

The Use of Regression Panel Analysis with Fixed Effects in International Trade: The Example of Poverty in Africa

Vladyslav Bato¹ D Peter Duhaň² D

Received: August 21, 2024 Revised: February 15, 2025 Accepted: February 16, 2025 Published: April 5, 2025

Keywords: Panel data; Regression; International trade; Development; GDP; FDI; Remittances; Export

Creative Commons Non Commercial CC BY-NC: This article is distributed under the terms of the Creative Commons Attribution-NonCommercial 4.0 License (https://creativecommons. org/licenses/by-nc/4.0/) which permits non-commercial use, reproduction and distribution of the work without further permission. **Abstract:** This paper explores the application and potential of panel data regression analysis in international trade. By leveraging panel data, the authors aim to understand the impact of various economic factors on poverty rates in African countries. The study uses fixed effects models to analyze the relationship between gross domestic product (GDP) per capita, foreign direct investment (FDI) inflows, remittances, and export rates on the proportion of the working population living in poverty. The findings indicate that higher GDP per capita and increased remittances reduce poverty rates, whereas FDI inflows and export rates do not show a statistically significant impact. The paper underscores the importance of economic growth and remittances in poverty alleviation and calls for more nuanced strategies to address poverty in Africa effectively. Future research should investigate the structural aspects of exports and regional specificities to enhance the understanding of these dynamics.

1. INTRODUCTION

International trade and business represent a complex and dynamic world where it is constantly necessary to analyze and predict various economic and commercial phenomena. International trade plays a critical role in shaping economic policies that drive sustainable development. The concept of sustainable development emphasizes economic growth that meets present needs without compromising the ability of future generations to meet their own needs. Within this framework, trade policies and economic strategies should be designed to foster long-term economic resilience, social equity, and environmental sustainability.

Poverty alleviation is a key component of sustainable development and aligns directly with the United Nations Sustainable Development Goals (SDGs). In particular, Goal 1 (No Poverty) seeks to eradicate extreme poverty, while Goal 8 (Decent Work and Economic Growth) aims to promote inclusive and sustainable economic growth, employment, and decent work for all (United Nations, 2024). International trade can contribute to these goals by creating employment opportunities, enhancing economic productivity, and facilitating the transfer of knowledge and technology across nations.

In this context, panel data regression analysis has become an important tool for understanding the relationships between different variables within the framework of international trade and

² University of Economics in Bratislava, Faculty of Commerce, Department of International trade, Dolnozemská cesta 1, 852 35 Bratislava 5, Slovak Republic



¹ University of Economics in Bratislava, Faculty of Commerce, Department of International trade, Dolnozemská cesta 1, 852 35 Bratislava 5, Slovak Republic

business. Panel data regression analysis is a form of analysis that takes into account data from multiple observations over time and across various units. This approach allows the behaviour of countries or companies to be considered over several periods (months, quarters, or years) in the field of international trade, providing insights into the factors influencing business decisions and company performance on an international level. For example, it is possible to analyze the impact of trade policies, economic indicators, technological advancements, competitive environments, and other factors on the development of international trade relations and business activities. This method helps identify key factors that influence success or failure in international trade and business, thereby enabling the formulation of better-informed strategies and business decisions.

Panel data are becoming an increasingly common type of data in empirical research in the fields of economics, social sciences, and medicine. The analysis of panel data represents a fundamental area of modern econometric research and multivariate statistics. Studies focused on these data are gaining increasing importance in research within these disciplines. Panel data regression analysis can address issues that are unsolvable with standard univariate data alone.

2. LITERATURE REVIEW

Regression analysis is a frequently used analytical technique in market research that enables the examination of relationships between dependent and independent variables. It offers several advantages, including the ability to verify whether an independent variable has a significant relationship with a dependent variable, estimate the strength of influence of various variables, and make predictions (Sarstedt & Mooi, 2019). According to Gallo (2015), regression analysis is a mathematical sorting process that selects a group of independent variables that influence the primary objective, the dependent variable. A supplementary definition is provided by Gunst and Mason (2018), who describe regression analysis as consisting of graphical and analytical methods for examining relationships, distinguishing it from other types of statistical analyses by its goal of expressing the dependent variable as a function of predictors.

Panel data combines elements of cross-sectional data and time series (Lukáčiková et al., 2018). These datasets consist of a set of individuals (typically persons, households, or companies) that are measured repeatedly over time, significantly expanding the sample size. This means that for each element in the cross-sectional sample, there is a time series. A common modeling assumption is that individuals are independent of one another, but observations of a given individual are dependent on each other. Compared to cross-sectional data, the advantage of panel data is that attributes expressing change from the original state can also be used in the analysis. On the other hand, compared to time series, panel data are not limited to regular chronological repetitions of individual observations. These data will be the subject of examination in this paper.

The importance of panel data and the significance of their use are discussed by Baltagi and Baltagi (2021), who provide a list of the advantages and limitations of using panel data. Among the advantages, panel data indicate that individuals, firms, states, or countries are heterogeneous. Panel data offer more informative data, greater variability, lower collinearity among variables, more degrees of freedom, and higher efficiency. They allow for more precise identification and measurement of effects that are not easily detectable in pure cross-sectional data or pure time series. The limitations include coverage issues (incomplete consideration of the target population), non-response problems (due to insufficient respondent cooperation or interviewer error), and the impact of data collection frequency, interview intervals, reference periods, or the use of truncation and time distortion in the sample.

The basic structure of regression models, according to Sul (2019), consists of time-invariant individual-specific variables, time-dependent common variables, and time-dependent individual-specific variables. Based on the structure of regression models, basic regression models for panel data will be gradually derived. Let y_{it} be the data of interest, representing individual *i* (or firm, group, country) at time t. The index *i* represents the cross-sectional unit, where the total number of cross-sectional units is denoted as n (i = 1, ..., n). The range of the time indicator is denoted as t = 1, ..., T. The variable *y* must have the same attributes across all *i* during *t*. Finally, the following general structure of panel data will be considered:

$$y_{it} = X_{it} + \alpha_i + \mu_{it}$$
 for $t = 1, ..., T$ and $i = 1, ..., n$ (1)

Brugger (2021) provides an illustrative example to help understand the individual components of this relationship, where y_{it} represents the level of concentration (the dependent variable) and X_{it} represents coffee consumption (the independent variable). Then a_i is the time-invariant component. This term expresses a certain individual effect of the cross-sectional unit, which in this case could be, for example, a natural ability to concentrate. Furthermore, β represents the estimated parameters (coefficients) for the individual independent variables, and μ_{it} is the idiosyncratic error, which may include factors that change over time for the given cross-sectional unit; in this example, it could be fatigue. Based on the given relationship, three basic types of panel regression models can be used: the fixed effects model, the random effects model, and the pooled regression model. However, the key model for this study will be the fixed effects model, which will be described in more detail in the methodology section.

To choose the appropriate model between the fixed effects and random effects models, the Hausman test is used. This statistical test allows the selection of the most suitable model based on the data and the problem at hand. The test states that if the result is:

- Null hypothesis H0, where p > 0.05; then it is more appropriate to use the random effects model.
- Alternative hypothesis H1, where p < 0.05; then it is more appropriate to use the fixed effects model (Zulfikar & STp, MM, 2018).

Baltagi and Baltagi (2021) mention several application areas of panel data regression analysis, such as the analysis of macroeconomic panel data, productivity measurement, consumer demand choice analysis, labor market outcomes panel econometrics, or gravity models of international trade.

It is worth highlighting several studies where panel regression analysis was used for international trade and, in some way, may have influenced decision-making or the resolution of situations. Suparman (2022) focused on the relationship between economic growth, income inequality, and poverty (by province) in Indonesia in his article. According to various studies he cites, creating economic opportunities and ensuring equal access are key components of this relationship. Indonesia faces challenges related to transforming its economic model, which is based on natural resources and low wages. A transition to inclusive and sustainable growth is essential. The data used in this study came from the Central Statistics Bureau. Specifically, the data included Gross Regional Domestic Product (GRDP), the number of poor people, and the GINI coefficient, which measured the level of inequality in the expenditures of the Indonesian population by province for the period 2015 to 2020. To analyze the relationship between these data, the author used panel regression analysis in all three forms: the pooled regression model, the fixed effects model, and the random effects model.

10th International Scientific Conference ERAZ 2024 Selected Papers

An interesting application of panel data regression analysis is found in the publication by Rahman et al. (2022). The authors aimed to verify the relationship between exports, imports, and the consumption of oil reserves on the level of oil production in Southwest Asian countries, where import, export, and income, or rather consumption of oil reserves, are independent variables, and oil production is the dependent variable. The outcome of the analysis was expected to confirm one of the hypotheses: either that the independent variables influence the dependent variable (hypothesis H1) or that the independent variables have no impact on oil production (hypothesis H0). Various tests were employed to select the most appropriate model, leading to the selection and use of the fixed effects model as the best fit for this problem. The analysis concluded that the independent variables have a high predictive ability to explain the dependent variable. Exports, imports, and oil reserves significantly impact oil production in Southwest Asian countries, thereby rejecting hypothesis H0.

In the article by Umar et al. (2020), panel regression analysis is applied to data on international trade in the West African subregion. In addition to trade itself, the authors also focused on foreign direct investment, which represents a significant component of capital flows for developing countries. Therefore, a study was conducted to examine the factors influencing international trade in this region of Africa, creating three models with dependent variables (exports, imports, and trade balance) and the same independent variables for each model (GDP, foreign direct investment, and exchange rate). In this case as well, after testing various types of models, the fixed effects model proved to be the most suitable. The results of the case study indicate that foreign direct investment is a key variable positively influencing international trade policy across West Africa during the observed period.

Another example of regression analysis in the field of international trade is provided by Isik et al. (2016), who examined the relationship between entrepreneurship and innovation in OECD countries from 1990 to 2011. This study utilizes dynamic panel data methods to analyze these relationships. One of the indicators of innovation used in the study is private-sector spending on research and development. The industries considered include pharmaceuticals, computers, electronics and optics, the aerospace industry, and the service sector. The study's results demonstrate that entrepreneurship and innovation have a long-term relationship. Countries that keep pace with trends in innovation and entrepreneurship enjoy greater economic prosperity. An interesting finding by the authors was that Japan was not among these countries; they observed that Japan significantly lagged in terms of overall entrepreneurial activity between 2001 and 2010. On the other hand, the finding that there is no long-term relationship between innovation and entrepreneurship in Turkey is attributed by the authors to the lack of policy frameworks in the country to support scientific and technological studies, which could lead to a greater number of entrepreneurs. This factor is crucial not only in Turkey but must also be considered in other countries.

Xinyan et al. (2023) assessed the impact of exports on the environment in the Beijing-Tianjin-Hebei urban agglomeration. The research article addresses this issue using an improved STIRPAT (Stochastic Impacts by Regression on Population, Affluence, and Technology) model and panel data from the Beijing-Tianjin-Hebei region for the period 2009-2020. The study also confirmed that GDP per capita and the amount of greenery in these cities have a mitigating effect on environmental pollution. Therefore, promoting ecological development and industrial transformation in this region is important.

From the above examples, it is evident that there are numerous cases and situations within international trade and business where panel data regression analysis is justified. Through this analysis, assumed hypotheses can be confirmed based on the available literature, but some facts can also be disproved or their certainty reduced. This often leads to interesting insights and reveals new relationships or dependencies. It allows for an in-depth exploration of factors from the perspective of a specific entity (country) and enables decision-making based on the results of the analysis, which could move forward the issue under investigation.

3. METHODOLOGY

This article aims to evaluate the potential and apply panel data analysis in the field of international trade using the quantification of panel analysis with fixed effects, demonstrated through a selected problem.

To achieve the aim, the following hypotheses are set:

- H1: With an increase in Gross Domestic Product (GDP) per capita, a decrease in the share of the working population aged 15+ living in poverty is expected.
- **H2:** With an increase in the share of Foreign Direct Investment (FDI) inflows as a percentage of total GDP, a decrease in the share of the working population aged 15+ living in poverty is expected.
- **H3:** With an increase in the share of remittance inflows as a percentage of total GDP, a decrease in the share of the working population aged 15+ living in poverty is expected.
- **H4:** With an increase in the share of total exports of goods and services as a percentage of GDP, a decrease in the share of the working population aged 15+ living in poverty is expected.

The subject of this research (the selected problem) is poverty in African countries. For territorial limitation, the total number of countries in Africa is 54, but due to unavailable data on the dependent variable, which will be introduced later, 47 of them were used in the research. The countries not included in the research are Djibouti, Eritrea, South Sudan, Libya, Equatorial Guinea, Seychelles, and São Tomé and Príncipe. The research is limited to 10 years, specifically from 2013 to 2022.

In the case of proving the hypotheses (H1-H4), the fixed effects model (FEM) will be used. Fixed effects regression (FE) is a method suitable for analyzing causal effects in the social sciences. This method provides unbiased estimates of causal effects even when there are unobserved factors that may influence the outcomes. These unobserved factors are common in the social sciences, making the fixed effects model an important tool in modern social research. These are individual characteristics, such as certain abilities or preferences, that cannot be observed, assuming these characteristics remain constant over time.

To analyze the obtained data using panel data regression analysis, the statistical tool GRETL, which offers the fixed effects model, was utilized. In processing the data within this tool, not only the modeling method was used, but also descriptive statistics and various graphical analyses.

FE regression can be applied to various types of data, but it is most commonly used with panel data. Panel data are usually arranged in a long format, where the observations of each subject are chronologically ordered. The main task of FE regression is to estimate the effect of a causal variable on the outcome variable while accounting for individual effects and group-specific factors (Best & Wolf, 2015).

The model assumes that there is a dependency between the independent variables and individual effects. In the case of the FE model, it is also assumed that the bias caused by omitting individual factors is specific to the group in question. To eliminate this bias, the intercept $\alpha i \ alpha_i \alpha i$, which is group-specific, is incorporated into the model. This intercept compensates for the effect of the omitted variable and is assumed to act in the opposite direction compared to the bias. The implementation of FE regression is therefore crucial in panel data analysis and allows for the acquisition of reliable estimates of causal effects, even when unobserved factors are present (William, 1997).

To express the model in a compact form, let *i* represent the *T*-dimensional vector of units y_i and X_i

$$y_i = X_i \beta + i\alpha_i + \mu_i \text{ for } t = 1, \dots, T \text{ and } i = 1, \dots n$$
 (2)

Lukáčiková et al. (2018) state that the estimation of the fixed effects model involves estimating the coefficients β and the unit-specific effect α_i for each unit *i*. In practice, the models of all cross-sectional units are combined into a single common regression model by adding unit-specific dummy variables d_i to d_n , which take the value $d_{ii} = 1$ for the given *i* cross-sectional unit. All other cross-sectional units have a value of $d_{ii} = 0$. Due to the introduction of dummy variables, this approach is also referred to as the Least Squares Dummy Variable method.

The variables included in this research can be seen in Table 1. Due to the diversity of economies and populations across African countries, it was decided to use GDP per capita. Other elements that describe the state of international trade in Africa and could be significant in addressing poverty include FDI and remittances. Both variables are expressed as a percentage of GDP. The last variable in the model is the export of goods and services, also expressed as a percentage of GDP.

Based on the estimates and assumptions, the expected effects of the individual variables were added to Table 1. These effects correspond to the established hypotheses.

GRETL Label	Variable Name	Variable Description	Expected Value of β
Work_pov_rate	Share of Poor Working Population	The variable represents the percentage of the working population aged 15+ living in poverty (i.e., living below the international poverty line - \$2.15/day).	
GDP_pc	Gross Domestic Product per Capita	This variable represents the gross domestic product per capita, expressed in current prices in USD.	-
FDI_inflows_rate_GDP	Share of FDI Inflows as a Percentage of GDP	The variable quantifies the inflow of foreign direct investment expressed as a percentage of gross domestic product.	-
Remit_inflows_rate_GDP	Share of Remittance Inflows as a Percentage of GDP	The variable quantifies the total remittance income expressed as a percentage of gross domestic product.	-
EXP_rate_GDP	Share of Total Exports as a Percentage of GDP	This variable shows the value of total exports of goods and services expressed as a percentage of gross domestic product.	-

 Table 1. List of variables for model and their expected effects

Source: Own processing

Basic statistical data of the dataset are displayed in Table 2. The dataset entered into the GRETL software contained the same number of cross-sectional units (47 African countries).

Variable Label	Work_pov_	GDP_pc	FDI_inflows_	Remit_inflows_rate_GDP	EXP_ rate_GDP
Maan	29.674	2 124 5	3.6876	4 1603	26 564
Madian	29,074	124,5	2 308	2 217	20,504
Minimum	20,20	241.05	2,398	2,217	5 5 4 6
Munimum	0,04	241,95	-0,3/	0	3,340
Maximum	/9,/1	11 3/6	37,336	26,/52	84,18
Standard Deviation	22,59	2 156	5,441	5,2027	12,639
Skewness	0,42531	1,8937	3,4195	1,8878	0,75187
Kurtosis	-0,88833	3,4046	15,13	3,3929	0,61865

Table 2. Descriptive Statistics of the Variables in Model

Source: Own processing

When examining the data, the economic diversity across African countries can be confirmed. GDP per capita shows a high maximum value compared to the average. The statistical data on FDI inflows and remittances are comparable, with minimal differences between their mean and median, which is also true for the standard deviation. A noticeable difference is seen in the minimum values, where FDI values can even be negative. However, negative values for remittances are not possible, so the minimum value is 0. Regarding probability distribution, both variables exhibit right-skewness, meaning most values are left of the mean. On the other hand, the difference in kurtosis coefficients is larger, but this does not change the nature of the probability distribution. In both cases, the distribution is more peaked than a normal distribution, as the kurtosis values are positive. The distribution of export values for goods and services shows a wide variance, with the smallest value at around 5% and the highest reaching 84%, while the mean and median are very close. Considering both the skewness coefficient and the standard deviation, it can be inferred that the distribution is slightly right-skewed, with the most frequent values likely falling in the 10% to 40% range (mean value - standard deviation; mean value + standard deviation).

Based on the selected variables, which were introduced and described through statistical data, we proceeded to define the equation. The final form for the fixed effects model can be seen in the attached equation (3). Based on the descriptive statistics, it would have been appropriate to log-transform the remittance and FDI inflows; however, these data contain zero and negative values. Log-transforming these variables would result in the loss of these values, thereby reducing the total number of observations. Therefore, we chose to use the original data, despite knowing that the variables do not follow a normal distribution.

$$Work_pov_rate_{it} = \alpha_i + \beta_1 GDP_pc_{it_1} + \beta_2 FDI_inflows_rate_GDP_{it_2}) + \beta_3 Remit_inflows_rate_GDP_{it_3} + \beta_4 Exp_rate_GDP_{it_4} + \mu_{it}$$
(3)

All data on individual African countries used in the model estimates were obtained from the OECD.Stat (2024) statistical database, specifically from the African Development Dynamics section. The complete database contains 31 tables with various attributes across different areas, of which, of course, not all were used.

4. RESULTS AND FUTURE RESEARCH DIRECTIONS

After defining the model equation, we proceeded to the actual model in GRETL. The results of the fixed effects panel data regression analysis can be seen in Table 3 below. First, it is important to note that the analysis covered nearly all observations from the available data source, excluding only one observation. The total number of observations was 469. GRETL included all African

countries from our adjusted list, which comprised 47 countries. The excluded observation resulted from missing data for one country in one specific year. This conclusion is based on the fact that the period of the model spans a minimum of 9 years and a maximum of 10 years.

We can reject the statistical insignificance with 99% confidence for two of the four independent variables, namely:

- We reject the hypothesis of insignificance for the variable GDP_pc, meaning GDP per capita, and therefore the estimated parameter can be interpreted. With an increase in GDP per capita by 1 unit (1 USD), a decrease in the share of the working poor by 0.003 percentage points is expected.
- We reject the hypothesis of insignificance for the estimate of the variable Remit_inflows_rate_GDP, meaning the share of remittance income expressed as a percentage of GDP. With an increase in the share of remittance income by 1 unit (1 percentage point), a decrease in the share of the working poor by 0.41 percentage points is expected.

For the variables FDI inflows and exports of goods and services, we could not reject the null hypothesis of statistical insignificance, and therefore, we conclude that we were unable to confirm the impact of these elements of international trade on the share of the working poor in African countries.

Time-series length: minimum 9, maximum 10				
Dependent variable: Work_pov_rate				
Standard errors clustered by unit				
	Coefficient	Std. Error	t-ratio	p-value
const	37,8687	3,12387	12,120	<0,0001 ***
GDP_pc	-0,00345	0,00108	-3,2070	0,0024 ***
FDI_inflows_rate_GDP	-0,07182	0,07981	-0,8999	0,3728
Remit_inflows_rate_GDP	-0,41254	0,14266	-2,8920	0,0058 ***
Exp_rate_GDP	0,03903	0,09364	0,4168	0,6788
Mean dependent var	29,57198	S.D. dependent var	22,5	0582
Sum squared resid	10 327,69	S.E. of regression	4,97	0654
LSDV R-squared	0,956432	Within R-squared	0,09	3807
Log-likelihood	-1 390,552	Akaike criterion	2 88	3,10
Schwarz criterion	3 094,78	Hannan-Quinn	2 96	6,39
rho	0,766184	Durbin-Watson	0,26	2509

Table 3. Fixed Effects Panel Data Regression Model

Source: Own calculations

Given that the fixed effects model assumes the heterogeneity of individual cross-sectional units (African countries), we examined whether this holds true for our model. We used a test statistic (F-test), which was also part of the model output, as shown in Table 4. The software calculated that the value of the F-statistic is 742.321, which is greater than the tabulated F value of approximately 1.37 at the 0.05 significance level for F(46; 146.4). Based on this relationship and the p-value (7.05893e-153), we were able to reject the null hypothesis (H0: The cross-sectional units have the same intercepts). This confirmed the appropriateness of the FEM model for our dataset. It indicates that individual African countries have different effects on the resulting share of the working poor and that the values of α_i from equation (3) are different for each country.

This model aimed to examine the effects of selected elements of international trade and business on the rate of so-called working poverty in Africa, specifically in individual countries on the continent. The parameter estimates were interpreted during the research process, but the evaluation will be addressed in this section, where they will also be compared with other studies. Hypothesis H1 is confirmed, leading to the conclusion that as GDP per capita increases, a reduction in the proportion of the working population living in poverty is expected. This finding underscores the importance of economic development in improving living conditions for the population. However, it is essential to recognize that economic growth alone is not sufficient to solve the problem of poverty. It is presumed that multiple factors, not just an increase in GDP per capita, need to be aligned. A comprehensive approach to poverty reduction is crucial for achieving sustainable and inclusive economic development.

Tab	le	4.	F-test
			1 0000

Robust test for differing group intercepts:
Null hypothesis: The groups have a common intercept
Test statistic: Welch F(46; 146,4) = 742,321
with p-value = $P(F(46; 146, 4) > 742, 321) = 7,05893e-153$

Source: Own calculations

Hypothesis H2 is rejected, as the study was unable to demonstrate the statistical significance of the estimate regarding Foreign Direct Investment (FDI) on the share of the working poor. Thus, the claim that an increase in FDI inflows would lead to a reduction in poverty rates is rejected. Magombeyi and Odhiambo (2018) examined the impact of FDI on poverty reduction in South Africa. Their results indicate that FDI has a positive impact on poverty reduction in the long term and a negative impact in the short term. The study recommends that poverty reduction policies based on FDI should focus on strengthening social infrastructure, investing in productive sectors of the economy, and examining the impact of other economic variables. Overall, it is concluded that FDI plays a less significant role in poverty reduction in South Africa, and its effect depends on the poverty reduction indicators used. Arogundade et al. (2022) explored the role of FDI in the context of poverty in Sub-Saharan African countries. Their findings suggest that FDI does not have a direct impact on the incidence and intensity of poverty, but its impact on poverty alleviation varies across different regions, indicating the need for specific regional policies. On the other hand, contrasting views are presented by Gohou and Soumaré (2012), who investigated whether FDI can reduce poverty rates in Africa and whether there are regional differences in these effects. This article evaluates the impact of FDI on welfare in African regions. The research used welfare indicators such as the Human Development Index (HDI) and real GDP per capita. A strongly positive connection between FDI and welfare improvement was found across Africa, although the impact varies between regions and is greater in poorer countries. It is assessed that FDI can be particularly beneficial in more productive sectors and less developed countries. To achieve balanced welfare across countries within regions, appropriate regional policies must be established to attract these investments. In further research on the impact of FDI, it would be appropriate to focus on individual economic sectors and examine them in detail. Many African countries have monocultural economies, and the inflow of FDI into unpopular sectors may not have a significant impact on welfare growth. Therefore, it is believed that when considering investments, it would be more appropriate to assess the correct sectors based on the specific country, particularly those crucial for its economy.

The influence of remittance inflows was confirmed, allowing the authors to validate Hypothesis H3. With an increase in the share of remittance inflows relative to total GDP, a reduction in the proportion of the working population aged 15 and above living in poverty is expected. This conclusion underscores the importance of linking economic flows, such as remittances, with social indicators like poverty rates. The results demonstrated that, in the short term, poverty drives remittance inflows when infant mortality is used as an indicator of poverty. However, when household consumption

expenditures were used, no causality between poverty and remittances was found in South Africa, regardless of the time horizon analyzed. Akobeng (2016) observed similar effects in Sub-Saharan African countries, reaching conclusions consistent with those of this research, which utilized the Fixed Effects Model (FEM). The study found that remittances significantly impact poverty and inequality, contributing substantially to their reduction. The study recommended that South Africa continue to support policies that reduce costs and simplify migration processes, thereby stimulating emigration and increasing remittance inflows. Collaboration with emigrant countries is also crucial to streamline policies related to sending money back to South Africa. Remittances also affect poverty reduction and income equalization from a macroeconomic perspective, with these effects being amplified by financial development. The International Monetary Fund should ensure the inclusion of informal and non-financial methods of sending remittances. Policymakers in Africa should consider remittances as a tool for reducing poverty and inequality and prioritize ensuring favorable conditions and policies aimed at lowering remittance costs.

The final hypothesis, H4, was also rejected due to the confirmed insignificance of the "*Exp_rate_GDP*" parameter. Although the hypothesis was rejected based on the available data and analysis, this does not mean that the issue is closed. On the contrary, the authors reviewed studies by other researchers. Skae and Barclay (2007) discuss the need for a comprehensive response to manage the connection and ensure efforts to reduce poverty within the context of a national export strategy. This framework aims to address issues of assignment and aggregation of poverty reduction goals, assign organizational responsibility, and evaluate the impact of initiatives. Balat et al. (2009) examined the impact of exports in rural parts of Africa and concluded that trade has a significant effect on poverty reduction in Uganda. The availability of export opportunities, such as access to markets in developed countries or high international prices for major export crops, can be potentially advantageous.

In future research, it would be beneficial to examine the structure of exports—specifically, what types of goods and services are exported, and whether these products have high added value or are primarily raw materials with low added value. It is also important to determine how export revenues are distributed across different segments of the population. Investigating the impact of institutional factors, such as corruption, political stability, and the quality of government policies, on the effectiveness of exports in reducing poverty is crucial. Analyzing case studies of African countries where exports have contributed to poverty reduction, and identifying key differences from countries where this effect has not been confirmed, would provide valuable insights. Regional differences within Africa should also be considered, as individual countries have different economic conditions and needs. This research should contribute to a better understanding of the complex relationships between exports and poverty, and help create more effective policies for combating poverty.

5. CONCLUSION

This article aimed to assess the potential and apply a panel data analysis in the field of international trade, focusing on the example of poverty in African countries. Through the analysis of fixed effects models, the study found that an increase in GDP per capita is associated with a decrease in the proportion of the working population living in poverty, highlighting the importance of economic growth in improving living conditions. However, it also emphasizes the need for a comprehensive approach to poverty reduction beyond merely increasing GDP per capita. The study did not find statistically significant evidence that an increase in FDI inflows reduces the proportion of the

working poor, suggesting that while FDI may play a role in economic growth, its direct impact on poverty reduction in the context of the African countries studied is not evident. The inflow of remittances, expressed as a percentage of GDP, significantly reduces the proportion of the working poor, emphasizing the crucial role that remittances play in alleviating poverty and highlighting the need for policies that facilitate and maximize remittance inflows. The study did not find significant evidence that an increase in the share of total exports in GDP reduces the proportion of the working poor, indicating that merely increasing export volume without considering the nature and distribution of export revenues may not be sufficient to reduce poverty. Furthermore, this study highlights the critical role of economic development in addressing poverty. The findings emphasize the need for policies that align with the broader objectives of sustainable development, particularly as outlined in the United Nations Sustainable Development Goals. The impact of remittances on poverty reduction suggests that financial flows supporting households can be an effective means of achieving long-term social and economic stability. Overall, the research underscores the complexity of the relationships between economic indicators and poverty, suggesting that targeted and multifaceted strategies are necessary for effective poverty alleviation in African countries. Additionally, the study underscores the necessity of a development-oriented approach to international trade, where economic policies not only foster growth but also contribute to sustainability and equitable wealth distribution. Future research should explore the structural aspects of exports and the regional specifics of the impacts of FDI inflows and exports to gain a deeper understanding of this dynamic. Also, research should further examine how international trade strategies can be integrated with sustainability frameworks to ensure inclusive development that benefits all segments of the population.

Acknowledgment

This paper is a part of research project VEGA N.1/0270/22 "Growth of Slovakia's innovative capabilities and competitiveness for foreign investors in post-covid deglobalization era from the aspect of knowledge creation and transfer", VEGA 1/0689/23 "Sustainable growth and the geopolitics of resilience in the context of crisis prevention" and I-25-101-00 "Current issues in international trade: deglobalization, sustainable development and circular economy approaches".

References

- Akobeng, E. (2016). Out of inequality and poverty: Evidence for the effectiveness of remittances in Sub-Saharan Africa. *The Quarterly Review of Economics and Finance*, 60, 207-223. https:// doi.org/10.1016/j.qref.2015.10.008
- Arogundade, S., Mduduzi, B., & Eita, H. (2022). Foreign direct investment and poverty in sub-Saharan African countries: The role of host absorptive capacity. *Cogent Economics & Finance*, 10(1). https://doi.org/10.1080/23322039.2022.2078459
- Balat, J., Brambilla, I., & Porto, G. (2009). Realizing the gains from trade: Export crops, marketing costs, and poverty. *Journal of International Economics*, 78(1), 21-31. https://doi.org/10.1016/j. jinteco.2009.01.016
- Baltagi, B. H., & Baltagi, B. H. (2021). Test of hypotheses with panel data. Econometric Analysis of Panel Data, 75-108. https://doi.org/10.1007/978-3-030-53953-5_4
- Best, H., & Wolf, C. (2015). Logistic regression. The SAGE handbook of regression analysis and causal inference. Los Angeles: Sage, 153-171.
- Brugger, B. (2021). A guide to panel data regression: theoretics and implementation with python. Towards data science, 6.

Gallo, A. (2015). A refresher on regression analysis. Harvard Business Review, 4.

- Gohou, G., & Soumaré, I. (2012). Does Foreign Direct Investment Reduce Poverty in Africa and are There Regional Differences? *World Development*, 40(1), 75-95. https://doi.org/10.1016/j. worlddev.2011.05.014
- Gunst, R. F., & Mason, R. L. (2018). *Regression analysis and its application: a data-oriented approach*. CRC Press. https://doi.org/10.1201/9780203741054
- Isik, H. B., Nihat, I. Ş. I. K., & Kilinc, E. C. (2016). The Relationship between Entrepreneurship and Innovation: A Dynamic Panel Data Analysis. *Eskişehir Osmangazi Üniversitesi İktisadi* ve İdari Bilimler Dergisi, 11(3), 7-20.
- Lukáčiková, A., Lukáčik, M., & Szomolányi, K. (2018). Úvod do ekonometrie s programom Gretl. Bratislava: Letra Edu, 345.
- Magombeyi, M. T., & Odhiambo, N. M. (2018). Dynamic impact of FDI inflows on poverty reduction: Empirical evidence from South Africa. Sustainable Cities and Society, 39, 519-526. https://doi.org/10.1016/j.scs.2018.03.020
- OECD.Stat. (2024). Africa's Development Dynamics Statistical Annex. https://stats.oecd.org/ Index.aspx?ThemeTreeId=9.
- Rahman, A., Muda, I., Caroline, C., Panjaitan, P. D., & Situmorang, R. Y. (2022). The panel data regression: relationship of the exports, imports and intake of oil reserves son oil production levels in southwest asian countries to contribute to state revenue (The implement of International Trade Theory). *International Journal of Professional Business Review*, 7(3), e0593. https://doi.org/10.26668/businessreview/2022.v7i3.0593
- Sarstedt, M., & Mooi, E. (2019). Regression Analysis. Springer Texts in Business and Economics, 209-256. https://doi.org/10.1007/978-3-662-56707-4_7
- Skae, F. O., & Barclay, B. (2007). Managing the linkage between export development and poverty reduction: an effective framework. *Management Decision*, 45(8), 1208-1223. https://doi. org/10.1108/00251740710819005
- Sul, D. (2019). Panel data econometrics: Common factor analysis for empirical researchers. Routledge. https://doi.org/10.4324/9780429423765
- Suparman, S. (2022). Relationship Between Economic Growth, Income Inequality and Poverty by Provinces in Indonesia: Panel Data Regression Approach. *International Journal of Environmental, Sustainability, and Social Science*, 3(1), 103-108. https://doi.org/10.38142/ijesss. v3i1.167
- Umar, Y. H., Muhammad, B., & Omoren, U. (2020). Panel Data Analysis of International Trade in West African Sub Region. *American Journal of Theoretical and Applied Statistics*, 9(4), 106-120. https://doi.org/10.11648/j.ajtas.20200904.14
- United Nations. (2024). Department of Economic and Social Affairs. The 17 goals. https://sdgs. un.org/goals
- William, H. (1997). Greene. Econometric Analysis.
- Xinyan, M., Jinmin, L., Han, W., Yuan, T., & YuXin, Z. (2023). Assessing the environmental impact of export trade on the Bejing-Tianjin-Hebei urban agglomeration. An analysis using the spatial panel stirpat model. *Environmental Engineering & Management Journal (EEMJ)*, 22(8), 1399-1411. https://doi.org/10.30638/eemj.2023.117
- Zulfikar, R., & STp, MM. (2018). Estimation model and selection method of panel data regression: An overview of common effect, fixed effect, and random effect model. *JEMA: Jurnal Ilmiah Bidang Akuntansi*, 9(2), 1-10. https://doi.org/10.31227/osf.io/9qe2b