attached to the author's thesis

Based on the results of the Hausman Test, the probability value obtained was 0.0000, which is lower than the 5 percent significance level (0.05). This indicates a significant difference between the estimations of the Fixed Effect Model and the Random Effect Model. Therefore, the null hypothesis, which states that the Random Effect Model (REM) is more appropriate, is rejected. Consequently, the Fixed Effect Model (FEM) is selected as the more suitable approach for this study.

This choice suggests that there is a correlation between country-specific individual effects and the independent variables being analyzed, making FEM the most accurate model to describe the relationships within the panel data.

2. Panel Regression Using the Fixed Effect Model (FEM)

The panel data regression using the Fixed Effect Model (FEM) was performed with EViews 9, and the results are presented as follows

Table 3. Panel Data Regression Results Fixed Effect Model

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	5.167921	0.315167	16.39742	0.0000
LOG(GDP_PER_CAPITA)	-0.238486	0.046600	-5.117727	0.0000
LOG(EXCHANGE_RATE)	-0.146618	0.030790	-4.761807	0.0000
LOG(TRADE_OPENESS)	0.102670	0.049469	2.075445	0.0403

Source: Data attached to the author's thesis, 2025

Based on the estimation results of the regression using the Fixed Effect Model (FEM), the regression equation can be formulated as follows.

$Y = \alpha + \beta 1X1 + \beta 2X2 + \beta 3X3 + \mu$

$Y = 5, 167 – 0,238X1 – 0,146X2 + 0,102X3 + \mu$

Where:

Y = Contribution of the Manufacturing Sector

α = Constant

β_1 = Linear regression coefficient for variable (X_1) GDP per capita

β_2 = Linear regression coefficient for variable (X_2) Exchange Rate

β_3 = Linear regression coefficient for variable (X_3) Trade Openness

X_1 = GDP per capita

X_2 = Exchange Rate

X_3 = Trade Openness

μ = Error term

Based on the regression estimation using the Fixed Effect Model (FEM), the interpretation is as follows.

a) The constant ($\alpha = 5.167$) indicates that when GDP per capita (X_1), exchange rate (X_2), and trade openness (X_3) are assumed to be zero, the contribution of the manufacturing sector (Y) is estimated at 5.167. This value reflects the average baseline contribution of the manufacturing sector in the absence of influence from the independent variables in the model.

b) GDP per capita (X_1) has a coefficient of -0.238, meaning that every one-unit increase in GDP per capita leads to a 0.238 percent decrease in the manufacturing sector's contribution, assuming other variables remain constant. This coefficient is significant at the 1 percent confidence level, indicating a significant and negative effect of GDP per capita on the contribution of the manufacturing sector.

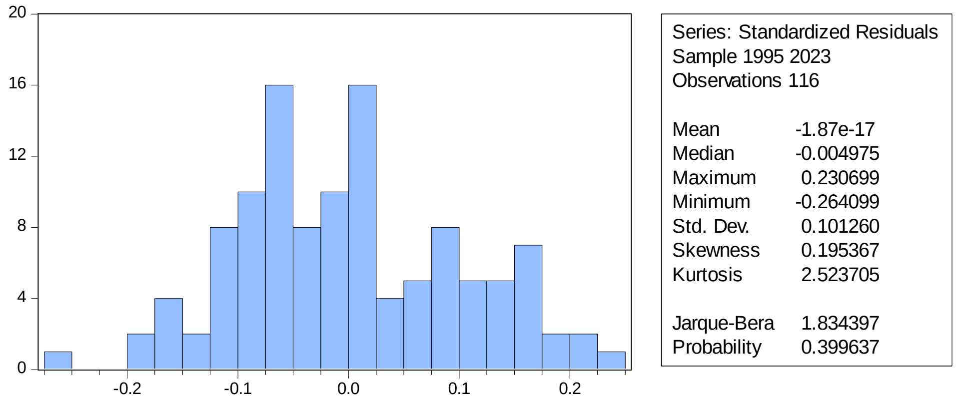
c) The exchange rate (X_2) has a coefficient of -0.146, suggesting that every one-unit increase in the exchange rate (e.g., depreciation against the US dollar) will reduce the manufacturing sector's contribution by 0.146 percent, assuming other variables are held constant.

d) Trade openness (X_3) has a coefficient of 0.102, indicating that a one percent increase in trade openness leads to a 0.102 percent increase in the contribution of the manufacturing sector, assuming other variables remain unchanged.

3. Classical Assumption Test

a) Normality Test

The regression model will yield more accurate and reliable results if it satisfies several fundamental assumptions. According to Wooldridge, several classical assumption tests must be conducted to ensure the model's validity, namely the normality test, multicollinearity test, and heteroskedasticity test. These tests are essential to ensure that the regression model is unbiased and can be used to draw reliable conclusions (Wooldridge, 2018). The normality test aims to determine the distribution of data in the variables used in the study and is conducted before processing the data through research models.



Source: Data attached to the author's thesis

Figure 1. Normality Test Results

Based on the figure, it can be observed that the probability value (p-value) is greater than 0.05. Therefore, the null hypothesis (H_0), which states that the residuals are normally distributed, cannot be rejected. This indicates that the residuals in this model follow a normal distribution, thereby fulfilling the normality assumption. This supports the validity of the panel regression model used in this study.

b) Multicollinearity Test

The multicollinearity test is conducted to determine whether there is a high degree of correlation among the independent variables in the regression model. This is important because high multicollinearity can result in unstable coefficient estimates, making interpretation difficult. A good regression model should indicate that the independent variables are mutually independent or not strongly correlated. The results of the multicollinearity test for the data used in this study are presented below.

Table 4. Multicollinearity Test Results

	LOG(GDP_PER_CAPITA)	LOG(EXCHANGE_RATE)	LOG(TRADE_OPENESS)
LOG(GDP_PER_CAPITA)	1	0.05597624737621154	0.2534524139168646
LOG(EXCHANGE_RATE)	0.05597624737621154	1	-0.03800983383493659
LOG(TRADE_OPENESS)	0.2534524139168646	-0.03800983383493659	1

Source: Data attached to the author's thesis

The correlation test results among the independent variables indicate that there is no strong relationship among the three variables. The correlation values between the independent variables are all below 0.8, suggesting that multicollinearity is not present in the regression model used.

c) Heteroscedasticity Test

The heteroskedasticity test is conducted to determine whether there is a variance inequality in the residuals across observations in the regression model. The decision rule is based on the chi-square probability value: if the probability is greater than 0.05, it indicates that the regression model is free from heteroskedasticity problems. The results of the heteroskedasticity test are presented in the following table.

Table 5. Heteroscedasticity Test Results

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	12.14182	2.128920	5.703277	0.0000
Log(GDP_PER_CAPITA)	-1.240278	0.633033	-1.959264	0.0521
Log(EXCHANGE_RATE)	0.181560	0.215705	0.841707	0.4014
Log(TRADE_OPENESS)	-0.063342	0.225434	-0.280980	0.7791

Source: Data attached to the author's thesis

Based on Table 5, it can be observed that the probability values for GDP per capita (X1), Exchange Rate (X2), and Trade Openness (X3) are all greater than 0.05. Therefore, it can be concluded that the regression model does not suffer from heteroskedasticity issues.

Hypothesis Testing

The hypothesis testing in this study is conducted as follows.

1) Simultaneous Significance Test (F Test)

Table 6. Results of Simultaneous Significance Test (F Test)

R-squared	0.849383	Mean dependent var	2.800781
Adjusted R-squared	0.841092	SD dependent var	0.260917
SE of regression	0.104010	Akaike info criterion	-1.630212
Sum squared residual	1.179171	Schwarz criterion	-1.464047
Log likelihood	101.5523	Hannan-Quinn criter.	-1.562758
F-statistic	102.4480	Durbin-Watson stat	0.295868
Prob(F-statistic)	0.000000		

Source: Data attached to the author's thesis, 2025

Simultaneous testing was conducted using the F-statistic test to determine whether all independent variables jointly have a significant effect on the contribution of the manufacturing sector to GDP. Based on the estimation results, the F-statistic value was 102.4480 with a probability value of 0.000000. Since this probability is significantly lower than the 5 percent significance level (0.000000 < 0.05), it can be concluded that H_0 is rejected and H_1 is accepted. This indicates that, simultaneously, GDP per capita (X1), exchange rate (X2), and trade openness (X3) have a significant effect on the contribution of the manufacturing sector (Y) in the four countries during the observation period. These findings suggest that the three independent variables used in the model collectively contribute to explaining the variation in the manufacturing sector's contribution to GDP.

2) **Partial Coefficient Significance Test (t-Test)**

Table 7. Results of the t-test

Dependent Variable: LOG(MVA)
Method: Panel Least Squares
Date: 07/15/25 Time: 21:40
Sample: 1995 2023
Periods included: 29
Cross-sections included: 4
Total panel (balanced) observations: 116

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	5.167921	0.315167	16.39742	0.0000
LOG(GDP_PER_CAPITA)	-0.238486	0.046600	-5.117727	0.0000
LOG(EXCHANGE_RATE)	-0.146618	0.030790	-4.761807	0.0000
LOG(TRADE_OPENESS)	0.102670	0.049469	2.075445	0.0403

Source: Data attached to the author's thesis, 2025

Based on the t-test results, it can be explained that the variable GDP per capita (X1) has a probability value of 0.0000, which is lower than the 5 percent significance level (0.0000 < 0.05). This indicates that, partially, GDP per capita has a significant effect on the contribution of the manufacturing sector to GDP. The regression coefficient is -0.238, which implies that an increase in GDP per capita by one unit will reduce the contribution of the manufacturing sector by 0.238 percent, assuming other variables remain constant.

Furthermore, the exchange rate variable (X2) has a probability value of 0.0000, which is also lower than 0.05. Therefore, the exchange rate has a significant partial effect on the contribution of the manufacturing sector. The regression coefficient is -0.146, indicating that an increase in the exchange rate by one unit will reduce the contribution of the manufacturing sector by 0.146 percent, ceteris paribus.

Finally, the Trade Openness variable (X3) also has a significant partial effect on the contribution of the manufacturing sector, with a probability value of 0.0403 (< 0.05). The regression coefficient is 0.102, meaning that an increase in trade openness by one percent will increase the contribution of the manufacturing sector to GDP by 0.102 percent, assuming the other variables remain constant.

Discussion of Research Findings

The Simultaneous Influence of GDP per Capita, Exchange Rate, and Trade Openness on the Contribution of the Manufacturing Sector in Four Countries during the 1995–2023 Period

The first hypothesis in this study states that the variables GDP per capita (X1), exchange rate (X2), and trade openness (X3) jointly influence the contribution of the manufacturing sector to GDP in four countries. The results of the F-test show that the calculated F-value is 102.4480 with a probability level of 0.000000, which is much smaller than the 5 percent significance level, thus H0 is rejected and H1 is accepted. This means that the three independent variables simultaneously have a significant effect on the contribution of the manufacturing sector. Moreover, the R-squared value of 0.8493 indicates that 84.93 percent of the variation in the contribution of the manufacturing sector to GDP can be explained by GDP per capita, exchange rate, and trade openness, while the remaining portion is explained by other factors outside the model that were not included in this study. These findings indicate that the model used is sufficiently robust in explaining the dynamics of the manufacturing sector's contribution in the four countries studied.

The Partial Influence of GDP per Capita, Exchange Rate, and Trade Openness on the Contribution of the Manufacturing Sector in Four Countries during the 1995–2023 Period

The discussion of the partial test results can be elaborated as follows.

1) The Effect of GDP per Capita (X1) on the Contribution of the Manufacturing Sector in the Four Countries

The t-test results in this study show that the GDP per capita variable has a negative regression coefficient of -0.238 and is statistically significant at the 5 percent significance level. This means that, partially, GDP per capita has a negative and significant effect on the contribution of the manufacturing sector to GDP. In other words, every one-unit increase in GDP per capita tends to reduce the manufacturing sector's contribution by 0.238 percent, assuming other variables remain constant. This finding indicates that growth in per capita income, when not accompanied by strengthening of the industrial sector, may lead to deindustrialization or a declining role of the manufacturing sector in the economy.

From the literature perspective, this finding is consistent with the study by Sinaga and Prasetyo (2025), which found that, in the long run, an increase in per capita income has a negative and significant effect on the share of manufacturing value added to GDP (Sinaga & Prasetyo, 2025). This aligns with Engel's Law, which states that as income increases, the proportion of consumption on basic needs tends to decline (Puspita & Agustina, 2019). As consumption patterns shift toward more complex goods and services, the role of the manufacturing sector in the economy begins to diminish. This phenomenon illustrates that increasing per capita income can trigger premature deindustrialization.

Research conducted by Pasaribu et al. (2024) shows that an increase in per capita income negatively affects the contribution of the industrial or manufacturing sector to total GDP. This means that as people's income rises, the share of manufacturing value added in total GDP declines. This reflects a deindustrialization trend, where economic growth marked by rising per capita income is no longer accompanied by proportional growth in the industrial sector, but rather shifts toward the dominance of services and other non-manufacturing sectors (Pasaribu et al., 2024). This condition serves as an important indication for policymakers to consider more adaptive industrialization strategies in response to structural economic changes accompanying rising welfare levels.

Pinheiro & Abreu (2025) found that as GDP per capita increases, the share of the manufacturing sector in total GDP or total employment tends to decline in Latin America. Moreover, imports of manufactured goods from China do not significantly influence the decline in manufacturing employment. In fact, within the analyzed sample, Chinese imports were associated with an increase in manufacturing's contribution to industrial value added rather than a decline. This suggests that competition from Chinese manufactured products is not the main driver of deindustrialization in Latin America (Pinheiro & Abreu, 2025).

However, this study's findings contradict those of Anggar and Syahruddin (2019), who argue that per capita income positively influences the manufacturing sector's value added to GDP. In their study, population and per capita income in ASEAN countries were positively associated with the industrial sector's value added. This suggests that increases in both variables tend to drive industrial output growth. Conversely, economic openness was found to have a negative effect on the industrial sector's value added, potentially indicating that increased international trade integration does not necessarily strengthen industrial performance in the region, especially without adequate protection and structural support (Anggar & Syahruddin, 2019).

This study's results also contrast with the findings of Sari & Wulansari (2022), who discovered that per capita income has a significant positive effect on the contribution of the manufacturing sector in industrial areas outside Java Island. This indicates that the higher the per capita income in a region, the greater the contribution of the manufacturing sector. In other words, economic welfare growth in these areas can positively drive industrial development.

2) The Effect of Exchange Rate (X2) on the Contribution of the Manufacturing Sector in the Four Countries

The t-test results show that the exchange rate variable has a negative regression coefficient of -0.146 and is statistically significant at the 5 percent significance level (p-value = 0.0000 < 0.05). This means that, partially, the exchange rate has a negative and significant effect on the contribution of the manufacturing sector to GDP. In other words, every one-unit increase in the exchange rate—indicating a depreciation of the domestic currency against the US dollar—reduces the manufacturing sector's contribution by 0.146 percent, assuming other variables remain constant. This finding suggests that currency depreciation can increase the cost of importing raw materials or capital goods, thereby suppressing manufacturing sector performance.

This result is in line with the research conducted by Fira Shabirina (2021), which showed that exchange rate fluctuations, particularly depreciation, negatively affect the manufacturing sector. The exchange rate variable negatively influences the performance of the processing industry. Currency depreciation is often viewed as a strategy to improve industrial performance through export growth (Mlambo, 2020). However, when the exchange rate appreciates, it can negatively impact industrial production by reducing export values, leading to trade balance deficits and output contraction (Kutu & Ngalawa, 2016). Furthermore, heavy dependence on imported raw materials means exchange rate appreciation increases production costs, thus reducing overall production capacity (Nampewo et al., 2013).

This study also aligns with Astuti & Ayuningtyas (2018), who found that exchange rate depreciation leads to increased prices of imported goods, raising production costs for industries relying on foreign inputs, ultimately reducing domestic productivity.

Mlambo (2021), in his analysis of macroeconomic variables and manufacturing performance in South Africa, found that the exchange rate has a negative relationship with the performance of the manufacturing sector. This is crucial because, theoretically, currency depreciation should increase the competitiveness of a country's manufacturing exports.

Similarly, Buabeng, Ayesu, and Adabor (2020) in Ghana found a negative and significant relationship between the exchange rate and manufacturing firm performance.

Falaye et al. (2019) showed that currency devaluation in Nigeria had a negative impact on manufacturing performance. Their study confirmed a significant negative relationship, both long-term and causal, between the exchange rate and the manufacturing sector's output.

However, this study contradicts the findings of Sulfiana & Sentosa (2021), which found that the exchange rate against the US dollar has a positive and significant effect on industrial export performance. In this case, currency depreciation enhances export competitiveness by making products cheaper in international markets, thereby boosting demand for exports and reducing demand for imports.

A similar result was found by Amri (2022), who examined macroeconomic variables' effects on the manufacturing sector in Indonesia using quarterly data from 2011:Q1 to 2020:Q4. Using an Error Correction Model (ECM), the study found that the exchange rate had a positive and significant impact on manufacturing performance in both the short and long term.

3) The Effect of Trade Openness (X3) on the Contribution of the Manufacturing Sector in the Four Countries

The t-test for the trade openness variable (X3) shows a regression coefficient of 0.102 with a probability value of 0.0403, which is less than the 5 percent significance level ($0.0403 < 0.05$). This means that, partially, trade openness has a positive and significant effect on the contribution of the manufacturing sector to GDP. The positive coefficient suggests that the more open a country is to international trade, the greater the contribution of its manufacturing sector to the economy. This finding indicates that greater trade openness creates opportunities for the manufacturing sector to grow through exports, technology transfer, and integration into global value chains.

The finding that trade openness positively affects the manufacturing sector aligns with the Flying Geese theory introduced by Kaname Akamatsu. This theory explains the industrialization pattern of developing countries following the lead of more advanced economies through technology absorption and industrial diversification. In this context, trade openness is a key factor, enabling countries to access international markets, new technologies, and foreign investment essential for manufacturing sector development. Countries more open to trade tend to integrate faster into global supply chains, thus giving their manufacturing sectors greater opportunities to grow and compete internationally.

From the literature perspective, this finding is consistent with Neoh & Lian (2021), who found that both the direct and dynamic effects of trade openness on manufacturing output growth in Malaysia are positive and significant. This supports the argument that trade openness can serve as a significant driver of manufacturing expansion in developing countries through improved market access, production efficiency, and foreign investment inflows.

This result is also consistent with Umoh & Effiong (2013) in Nigeria, which found that trade openness significantly and positively affects manufacturing productivity in both the short and long term. The study emphasized that a more open trade policy, when supported by the right incentives and trade facilitation measures, can serve as a strategic tool for improving the manufacturing sector's performance.

Likewise, Khobai & Moyo (2021) found that in the SADC region, trade openness generally has a positive impact on industrial performance. However, it may also exert pressure on the manufacturing sector due to low competitiveness and rising imports. The study highlighted that trade openness without simultaneous improvements in infrastructure, human capital, and reskilling strategies can harm manufacturing through reduced output and job losses.

This study's findings are also aligned with Wong (2009) in Ecuador, which found that trade openness had a positive and significant effect on manufacturing productivity, particularly in export-oriented industries, following trade reforms in the 1990s. Although productivity declined after 2000, the initial results support the notion that trade liberalization can improve efficiency and competitiveness by driving performance improvements among more productive firms.

However, this finding contradicts the study by Umer & Alam (2013), which reported that trade openness negatively affects industrial sector growth in the long run. Their study explained that openness can suppress industrial growth through channels such as monetary and fiscal policy and foreign direct investment dynamics. In contrast, this study finds that trade openness has a positive and significant effect on the manufacturing sector's contribution, indicating that for the four countries analyzed, international trade integration provides industrial expansion opportunities. This difference may reflect variations in economic structure, industrial strategy, and readiness for global competition across countries.

CONCLUSION

Based on the results of the analysis described in the previous chapter, the conclusions drawn to answer the research questions in this study are as follows:

1) The variables of GDP per capita, exchange rate, and trade openness are proven to have a significant simultaneous effect on the contribution of the manufacturing sector to GDP in the four countries.
2) Partially, the variables of GDP per capita and exchange rate have a negative and significant effect on the contribution of the manufacturing sector to GDP in the countries studied. Meanwhile, trade openness has a positive and significant effect on the contribution of the manufacturing sector to GDP.

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