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Globalization and Energy Consumption: Empirical Implications for Income Inequality in Developing Countries

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ABSTRACT

The objective of this study is to envisage the impact of globalization and energy consumption on income inequality in developing countries. The specific objectives are to discover the impact of economic, social, political, and overall globalization along with energy consumption on income inequality. To attain the empirical outcomes, this study employed the System-GMM on a panel dataset from 1996 to 2018 in a sample of sixty-nine developing countries as per the classification of World Bank. To further validate the empirical outcomes different interaction terms between overall globalization and energy use, political globalization and energy consumption, social globalization and energy consumption are all regressed on income inequality. The main finding of this study is that income inequality is positively affected by globalization and is statistically significant. This research also discovered a negative correlation between energy consumption and income inequality. The study suggests that developing nations should adopt policies to open their markets to the entire world, make effective use of globalization, and promote policies that reduce income inequality.

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1. Introduction

World economies are achieving significant economic growth, but this success is not acquired in terms of equal income distribution (Shabaz et al., 2021). The increase in income inequality has becomes a matter of concern to all developed as well as developing nations. The rapid decline in equal distribution of income leads to more focus on the examination of the dynamics of income inequality in developing countries (Wildman, 2021). Extreme income disparities have gone out of control. Hundreds of millions of people live in poverty Hulme and Shepherd (2003) whereas the richest one percent of the population gets huge profits. Millionaires are in greater numbers than ever before, and their incomes have climbed to new heights. During this time, the world's poorest people grew poorer.

Globalization seems to have economic, political, as well as social effects on all people throughout the world and Globe is known as a globalized society, and people socially know each other through various forms of communication and globalization is a way through which the economy of the World is linked via foreign direct investment and trade (Mishkin, 2009). Through the influx of capital for economic development, globalization has brought the world's established and growing economies closer. Many countries have benefited from globalization, which has had a major impact on the socio-economic, environmental, and political elements of human life. By producing and investing in goods and services, technical change, financial convergence and information exchange all contribute to the increased interconnection between countries as a result of globalization. Globalization reduces the income gap in emerging countries by increasing labor's demand because emerging countries are richer in unskilled labor (Ha, 2012). Globalization, on the other hand, promotes economic disparities in emerging countries (Bukhari & Munir, 2016). As a result, analyzing the influence of globalization on income disparity has become a significant topic in the political economy and internationally (Dixon & Boswell, 1996; Rudra, 2008; Lundberg & Squire, 2003; Milanovic & Squire, 2005).

Energy consumption is a parameter for measuring the rate of economic growth and industrial development. In both industrialized and emerging countries, energy usage serves as a fuel for rapid economic expansion. Inequalities are frequently explored in-depth in terms of income, but differences in energy availability and usage might show income disparities as well. As a result, overall energy statistics can be utilized to uncover economic disparities at the worldwide, geographical, and national levels (Mainali et al., 2014). Oil, natural gas, coal, nuclear, solar, hydraulic, biomass and wind are primary energy sources that are utilized directly. Secondary sources of energy that are utilized after being converted include diesel oil, solar energy, gasoline, and coal-based electricity. Primary energy consumption makes it simpler to uncover income inequalities (Sonora, 2021). This is because the primary energy source is the most readily controllable kind of energy.

Income inequality is affected by several variables such as GDP (Deininger & Squire, 1997; Hoffmann et al., 2020; Yang & Greaney, 2017; Zungu et al., 2021), population (Bor et al., 2017; Dong et al., 2018; Zhan et al., 2021; Zhong, 2011), and unemployment (Costantini et al., 2018; Mishchuk et al., 2018). This is an insufficient list, but it does indicate a general tendency in the existing literature.

The influence of globalization on income disparity was scientifically explored by previous recent researchers and concluded that globalization has a positive impact on income disparity (Ha, 2012; Dorn et al., 2018; Abakumova & Primierova,2018; Auguste, 2018; Elgindi, 2016; Asteriou et al., 2013; Mah, 2013; Choi et al., 2019). While On the other hand, the studies of globalization and income inequality found that globalization harms income inequality (Cabral et al., 2016; Ruana, 2020; Balanet et al., 2015; Zhou et al., 2011; Lee, 2010; Bechtel, 2014; Kinnaman, 2018; Mohanty, 2017). Related to this, Some studies discovered a positive link between income inequality and energy usage. (Topcu & Tugcu, 2019; Uzar, 2020; Asongu & Odhiambo,2020; Bianco et al., 2018; Ajmi et al., 2015; Salgado et al., 2020; Galvin & Sunikka, 2018). While some researchers found that energy use has a negative relationship with income inequality (Duan & Chen, 2018; Mohanty, 2017), the significant results are still unclear. The goal of this research is to find significant results by estimating globalization and energy use on income inequality in developing countries.

Income inequality is a problem from the social point of view. For the economists and policymakers, rising income inequality among the developing countries is a major challenge. It is often assumed that Globalization offers countries more opportunities to pursue higher productivity growth. Globalization provides new chances for countries to improve their growth and development, but it also

creates conflicts for policymakers in regulating global, regional, and national economic systems, as well as imposing constraints on them. There is a lot of discussion over why certain countries profit more from globalization than others. Complementary policies and initial conditions in the host country have also resulted in a divergence of benefits from globalization among countries. Over the previous few decades, the gap between rich and poor countries has widened because of globalization. Despite the enormous potential afforded by globalization, its current patterns are exceedingly complicated and uneven, and detractors are always saying that as globalization increases, rich countries have more benefited at the expense of poor countries. Despite advances in technology, neoliberal reforms, and cross-national integration, the benefits of increased incomes and output growth have not been evenly distributed among the population which caste a serious doubt on the impact of globalization on the income inequality. The main questions arise how different type of globalization like political, social, and economic globalization along with the energy consumption impact the income inequality of the developing countries.

This study is consisting of five sections. Section one contains introduction, second section establishes the review of existing studies, section three is data and econometric Strategy, section four presents the result and discussions and finally section five concludes the study.

2. Literature Review

In this section, the connection between globalization, energy consumption, growth, population, and unemployment are reviewed. The researcher will try to pinpoint these connections with respect to theoretical and empirical research and reviewed a variety of macroeconomic channels. Several empirical studies have investigated the relationship between globalization and macroeconomic factors, as well as a few other topics such as globalization and economic growth. (Bataka, 2019; Kurniawati, 2020; Majidi, 2017; Radulovic & Kostic, 2020; Samimi & Jenatabadi, 2014; Zahonogo, 2018 among others); inflation (Ahmad & Civelli, 2016; Ali et al., 2019; Altansukh et al., 2017; Lv et al., 2019; Mazumder, 2017 among others); education (Ali et al., 2019; Malinetskiy & Sirenko, 2020; Poddubnaya et al., 2021; Spring, 2008; Zajda, 2020 among others); financial development (Hussain et al., 2020; Kandil et al., 2017; Muye & Muye, 2017; Kılıçarslan et al., 2018; Zameer et al., 2020 among others); (Fuinhas et al., 2019; Hassan et al., 2019) environment (Crawford-Brown, 2013; Gallagher, 2009; Kayikci, 2019; Pischke, 2018; Postolache et al., 2019; J. Yang et al., 2019 among others) globalization.

However, only a few researchers have found a link between globalization and income inequality (Abakumova & Primierova, 2018; Adams, 2008; Balan et al., 2015; Heimberger, 2020 among others). The majority of literature supports that globalization has a positive impact on income inequality such as (Baddeley, 2006; Chordokrak & Chintrakarn, 2011; Khan & Faridi, 2008; Urata & Narjoko, 2017 among others) and others have a negative impact like (Adams, 2008). Asteriou et al., 2014 has empirically analyzed the association linking globalization and income disparity by using the panel data of twenty-seven EU countries. According to their findings, there is a positive relationship between globalization and income disparity. Dorn et al. (2018) examined the link between globalization and income disparities using panel data from 140 countries. They used instrumental variable estimates to conclude that globalization has a large positive impact on income disparity. Similarly, using data from both developed and developing nations, Atanasova and Tsvetkov (2021) evaluated the impact of globalization on income disparity. For data estimation, they employed ADF and PP Fisher approaches. Globalization has a detrimental influence on income disparity in emerging countries, according to the study's findings. On the other hand, GDP growth has no positive relationship with income disparity.

While on the other hand Munir and Bukhari (2020) analyzed the relationship between inequality and globalization by taking three aspects of globalization as financial globalization, trade globalization, and technological globalization. This study used HO and SS theorem as a theoretical base. They used panel data and found that financial globalization positively influences the income disparity, trade globalization negatively influences the income disparity and technological globalization also has a negative connection with income disparity. Heinze (2020) explored the association between globalization and inequality, and poverty. Finally, they reported that globalization has a positive impact on income disparity but has a negative impact on poverty.

Several empirical kinds of research, on the other hand, have looked into the relationship between energy consumption and macroeconomic variables, as well as other variables such as energy consumption and growth. (Chen et al., 2020; Dat et al., 2020; Esen & Bayrak, 2017; Huang & Huang, 2020; Ivanovski et al., 2021; Magazzino et al., 2021; Shahbaz et al., 2020 among others); inflation (Bassey & Ekong, 2019; Naraghi et al., 2021; Sultan et al., 2020; Talha et al., 2021 among others); employment (Glasure & Lee, 1995; Muniyoor, 2020; Payne, 2009; Tiwari, 2010; Yu & Jin, 1992 among others); trade (Alkhateeb & Mahmood, 2019; Amri, 2019; ben Aïssa et al., 2014; Farhani et al., 2014 among others); health (Akbar et al., 2020; Caruso et al., 2020; Haseeb et al., 2019; Qu et al., 2017; Xing et al., 2019 among others); human capital (Akram et al., 2019, 2020; Alvarado et al., 2021; Asghar et al., 2020; Salim et al., 2017; Yao et al., 2019); financial development (Khan et al., 2020; Magazzino, 2018; Odhiambo, 2019; Raza et al., 2020; Tsaurai, 2020; Yang et al., 2020 among others)

Duan and Chen (2018) used a graphical analysis of the Lorenz curve to investigate the relationship between energy usage and income disparity. Panel data of 121 countries were analyzed by the Multi-regional input out the model and found that energy consumption reduces income disparity in all three forms such as petroleum, coal, and natural gas. Topc and Tugcu (2020) examined the correlation between renewable energy consumption and income disparity and found that renewable energy use had a negative influence on income inequality. (Santillán-Salgado et al., 2020) used a sample of 134 countries to empirically investigate the impact of GDP growth and energy use on wealth disparities. They used the GINI index as a proxy if income inequality. The main findings of the study demonstrated that energy use has a long-term favorable impact on income disparities. While on the other hand Dong and Hao (2018) empirically analyzed the electricity consumption and income disparity in China using a panel from 1996 to 2013. They used the GMM approach for the estimation of panel data. Their findings revealed that the urban and rural effects of income inequality on electricity are dependent on income level. The study also revealed a substantial inverted U-shaped association between per capita power usage and per capita GDP. Galvin and Sunikka-Blank (2018) explored the relation of energy use with income disparity in high-income countries using data from the 1950s to the 1980s. The data revealed a negative link between income disparity and energy use. The majority of studies discovered a link between energy use with income inequality. The dependent variable was energy consumption, while the independent variable was income disparity. Only one study has looked into how energy consumption affects inequality. However, past empirical research implies that the actual influence of energy use on income inequality there may be needed to be investigated. As a result, the goal of this research is to find out how globalization and energy use affect economic inequality.

While on the other hand Topcu and Tugcu (2019) used panel data from developed countries (1990-2014) to investigate the association between renewable energy use and inequality. The generalized methods of moments and the dynamic common effects estimator were both used in this work as panel data methodologies. According to their findings, increasing renewable energy usage leads to a reduction in income disparity. While on the other hand Globalization's impact on income inequality

in emerging and developed countries, according to Baekand and Shi (2016). They estimated panel data for 52 developing and 26 developed nations throughout the period 1990-2010. They used the Gini index, HO, and SST model for using the comprehensive sets for this study. The result of the study showed the positive relation of globalization with income inequality in developing countries. Heshmati and Lee (2010) used panel data by taking 61 developing and developed throughout 1995-2001. The finding of the study indicated that there has a negative relation between globalization with income disparity.

3. Data and Econometric Strategy

3.1 Data Source

The effect of globalization and energy usage on income inequality in developing nations is investigated using panel data collected over a twenty-three-year period from 1996 to 2018.This study is based on secondary sources of information.

Table 1 Description of variables and data sources

Variables	Symbol	Measurement	Data Sources
GINI index	GINI	It is a statistical dispersion measure used to describe income disparity.	SWIID*
Globalization index	GLOB	Is measured by political, economic and social dimensions of globalization.	KOF index (Dreher, 2006)
Economic globalization index	EGLOB	Is measured by trade flow, FDI & portfolio investment, and restrictions on these outflows and inflows.	KOF index (Dreher, 2006)
Political globalization index	PGLOB	Is measured by the membership of international organizations, number of treaties signed by other countries, embassies numbers, and UN Security Council meetings.	KOF index (Dreher, 2006)
Social globalization index	SGLOB	Is measured by information flows, personal contact, and cultural nearness.	KOF index (Dreher, 2006)
Energy Consumption	ENC	Energy use (kg of oil equivalent per capita).	WDI**
GDP growth rate	GDPr	GDP growth rate (annual %).	WDI
Total population	POP	The de facto definition of population, which includes all residents regardless of legal status or citizenship, is used to calculate the total population.	WDI
Total unemployment	UEMP	Unemployment, total (% of the total labor force) (modeled ILO estimate).	WDI

* Standardized World Income Inequality Data base, ** World Development Indicators

System GMM is used for the analysis of unbalanced panel data for developing countries. We used eight econometric models to find out the impact of globalization and energy consumption on income inequality in developing countries. Income disparity is described as a function of globalization, energy usage, income, population, and unemployment, as seen below:

3.2 Model Specification

To unveil the impact of globalization and energy consumption on income inequality in developing nation the following models are to frame

$$GINI = f(GLOB, ENC, GDPr, POP, UNEMP) \quad (1)$$

The squared term of GDP growth incorporates in the model because the Kuznets-type model is used to analyze the influence of globalization and energy consumption on income inequality in developing countries.

$$GINI = f\,(GLOB, ENC, GDPr, GDPr^2, POP, UNEMP) \quad (2)$$

All variables are in logarithm form, where GINI represents the GINI coefficient, GLOB indicates the globalization index, ENC is the energy consumption, GDPr is the GDP per capita growth rate, POP indicates the total population and UNEMP represents the unemployment rate.

$$GINI_{it} = \beta_{0it} + \beta_1 GINI_{it-1} + \beta_2 GLOB_{it} + \beta_3 ENC_{it} + \beta_4 GDPr_{it} + \beta_5 GDPr^2{}_{it} + \beta_6 POP_{it} + \beta_7 UNEMP_{it} + \varepsilon_{it} \quad (3)$$

$$GINI_{it} = \beta_{0it} + \beta_1 GINI_{it-1} + \beta_2 EGLOB_{it} + \beta_3 ENC_{it} + \beta_4 GDPr_{it} + \beta_5 GDPr^2{}_{it} + \beta_6 POP_{it} + \beta_7 UNEMP_{it} + \varepsilon_{it} \quad (4)$$

$$GINI_{it} = \beta_{0it} + \beta_1 GINI_{it-1} + \beta_2 PGLOB_{it} + \beta_3 ENC_{it} + \beta_4 GDPr_{it} + \beta_5 GDPr^2{}_{it} + \beta_6 POP_{it} + \beta_7 UNEMP_{it} + \varepsilon_{it} \quad (5)$$

$$GINI_{it} = \beta_{0it} + \beta_1 GINI_{it-1} + \beta_2 SGLOB_{it} + \beta_3 ENC_{it} + \beta_4 GDPr_{it} + \beta_5 GDPr^2{}_{it} + \beta_6 POP_{it} + \beta_7 UNEMP_{it} + \varepsilon_{it} \quad (6)$$

EGLOB, PGLOB and SGLOB are economic globalization, political globalization and social globalization respectively. The interaction term might be expressed as follows to evaluate the contribution of globalization in moderating the impact of energy usage on income disparity.

$$GINI_{it} = \beta_{0it} + \beta_1 GINI_{it-1} + \beta_2 GLOB_{it} + \beta_3 ENC_{it} + \beta_4 GDPr_{it} + \beta_5 GDPr^2{}_{it} + \beta_6 POP_{it} + \beta_7 UNEMP_{it} + \beta_8 (GLOB * ENC_{it}) + \varepsilon_{it} \quad (7)$$

$$GINI_{it} = \beta_{0it} + \beta_1 GINI_{it-1} + \beta_2 EGLOB_{it} + \beta_3 ENC_{it} + \beta_4 GDPr_{it} + \beta_5 GDPr^2{}_{it} + \beta_6 POP_{it} + \beta_7 UNEMP_{it} + \beta_8 (EGLOB * ENC_{it}) + \varepsilon_{it} \quad (8)$$

$$GINI_{it} = \beta_{0it} + \beta_1 GINI_{it-1} + \beta_2 PGLOB_{it} + \beta_3 ENC_{it} + \beta_4 GDPr_{it} + \beta_5 GDPr^2{}_{it} + \beta_6 POP_{it} + \beta_7 UNEMP_{it} + \beta_8 (PGLOB * ENC_{it}) + \varepsilon_{it} \quad (9)$$

$$GINI_{it} = \beta_{0it} + \beta_1 GINI_{it-1} + \beta_2 SGLOB_{it} + \beta_3 ENC_{it} + \beta_4 GDPr_{it} + \beta_5 GDPr^2{}_{it} + \beta_6 POP_{it} + \beta_7 UNEMP_{it} + \beta_8 (SGLOB * ENC_{it}) + \varepsilon_{it} \quad (10)$$

To find out the relationship between globalization and energy consumption on income inequality, environmental quality, and economic growth, a total of sixty-nine countries are selected. The list of developing countries was taken by UNDP (2020). All the models were estimated by System GMM estimation technique.

3.3 Estimation Technique

The first distinction is that Arellano and Bond developed the GMM estimator (1991). In the right-hand side of the model, the dependent variable's lag is added as a regressed. When the lag of the dependent variable is used as a regressor, the issue of correlation between the error term and the regressors arises. The difference GMM estimator is used with the lag of the regressor as an instrument. Even though the model contains autocorrelation, these instruments may be insufficient. GMM contains a variety of potential faults, according to Arellano and Bover (1995) and Bond and Blundell (1995). If the variables are persistent, the authors suggest that lag levels are insufficient instruments in first difference GMM estimation. According to the authors, using lag level and lagged difference variables as instruments in the model eliminates the problem of endogeneity and weak instruments. Arellano and Bover (1995) and Bond and Blundell (1995) created the two-step system GMM estimation approach (1998). This method is used to overcome the limitations of the panel and cross-sectional investigations. Due to heterogeneity and endogeneity, the first issue is omitted variable bias. System GMM equation is given below.

$$\Delta Y_{it} = \alpha + \beta_1 Y_{i,t-1} + \beta_2 X_{it} + \lambda_i + \varphi_t + €_{it} \quad (11)$$

Where X_{it} denotes control variable, β_1 denotes the coefficient of lag of dependent variable λ_i denotes the cross country unobserved effect, φ_t denotes time effect
$€_{it}$ denotes error term, i represents country and t represents time.

4. Results and Discussion

4.1 Descriptive statistics

The following table shows the descriptive statistics that comprise mean, maximum, median, minimum, standard deviation, Kurtosis and skewness values. The values of GINI, GLOB, EGLOB, SGLOB, ENC, and POP are positively skewed while PGLOB, and GDPr are negatively skewed.

Table 2 Descriptive Statistics

	Mean	Median	Minimum	Maximum	Std. Dev.	Skewness	Kurtosis
GINI	43.20	42.10	5.90	68.00	8.41	0.23	3.10
GLOB	55.62	55.73	24.45	88.55	11.86	0.08	2.72
EGLOB	49.94	49.68	18.03	87.00	13.46	0.35	2.94
PGLOB	68.50	69.36	23.40	93.50	14.25	-0.38	2.52
SGLOB	48.26	48.62	9.78	88.22	17.38	0.02	2.26
ENC	1066.64	694.18	113.09	12172.41	1285.05	4.58	30.66
GDPr	26.21	26.32	0.01	41.68	3.88	-0.91	8.44
POP	7.06E+7	2.03E+7	1.11E+06	1.40E+09	2.03E+08	5.38	31.75
UEMP	7.53	5.75	0.21	33.29	5.70	1.39	4.98
Source: Author's calculation							

4.2 Correlation Matrix

Table 3 shows the correlation matrix of some selected variables of the 69 developing nations, which will be used to determine the strength of factors. The correlation matrix may also be used to check for multicollinearity between variables; if the correlation coefficient is larger than 0.8, there is a lot of multicollinearities.

Table 3: Correlation Matrix

Correlation	GINI	GLOB	EGLOB	PGLOB	SGLOB	ENC	GDP	POP	UEMP
GINI	1								
GLOB	-0.19	1							
EGLOB	-0.09	0.31	1						
PGLOB	-0.11	0.18	0.04	1					
SGLOB	-0.23	0.40	0.37	0.13	1				
ENC	-0.35	0.19	0.19	0.05	0.28	1			
GDPr	-0.02	-0.04	-0.02	-0.04	-0.07	-0.05	1		
POP	-0.12	-0.03	-0.05	0.10	-0.05	-0.02	0.06	1	
UEMP	0.31	0.08	0.08	-0.02	0.13	0.01	-0.10	-0.05	1

4.3 Panel Regression Results and Discussions

Table 4 presents the results of System-GMM of developing countries. The usage of lagged terms in all models is statistically significant, indicating that the study was conducted using a dynamic model, and indicates that one year of income inequality is highly affected by the previous year of income inequality.

Table 4 Dependent Variable : Income Inequality (Two-step S-GMM results of developing countries)

	Dependent Variable: Natural logarithm of Gini coefficient index							
VARIABLES	**(1)**	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**	**(7)**	**(8)**
L.LNGINI	1.038***	1.005***	1.059***	1.036***	1.037***	1.041***	1.018***	1.037***
	(0.010)	(0.009)	(0.008)	(0.007)	(0.009)	(0.007)	(0.001)	(0.001)
LNGLOB	0.047**				0.076***			
	(0.023)				(0.006)			
LNENC	-0.017*** (0.004)	-0.021* (0.011)	-0.018** (0.009)	-0.011*** (0.003)	-0.068*** (0.007)	-0.063*** (0.012)	-0.034*** (0.001)	-0.043*** (0.002)
LNGDPr	0.171**	0.160***	2.070***	0.170**	0.158**	0.183**	0.005**	0.013*
	(0.081)	(0.049)	(0.187)	(0.069)	(0.080)	(0.074)	(0.002)	(0.007)
$LNGDPr^2$	-0.167*** (0.055)	-0.156*** (0.041)	-1.687* (0.871)	-0.158*** (0.057)	-0.148** (0.066)	-0.168*** (0.060)	-0.025*** (0.001)	-0.022** (0.011)
LNPOP	0.004**	0.004**	0.005**	0.004**	0.002**	0.005**	0.004**	0.003**

		*	*					*
	(0.002)	(0.001)	(0.001)	(0.002)	(0.001)	(0.002)	(0.002)	(0.001)
LNUEMP	0.010**	0.008**	0.010**	0.007***	0.005**	0.006**	0.007*	0.008**
	(0.005)	(0.004)	(0.005)	(0.001)	(0.002)	(0.003)	(0.004)	(0.004)
LNEGLOB		0.028***				0.078** (0.039)		
		(0.005)						
LNPGLOB			0.011*** (0.003)				0.036*** (0.001)	
LNSGLOB				0.013				0.044
				(0.012)				(0.052)
LN(GLOB*ENC)					-0.022* (0.012)			
LN(EGLOB*ENC)						-0.018***		
						(0.002)		
LN(PGLOB*ENC)							-0.019*	
							(0.011)	
LN(SGLOB*ENC)								-0.020
								(0.021)
Constant	0.571***	0.595***	5.803***	0.591***	0.488**	0.586***	0.212***	0.111***
	(0.201)	(0.139)	(0.509)	(0.203)	(0.229)	(0.202)	(0.006)	(0.004)
Groups	69	69	69	69	69	69	69	69
Instrument	44	49	52	52	49	49	66	67
Observations	1,225	1,225	1,225	1,225	1,225	1,225	1,225	1,225
AR (1) p-value	0.0894	0.0785	0.000221	0.0807	0.0646	0.0873	0.001	0.000
AR (2) p-value	0.112	0.109	0.343	0.117	0.112	0.117	0.147	0.157
Hansen p-value	0.594	0.727	0.491	0.808	0.735	0.499	0.577	0.451

Source: Author's calculation; Standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1

Results are presented in table 4 and indicate a significant positive effect of globalization on income disparity in selected developing countries ($\alpha_2 = 0.047, p < 0.05$). Therefore, it is concluded that globalization worsens the distribution of income in selected developing countries. Model one further shows a significantly negative relationship between energy consumption and income inequality ($\alpha_3 = -0.017, p < 0.01$). It means energy use has a positive effect on income disparity. The overall results reveal that energy consumption has a negative association with income inequality. All the production sectors are entirely dependent on energy use because of excessive use of energy due to this, production increases which leads to generating employment, as results income inequality decreases in

overall developing countries. The coefficient value of GDP growth showed a positive relationship between growth and income disparity ($\alpha_4 = 0.171, p < 0.05$). It implies that growth has a significantly favorable impact on income inequality. Additionally, the estimated GDP square coefficient demonstrates a negative relationship between income inequality and growth ($\alpha_5 = -0.167, p < 0.01$). It means growth square has a significantly negative impact on income disparity. The Inverted U-shaped relation between GDP growth and income disparity is exposed by this result. This supports the Kuznets hypothesis (1955), which states that when a country's per capita income rises, income disparity rises to a certain level and then income inequality starts reducing as per capita income rises.

The coefficient value of population shows a positive association between population and income disparity ($\alpha_6 = 0.004, p < 0.05$). It means the population has a statistically positive relation to income inequality. The coefficient value of unemployment shows the positive relationship between unemployment and income inequality ($\alpha_7 = 0.010, \mathrm{p} < 0.01$). It means that unemployment has a statistically significant positive association with income inequality. Economic globalization shows a positive relationship with income inequality in selected developing countries ($\alpha_8 = 0.028, p < 0.01$). It means that economic globalization is positively associated with income inequality. Political globalization also shows a positive association with income inequality in selected developing countries ($\alpha_9 = 0.011, p < 0.01$). Political globalization is positively affecting income inequality. It means that political globalization has a worse effect on income inequality in selected developing countries. Social globalization has a positive but insignificant correlation with income disparity in developing nations ($\alpha_{10} = 0.013, p > 0.1$). It means that social globalization has an insignificant effect on income disparity in all developing nations.

Four interaction terms are introduced in this analysis. First, in model five, the interaction term of overall globalization and energy consumption is introduced. The coefficient value of that interaction showed a significantly negative correlation with income inequality ($\alpha_{11} = -0.022, p < 0.1$). So, the interaction term of model five concluded that the joint effect of globalization and energy use that is used as an interaction term is helpful for income inequality in selected developing countries. Second, in model six, the interaction term of economic globalization and energy consumption is introduced. The coefficient value of that interaction term showed a significantly negative relationship with income inequality ($\alpha_{12} = -0.018, p < 0.01$). Therefore, the interaction term of model six concluded that the joint effect of economic globalization and energy use that is used in the interaction term is helpful for income inequality in selected developing countries.

Third, in model seven, the interaction term of political globalization and energy consumption is introduced. The coefficient value of that interaction term showed a significantly negative correlation with income inequality ($\alpha_{13} = -0.019, p < 0.1$). hence, the interaction term of model seven concluded that the combined effect of political globalization and energy consumption which are used in the interaction term showed a positive effect on income disparity in selected emerging countries. Fourth, in model eight, the interaction term of social globalization and energy consumption is introduced. The coefficient value of that interaction term showed an insignificantly negative relationship with income inequality ($\alpha_{14} = -0.020, p > 0.1$). The interaction term of model eight concluded that the combined effect of social globalization and energy consumption which are used in an interaction term has no significant impact on income disparity in selected emerging countries.

All model's diagnostic tests on System-GMM reveal the results. The findings of Arellano and Bond's (1991) serial correlation test are presented in this analysis. The presence of first-order AR (1) serial correlations does not mean that the estimates are inconsistent. All models succeeded the AR (1)

and AR (2) tests, as evidenced by their p-values. The existence of second-order AR (2) autocorrelation, on the other hand, indicates that the estimates are inconsistent. As a result, AR (2) is more genuine. The results of AR (2) show that there is no serial correlation in this investigation. Extra instruments have been used as a necessity for System-GMM, the p-values of the Hansen tests reflect the total instruments' validity. When the p-value is significant, we reject the null hypothesis and conclude that the instruments are invalid. But in these models, we don't reject the null hypothesis of the Hansen test meaning that the instrument is valid in all models. As a consequence of these tests, it is possible to conclude that the estimated model is correctly specified.

5. Conclusion and Policy Recommendations

This study's main goal is to examine how globalization and energy consumption affect income inequality in developing nations. The purpose of the research is to achieve the hypothesis that "globalization and energy consumption improves economic growth but deteriorates income inequality". Sixty-nine developing countries are selected for this analysis. The estimation method used in this analysis is System-GMM (S-GMM) two-step method.

Finally, the study has concluded the whole findings regarding the impact of globalization, energy consumption on income inequality. According to the finding of this study, income inequality in developing nations is positively and statistically associated with globalization. The positive association between globalization and income inequality indicates that an increase in globalization leads to increasing income inequality is due to, it increases the demand for labor, the high-skilled labor earned more as compared to low-skilled labor, which creates income inequality. Income inequality and energy consumption are negatively and significantly correlated, as energy consumption increases it reduces income inequality. Because most production sectors depend on energy consumption, which leads to increased employment as a result, income inequality decreases. Moreover, in this empirical research, the interaction term of globalization and energy consumption, economic globalization and energy consumption, and political globalization and energy consumption all have a significant and favorable influence on lowering income inequality in developing countries. while the interaction term of social globalization and energy consumption shows negative and insignificant relationship income inequality in developing countries. Furthermore, population and unemployment have a positive link with income inequality. Additionally, there is a positive correlation of population and unemployment with income inequality.

Based on the findings of panel data analysis, it is recommended that globalization and industrial growth should be designed to minimize income disparity in all developing nations. Because globalization does not contribute to the notion of sustainable development, developing nations should adopt policies to open their markets to the entire world, make effective use of globalization, and promote policies that reduce income inequality. According to the findings, developing countries should use applicable policy instruments to channel investment inflows and trade-induced technological change to achieve the sustainable development goals (SDGs).

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