

Role of industrial growth on economic development: A comparative analysis of developed and developing countries

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Abstract:

Industrialization has played a pivotal role in shaping economic transformation, influencing growth patterns globally across different stages of development. This study investigates the role of industrialization on economic development by controlling labor force, capital formation, school enrollment, and institutional quality. The panel data of 62 developing and 96 developed countries are collected from World Bank from 1990 to 2023. The empirical results are estimated by using the Panel Quantile Regression (PQR), and its robustness is checked through the Method of Movement-Quantile Regression (MM-QR) approach. The empirical results found the U-shaped relationship between industrialization and economic development in both samples. The labor force significantly increases economic development in developed countries while declines in developing countries. Gross capital formation and preprimary education also significantly enhance economic development. The institutional quality surges economic development in developed countries and declines in developing countries. The MM-QR approach also shows similar results, proving the PQR approach's robustness. This study recommends that all countries should focus on industrial diversification, improving infrastructure and energy access, strengthening institutions, building a skilled workforce, and ensuring environmental sustainability.

Keywords: Industrialization, Economic Development, Institutional Quality, Labor Force, Gross capital formation

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Introduction

Nowadays, industrialization is considered the driving force behind unprecedented economic development and societal transformation. Rapid industrialization has transformed every sector of the economy. Its broader process has changed the way of production and consumption of goods and services in societies (Vrana & Singh, 2023). Industrialization transform agrarian-based economies into industry-based economies due to increasing return to

scale. While Industrialization involves extensive machinery, modern infrastructure, and specialized labor to increase the efficiency of production and output (Tunio et al., 2024). This diversification provides jobs in numerous industries, resulting in improved employment options and, ultimately, better salaries for a broader population. This process has had profound social, economic, and technological impacts on societies worldwide (Buyukyazici et al., 2024).

Industrialization has historically changed in several significant ways over the years. These changes are categorized into different phases, each characterized by distinct technological developments, economic structures, and societal impacts. It originated as a transformational force by discovering the steam engine, which powered industries and transportation, catalyzing the transition from agricultural to industrial and manufacturing-based economies. This profound shift resulted in the mechanization of key industries such as textiles and steel, the expansion of urban centers, the development of modern infrastructure, and the rise of global trade networks, ushering humanity into the modern era and drastically altering the course of human civilization (Sovacool et al., 2023)

This study brings the association between industrialization and economic development. Industrialization brings numerous benefits to society, the economy, and individuals. It is a driver of economic development. It leads to increased production and productivity, which results in higher GDP and improved living standards (Graziano & Ruggiero, 2023). It creates jobs in various sectors, including manufacturing, construction, transportation, and services. This reduces unemployment rates and alleviates poverty. It also promotes technological innovation and the development of new technologies. This leads to advancements in various fields, including medicine, communication, and transportation. It typically involves machinery and technology, which significantly boost productivity in various sectors, leading to higher output with fewer resources (Zhou et al., 2024). Undoubtedly, the industrial sector has been considered an essential factor behind the consistent development in many developed countries (Lenort et al., 2023).

The link between industrialization and economic development is more contentious among scholars and policymakers. It is a debate whether industrialization improves or diminishes the economic development. Many research works investigate that industrialization boosts the economic development and prosperity (Pradhan et al., 2021). The robust industrialization helps to increase employment opportunities for population, which increase economic development. It also supports trade which enhance foreign exchange and trade finance, which may improve the flow of products and services between nations and boost economic growth. In contrast, many researches in the prior literature stated that industrialization decreased economic development (Cheng et al., 2021; Wen et al., 2021). These research works show that this phenomenon happens when industrialization sectors face many regulations resulting in a fall in economic development. So there exists a non-linear relationship among the industrialization and economic development.

The key objective of this study to investigate the empirical analysis of industrial growth on economic development. This study is very significant for policy makers and researchers because it brings knowledge for what extend the industrial growth increases economic

development. This study is novel because it empirically examines the non-linear analysis of industrial growth on economic development in a global perspective.

This study is arranged as the second section discusses the literature reviews, third section enlists the data sources and methodologies, fourth section displays the empirical results and discussions and last section illustrates the conclusion and policy recommendations.

Literature Review:

Industrialization significantly contributes to economic development by enhancing productivity, creating employment opportunities, and diversifying the economy. As countries transition from agrarian-based economies to more industrialized ones, they experience a shift of resources to higher-productivity manufacturing sectors, resulting in increased overall output and efficiency. This process stimulates job creation, raises income levels, and drives consumer demand, further fueling economic expansion. Several studies explored that industrialization increases economic development. Ajmair (2014) explored the effect of different components of industrialization on GDP of Pakistan from 1950 to 2010 and a positive association between each component of the industrial sector and the GDP was observed. Similarly, Qaiser (2020) examined the long-term association between industrialization and economic growth in Pakistan. The study indicates that higher industrial output adds to the economic growth. Qayyum et al. (2021) highlights the industrial sector's key role in economic development. They found a positive and significant correlation between industrial construction and economic activities in Pakistan.

The manufacturing sector is widely regarded as a key indicator of industrialization due to its role in transforming raw materials into finished goods, thereby adding significant value to the economy. It serves as a driver of economic development, employment generation, and technological advancement. Ndiaya and Lv (2018) pointed out the role of manufacturer industries on economic development. The econometric findings indicate that the rise in industrial output associates with an increase in economic development in Senegal. Ossadzifo (2019) connected the engineering sector with GDP growth in African economies from 1990 to 2015. It showed a positive linkage between engineering sector productivity and GDP growth. Bokosi (2022) adopted manufacturing sector as an industrialization to determine the economic development. The empirical findings show that increased industrialization is positively associated with economic development. The relationship between industrial structure, employment structure, and economic development is complex and multifaceted. Zhou et al. (2023) examined the role of industrial structure in economic development. Research indicates that optimizing the structures significantly contributes to economic development, particularly as China transitions towards high-quality development (Ahmed, N., et al., 2022 & Sibte-Ali, 2023).

However, literature also observed that in some circumstances, industrialization negatively impacts economic development if not managed properly. For example, rapid industrial expansion strains natural resources and causes pollution, harming public health and productivity. Additionally, if the benefits of industrial growth are not equitably distributed, it widens income inequality and leads to social unrest. Ibbih and Gaiya (2013) explored how industrialization links to growth by evaluating data from 54 African countries through cross-sectional analysis. The results pointed out a relationship between industrialization and economic development and

explored the weak connection between them. Iheoma and Jelilov (2017) found that industrialization negatively impacts economic growth in Nigeria in the long run. Khan and Majeed (2023) explored the dynamic link between industrialization and environmental impact, to determine the economic development. The study concluded that carbon intensity and industrialization are the primary factors driving decoupling. The advancement of industrialization and economic development has negatively affected the decoupling efforts in Pakistan (Li, H., et al., 2024 & Ma, X., 2022).

Apart from industrialization, there are several determinants of economic development in the literature. Labor force participation (LF) is considered the significant deterrent of economic development. Numerous studies have scrutinized the relationship between LF and economic development, emphasizing that a higher LF significantly contribute to a country's economic expansion. Lahoti and Swaminathan (2016) examined the link between LF involvement and economic development in India from 1983 to 2012. It explored that skilled LF expanded economic development. Appiah et al. (2019) observed a positive link between the LF and economic development. Haque et al. (2019) found a bidirectional connection between Bangladesh's LF and economic development. Yakubu et al. (2020) inspected that escalation in the LF led to a boost in economic development. Wijaya et al. (2021) inspected the direct and indirect effects using time series data and proved a positive association between the LF and GDP growth.

While the prevailing view is that higher LF boosts economic development, some studies argue that it has the opposite effect under certain conditions. If an economy is characterized by high levels of underemployment or if the labor market is not able to absorb the increased supply of workers effectively, cause lower productivity and a strain on public resources. Guirguis et al. (2024) explored that female LF negatively impacts economic development.

The classical growth model suggests that labor and capital are the significant determinants of the economic development. Several studies used the as the gross fixed capital formation (GFCF) from World Bank indicators as a proxy of capital. Saez (2016) explored that GFCF directly enhanced economic development using granger causality in South Africa. Lymonova (2019) revealed the positive association between GFCF and GDP growth. Meyer and Sanusi (2019) stated that GFCF increased GDP in South African economies. Besides, Kong et al. (2020) and Aslan and Altinaz (2021) revealed a negative relationship between capital formation and economic development.

Education is also significant determinant of the economic development. In Pakistan, Afzal et al. (2012) scrutinized that school education directly and significantly contribute in GDP growth. Jude et al. (2015) found a positive association between primary education and economic development. Kotásková et al. (2018) evaluated a positive relationship between school enrollment and economic development. Joesoef (2021) revealed a positive influence of school education on GDP per capita. Katoch et al. (2023) determined a positive relationship between education enrollment and expenditure with economic evolution.

After over viewing the previous literature, it is observed that there exists linear association between industrialization and economic development and prove that industrialization

contributes in the economic development (Ajmair, 2014; Khan & Majeed, 2023; Ossadzifo, 2019; Qayyum et al., 2021; Zhou et al., 2023; Bokosi, 2022; Ndiaya & Lv, 2018; Zhou et al., 2023). Besides a few studies identified that industrialization declines economic development as well (Iheoma & Jelilov, 2017; Yangailo, 2023; Wu et al., 2022). Thus, empirical evidences are scant to for conclusive results. Therefore there is need to have further research on this phenomenon.

Data and Methodology:

This section develops the empirical model to achieve the objective to examining the role of industrialization on economic development. The economic development is measured by using GDP per capita as the constant and serve as the dependent variable. The industrialization is measured as the industry value added as percentage of GDP and serves as the key independent variable. Apart from these variables labor force participation, gross capital formation, preprimary school enrollment, and institutional quality index are added as an explanatory variables. This study chooses the 96 developed countries and 62 developing countries from 1990 to 2023. Further details of the variables and data sources are listed in Table 1.

Table 1. Description of the Variables

Symbol	Description	Units	Sources
GDPC	GDP per capita	constant 2015 US\$	GFN (2024)
IND	Industry value added	% of GDP	WDI (2024b)
LF	Labor force participation	Total	WDI (2024b)
GFCF	Gross fixed capital formation	% of GDP	WDI (2024b)
Pre	Preprimary school enrollment	% gross	WDI (2024b)
IQ	Institutional Quality	Index	WDI (2024b)

Several studies connected the industrialization and economic development in the literature (Bokosi, 2022; Iheoma & Jelilov, 2017; Khan & Majeed, 2023). Bi-variate analysis between industrialization and economic development presented in Figure 1 shows the non-linear trend. The non-linearity is captured through the quadratic effect. So, the quadratic term of industrialization is used in this model.

$$GDPC=f(IND, IND^2, LF, GFCF, PRE, IQ) \quad (1)$$

The natural logarithm is used of the GDPC, IND, IND^2 , LF, GFCF, and PRE variables to capture the variability of the variables. Based on equation (4.1), multiple regression can be written as

$$LNGDPC = \alpha_0 + \alpha_1 IND_{it} + \alpha_2 IND_{it}^2 + \alpha_3 LNLF_{it} + \alpha_4 LNGFCF_{it} + \alpha_5 LNPRE_{it} + \alpha_6 IQ_{it} + \varepsilon_{it} \quad (2)$$

In equation (2), α_1 and α_2 shows the linear and quadratic coefficient of IND, which is used to check the validity of the non-linearity. To calculate the cut-off value of the LNIND, partial derivative with respect to LNIND is used as:

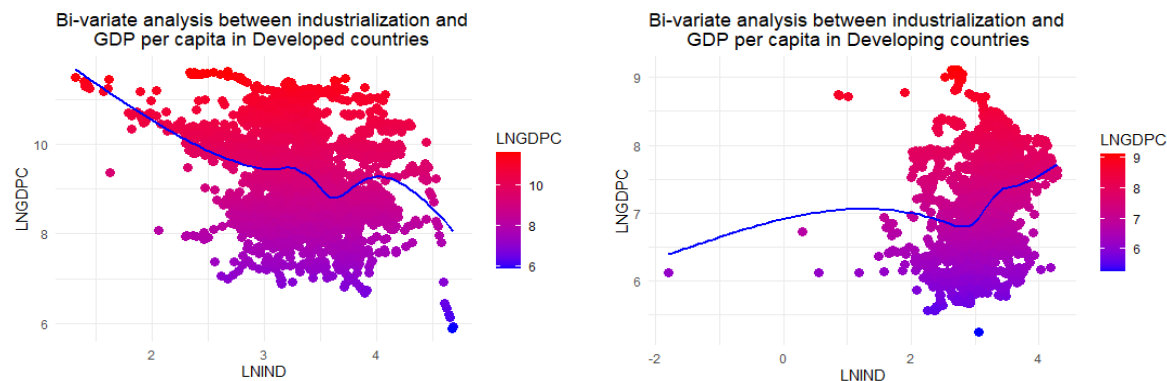
$$\frac{\partial LNGDPC}{\partial LNIND} = \alpha_1 + 2\alpha_2 LNIND = 0$$

$$LNIND^* = -\frac{\alpha_1}{2\alpha_2} \quad (3)$$

Expression (3) shows the cut-off value of the LNIND to estimate the minimum value of the U-shaped curve and maximum value of the inverted U-shaped curve.

The empirical of this study is estimated by using the Panel Quantile Regression (PQR) approach. This approach is suitable to address the outliers and non-normality in the variables. The robustness of the PQR approach is checked through Method of Movement Quantile Regression (MM-QR) approach.

Figure 1. Bi-Variate Analysis Between Industrialization and Economic Development



Results and Discussions:

Tables 2 provides statistics describing the empirical characteristics of developed and developing countries. It represents the different aspects of variables like mean, standard deviation, and minimum and maximum values. In this study, mean value of the economic development (LNGDPC) is greater in developed countries as compare to the developing countries. In developed countries its minimum score is observed in Equatorial Guinea while maximum score is observed in Luxembourg. In developing countries, its minimum score is noted in Djibouti and maximum in Lebanon. Furthermore, average score of industrialization (LNIND) is greater in developed countries which is 3.27. In developed countries, its minimum score is observed in Palau and maximum in Equatorial Guinea. While in developing countries, minimum score is noted in Madagascar and maximum in Angola. While the remaining factors (LNLF, LNGFCF, LNPRE, and IQ) serve as the control variables (Amjad, 2023; Amjad & Rehman, 2023).

Table 2. Descriptive Statistics

Developed Countries					
Variable	Obs	Mean	Std. dev.	Min	Max
LNGDPC	3298	9.3177	1.0484	5.8747	11.6300
LNIND	3272	3.2708	0.4402	-0.9444	4.6888
LNLF	3026	15.0047	1.8473	10.3961	20.4748
LNGFCF	3019	3.0808	0.4189	-2.7210	5.3649
LNPRE	3229	4.0632	0.6955	-2.0784	5.1722
IQ	3298	0.0235	0.9656	-6.5459	7.1307
Developing countries					
LNGDPC	2138	7.0030	0.7321	3.4650	9.1091
LNIND	2088	3.0531	0.4987	-1.8006	4.2866
LNLF	2108	15.1363	1.7019	10.5119	20.1956
LNGFCF	1819	2.9611	0.5706	-1.2280	5.9384
LNPRE	1920	2.6490	1.4258	-3.3757	6.0715
IQ	2142	0.0454	1.0178	-6.7573	8.4811

Figure 2 shows the correlation plot to detect multicollinearity in the model. It shows the visual representation of the pairwise correlation between the series. Its lower part shows a colour scale ranging from -1 to 1. The dark bubble shows the perfect positive correlation, and the dark red colour presents the perfect negative correlation. The light blue and red colour displays the weak correlation between the variables. Except for diagonal bubbles, all the bubbles are light red and blue colours, which shows a weak multicollinearity, and both models can be used for further estimation (Amjad et al., 2022, 2023; Asghar et al., 2023).

Figure 2. Correlation Plot

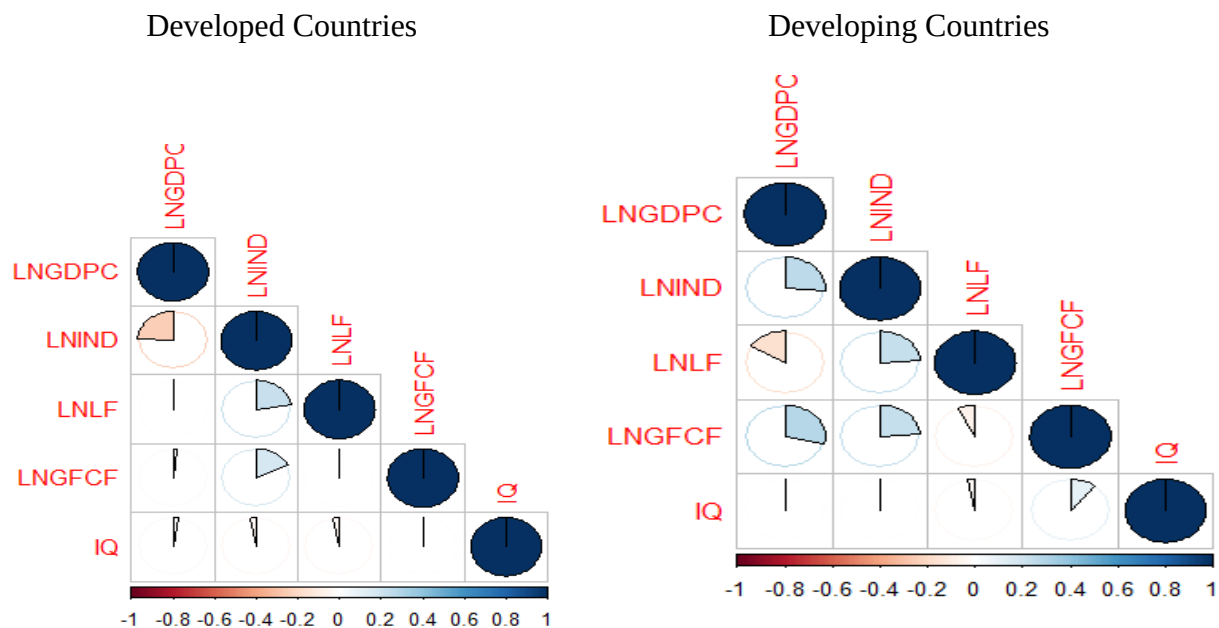


Table 3 shows the results of the Shapiro-Wilk test to check the normality of both models. It indicates whether each model is normally distributed or deviates from it. The probability value of both models is statistically significant, shows both models are not normally distributed (Aslam et al., 2023, 2024; Sial et al., 2022).

Table 3. Results of Shapiro-Wilk Tests

Variable	Developed countries		Developing countries	
	W	W'	W	W'
LNGDPC	0.9842*	0.9842*	0.9906*	0.9905*
LNIND	0.9472*	0.9466*	0.9302*	0.9294*
LNLF	0.9907*	0.9902*	0.9807*	0.9810*

LNGFCF	0.8216*	0.8200*	0.8911*	0.8898*
LNPRE	0.8323*	0.8316*	0.9546*	0.9547*
IQ	0.8838*	0.8831*	0.8736*	0.8721*

Note. * Shows the 1% level of significance

Table 4 displays the Pesaran and Yamagata (2008) slope heterogeneity result. The fact that the delta and adjusted value are statistically significant indicates that the model has not existed slope heterogeneity (Voumik et al., 2023).

Table 4. Slope Heterogeneity Test

	Developed countries		Developing countries	
	Delta	p-value	Delta	p-value
	0.359	0.720	-1.166	0.244
adj.	0.372	0.710	-1.254	0.210

Table 5 demonstrates the different panel unit root tests. In developed countries, the all variables become stationary at level except LNIND. In case of developing countries, the LLC tests shows that except LNIND and LNGFCF all variable stationary at level, while IP, ADF, and PP tests demonstrates that all variables stationary at I(0) except LNIND. The findings reveal that all series become stationary at the order I(0) or I(1) at no trend, while no single variable becomes stationary at I(2). So, the panel unit test demonstrates that the PQR model is best to adapt the empirical estimation of the results.

Table 5. Results of Panel Unit Root Tests

	Developed countries				Developing countries			
	LLC	IPS	ADF	PP	LLC	IP	ADF	PP
I(0)								
LNGDPC	-20.244*	-29.041*	1182.12*	2054.24*	-1.37***	-1.466***	70.232***	162.64*
LNIND	-0.03785	14.0566	52.2927	85.3564	4.14257	10.5737	19.7259	26.9777
LNLFF	-13.900*	-20.978*	819.719*	1650.58*	-1.35***	-1.438***	63.959*	168.005*
LNGFCF	-14.317*	-22.330*	889.829*	1792.59*	2.73652	-3.178*	108.30*	292.663*

LNPRES	-19.898*	-27.010*	1085.8*	2006.27*	-2.291**	-3.4590*	95.966*	235.622*
IQ	-22.461*	-28.163*	1138.1*	2052.95*	-5.897*	-7.9200*	188.11*	381.509*
I(1)								
LNGDPC	-41.64*	-57.217*	2440.54*	2415.59*	-15.284*	-21.447*	486.6*	787.91*
LNIND	-22.177*	-28.857*	1157.56*	2072.14*	-2.872*	-7.5334*	178.89*	309.58*
LNLF	-27.815*	-43.99*	1785.34*	2381.39*	-21.809*	-26.554*	573.29*	766.58*
LNGFCF	-26.694*	-43.600*	1821.67*	3281*	-11.215*	-23.368*	537.57*	775.48*
LNPRES	-39.38*	-52.654*	2225.8*	2453.6*	-19.412*	-26.255*	556.28*	807.71*
IQ	-40.834*	-55.478*	2378.25*	2339.06*	-17.872*	-26.585*	600.82*	770.9*

Note: * $p < 0.01$, ** $p < 0.05$, *** $p < 0.1$; LLC: Levin, Lin & Chu t, IP: Im, Pesaran and Shin W-stat, ADF: ADF - Fisher Chi-square, PP: PP Fisher Chi-square

In Table 6, the KAO, Pedroni and Westerlund tests for co-integration are used to examine the long run relationship between variables. The null hypothesis is rejected because the ADF values of the Kao test and the variance ratio of Westerlund test are statistically significant. It verifies the long-run links between the variables in both models (Abid et al., 2022; Amjad et al., 2021b, 2021a).

Table 6. Co-integration Test

	Developed countries		Developing countries	
Kao test for co-integration				
	Statistic	p-value	Statistic	p-value
Modified Dickey–Fuller t	-13.0803	0.0000	-8.6265	0.0000
Dickey–Fuller t	-19.1793	0.0000	-9.6770	0.0000
Augmented Dickey–Fuller t	-15.4442	0.0000	-3.2947	0.0005
Unadjusted modified Dickey–Fuller t	-83.253	0.0000	-42.2034	0.0000
Unadjusted Dickey–Fuller t	-38.4801	0.0000	-19.4979	0.0000
Pedroni test for co-integration				

Modified Phillips–Perron t	-25.2988	0.0000	-10.2874	0.0000
Phillips–Perron t	-36.8919	0.0000	-14.6176	0.0000
Augmented Dickey–Fuller t	-28.9596	0.0000	-6.7958	0.0000
Westerlund test for cointegration				
Variance ratio	-4.9466	0.0000	-4.1336	0.0000

Table 7 demonstrates the result of PQR at various quantiles to examine the impact of industrialization on economic development from 1990 to 2023. The low value of the Pseudo R^2 shows the value in the model that offers the goodness of fit by comparing the sum of the weighted deviation of this model to the sum of the model with intercept (Koenker & Bassett, 1978).

Estimated empirical results show that one percent increase in the LNIND in developed countries declines LNGDPC, with an average of 4.55, 4.31, and 3.68 percent in the 25th, 50th, and 75th quantile groups, respectively. However, the same one percent increase in the LNIND in developing countries decreases LNGDPC by an average of 0.60 and 0.38 at 25% and 50th, respectively. Similar results were estimated in the literature by Iheoma and Jelilov (2017) in Niger that industrialization negatively impacts economic development in the long run.

Furthermore, the quadratic coefficients of LNIND are also used in this study to capture the non-linear impact of industrialization on economic development. One unit increase in the quadratic coefficient of LNIND significantly increases 0.65, 0.61, and 0.56 in the 25th, 50th, and 75th quantile groups, respectively. In developing countries, the higher industrial growth (i.e. LNIND²) increases LNGDPC by an average of 0.19, 0.15, and 0.14 in the 25th, 50th, and 75th quantile groups, respectively. It is observed that the linear coefficient of LNIND behaves negatively, and quadratic coefficients of LNIND positively impact the LNGDPC in all groups, which proposes the U-shaped relationship. It shows a higher level of LNIND increases LNGDPC. However, no specific study has explored the U-shaped relationship between LNIND and LNGDPC in the literature. Several literatures explored that LNIND increases LNGDPC. In 54 African countries Ibbih and Gaiya (2013) explored that industrialization increased economic development. In Pakistan, Ajmair (2014) found a positive association between each component of the Industrial Sector and the GDP. Ahmad and Zhao (2018) concluded that industrialization increased EG in thirty provinces of China. Opoku and Yan (2019) employed a positive linkage between industrialization and EG in thirty-seven African countries.

Table 7. PQR Results

Dependent variable: LNGDPC	
Developed countries	Developing countries

	$\tau = 25th$	$\tau = 50th$	$\tau = 75th$	$\tau = 25th$	$\tau = 50th$	$\tau = 75th$
LNIND	-4.5509*	-4.3101*	-3.6792*	-0.6014*	-0.3783*	-0.2057
	(0.4424)	(0.5541)	(0.5826)	(0.1462)	(0.1079)	(0.1767)
LNIND ²	0.6473*	0.6143*	0.5617*	0.1911*	0.1475*	0.1436*
	(0.0673)	(0.0843)	(0.0887)	(0.0250)	(0.0185)	(0.0302)
LNLF	-0.0018	0.0299***	0.0576*	-0.1199*	-0.1212*	-0.1421*
	(0.0121)	(0.0152)	(0.0160)	(0.0097)	(0.0071)	(0.0117)
LNGFCF	0.0384	0.1233***	0.2629*	0.1834*	0.1242*	-0.0070
	(0.0590)	(0.0739)	(0.0777)	(0.0284)	(0.0210)	(0.0344)
LNPRES	0.5385*	0.7095*	0.7034*	0.2735*	0.2953*	0.2659*
	(0.0313)	(0.0391)	(0.0412)	(0.0115)	(0.0085)	(0.0139)
IQ	0.0315	0.0071	0.0488***	-0.0359**	-0.0098	0.0011
	(0.0216)	(0.0271)	(0.0285)	(0.0153)	(0.0113)	(0.0185)
CONS	14.2985*	13.0655*	11.4754*	7.2618*	7.4741*	8.0541*
	(0.7078)	(0.8865)	(0.9320)	(0.2569)	(0.1896)	(0.3105)
Cut-off values	3.5105	3.5084	3.2750	1.573417	1.282606	0.716304
Pseudo R2	0.1336	0.1668	0.1346	0.3155	0.3174	0.2335
No. of obs.	3,345	3,345	3,345	1,998	1,998	1,998

Note. * $p < 0.01$, ** $p < 0.05$, *** $p < 0.1$, () shows standard error

The lower part of Table 7 estimates the cut-off value of LNIND to find the minimum value where the non-linear U-shaped started an increasing trend. The cut-off values of long-run LNIND values in developed countries are 3.51, 3.51, and 3.28 in the 25th, 50th, and 75th quantiles, respectively, and in developed countries, are 1.57 and 1.28 in 25th and 50th quantile groups, which is laid between the maximum and minimum values of the original sample values of both groups of countries.

Haans et al. (2016) recommended the level negative and quadratic positive coefficient of LNIND demonstrate the U-shaped curve. Dawson (2014) made a template of the non-linear quadratic curves on an Excel sheet and presented it in Figures 3 and 4. These figures are traced only for long-run coefficients using constant, mean, and standard deviation values. Figure 3 shows the quadratic effect of LNIND and LNGDPC in the 25th, 50th, and 75th quantiles.

Figure 3. Quadratic Effect in Developed Countries

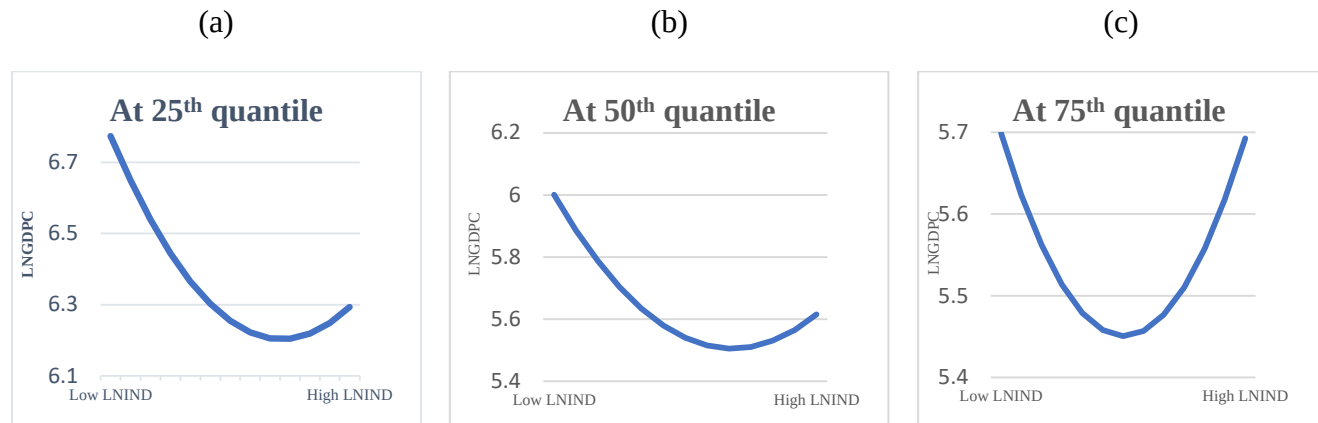
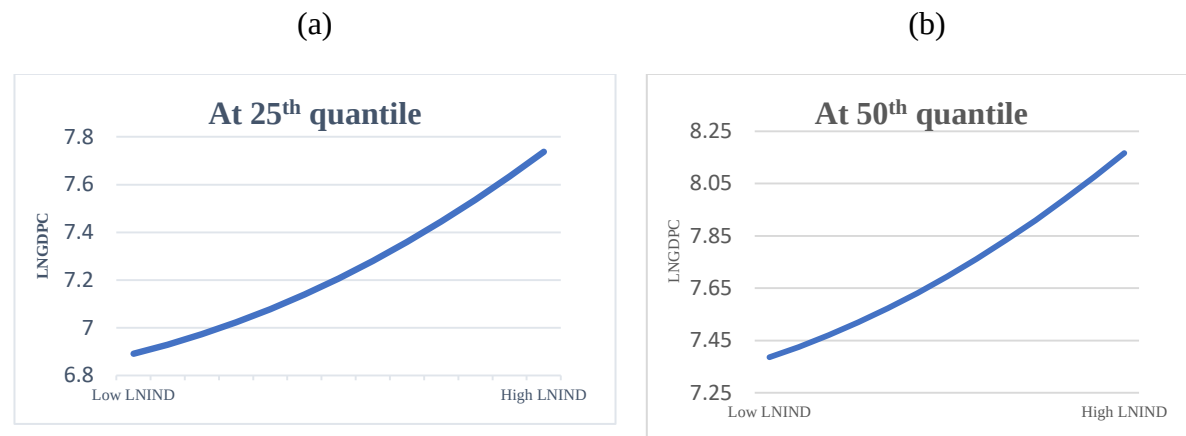


Figure 4 shows the quadratic effect of LNIND and LNGDPC in developing countries in the 25th and 50th quantile groups. Its positive side is much greater than its negative side, showing that most developing countries' industrial sectors contribute to their economic development.

Figure 4. Quadratic Effect in Developing Countries



Linearized marginal effect of the LNIND in both developed and developing countries are also estimated. The results of the developed countries show that among 96 countries, only a few countries (Algeria, Armenia, Azerbaijan, Bahrain, Belarus, China, Equatorial Guinea, Indonesia, Iraq, Kazakhstan, Malaysia, Oman, Paraguay, Qatar, Saudi Arabia, Thailand, Trinidad and

Tobago, Turkmenistan, United Arab Emirates) lay behind the minimum threshold value which increases economic development in all quantile groups. The linearized marginal effect of 62 developing countries' results demonstrates that all selected developing lie after the turning point of the U-shaped curve in all quantile groups. It indicates that in all selected developing countries, 'industrial growth increased economic development.

Apart from industrialization, there are also few control variables used in this study. The LNLF (Natural log of labor force) is one the significant control variable. It shows mixed effect in different quantile groups across both groups. In case of developed countries, it significantly declines LNGDPC at lower quantile groups. In the literature, Guirguis et al. (2024) explored that female labor force participation negatively affect the economic development in developed countries. Furthermore, in middle and higher quantile groups, the LNLF significantly positively impact the LNGDPC. This relationship is supported by using different studies. Haque et al. (2019) found a positive connection between Bangladesh's labor force and EG. Yakubu et al. (2020) inspected that escalation in the labor force led to a boost in EG. Wijaya et al. (2021) inspected the direct and indirect effects using time series data and proved a positive association between the labor force and EG. In developing countries, LNLF significantly inversely impacts the LNGDPC in all quantile groups. In Nigeria, Bown and Freund (2019) pointed out that declining labor force participation rates slow EG by reducing the number of people contributing to the nation's output of goods and services.

The LNGFCF (Natural log of gross fixed capital formation) is used as the proxy of capital. In this LNGFCF significantly increases LNGDPC in both samples. This association is supported by using the several previous literatures. In South Afriaca, Saez (2016) explored that GFCF directly enhanced economic development. In Euro Area, Lymonova (2019) found that GFCF increased economic development. In South African countries, Meyer and Sanusi (2019) stated that GFCF increased economic development .

The LNPRE (Natural log of preprimary enrollment) serve as the proxy of education. It is highlighted in the empirical results in both groups LNPRE significantly increases economic development in all quantile groups. Similar results were estimated by Kotásková et al. (2018) in India and indicated a positive relationship between school enrollment and economic development. Joesoef (2021) revealed a positive influence of school education on economic development. Suwandaru et al. (2021) estimated that education enrollment increased economic development. Katoch et al. (2023) revealed a positive relationship between education enrollment and expenditure with economic evolution.

IQ (Institutional quality index) shows mixed results in both groups. In developed countries, the IQ significantly increases the economic development. The basic reason for this is that these countries have strong government institutions that provide a favorable environment for investment. In contrast, in developing countries, economic development significantly declines the EG. Most developing countries have poor governance and political instability, which discourage investments.

The robustness of the PQR approach is checked by using the MM-QR approach. This approach uses the location and scale parameters. The location parameters show the average score

of the series across quantiles. In contrast, scale parameters indicate the degree of variability or dispersion of the dependent variable around the location parameter at each quantile, indicating how spread out the values are within that distribution segment. In both cases, the location parameters display the U-shaped relationship between LNIND and LNGDPC because its level coefficient is negative, and the quadratic coefficients are positive. These results are similar to the estimated PQR results, which shows their robustness. Furthermore, this approach also verifies the empirical results in the 25th, 50th, and 75th quantile groups. In both cases, at all quantile groups, the level coefficient of LNIND negatively impacts the LNGDPC, while its quadratic coefficient positively impacts the LNGDPC. It shows the U-shaped relationship between LNIND and LNGDPC.

In developed countries, the location and scale parameters and at 0.75 quantile LNLF significantly increase LNGDPC. In contrast, in developing countries at location and scale parameters the LNLF significantly declines LNGDPC in all quantile groups. These results are also consistent with the findings of the PQR estimation, which shows that LNLF increases LNGDPC in developed countries. while there is a negative relationship between them.

The LNGFCF significantly increases LNGDPC in location and scale parameters, as well as in most quantile groups. The PQR results also show similar results as LNGFCF increases LNGDPC also increases, which shows robust results. The LNPRE significantly increases the LNGDPC in all quantile groups. The IQ also significantly increases the LNGDPC in most quantile groups in developed countries, however, the relationship is inverse in case of developing countries. It implies that Overall, the MM-QR approach shows results similar to the PQR approach. This study demonstrates reliable and consistent results.

Conclusion and Policy Recommendations:

Study aims to examine the role of industrialization on economic development. Study used the panel data from 62 developing and 96 developed countries from the period 1990-2023. The empirical results are estimated by using the Panel Quantile Regression (PQR), and its robustness is checked through the Method of Moverment-Quantile Regression (MM-QR) approach in the 25th, 50th, and 75th quantiles. This study uses industrialization as the key independent variable and economic development is the dependent variable. Economic development is measured by GDP per capita.

Before applying these approach, different preliminary diagnostic tests are also conducted. The descriptive statistics demonstrate the mean, standard deviation, minimum and maximum values of all series used in this study. The correlation plot and variance inflation factor show the absence of the multicollinearity issue in the model. The normality test indicates that the series is not normally distributed. The slope heterogeneity test found the absence of slope heterogeneity in the models. The panel unit root tests evidence that all variables become stationary at 1st difference. The co-integration tests prove the existence of long run relationship among the variables.

The PQR approach reveals the U-shaped relationship between industrialization and economic development in developed and developing countries. The labor force significantly

increases economic development in developed countries while declines in developing countries. Gross capital formation and preprimary education also significantly enhance economic growth in both developing and developed economies. In contrast, the institutional quality surges economic growth in developed countries, while decline the economic development in developing countries. The MM-QR approach also shows similar results, proving the PQR approach's robustness.

To promote economic development through industrialization, this study suggests that developing countries should focus on industrialization, improve infrastructure and energy access, strengthen institutions, build up skilled workforce, and ensure environmental sustainability.

However, the Developed countries should prioritize high-tech industries, sustainable practices, and increased R&D investment while supporting declining industrial regions and modernizing regulatory frameworks. Both groups should collaborate on global trade and technology transfer to support inclusive growth and address inequalities, ensuring that industrialization benefits all segments of society.

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Table 5.12. MM-QR Results of the Industrialization and Economic Growth

Dependent variable: LNGDPC										
Developed countries						Developing countries				
	Location parameters	Scale parameters	$\tau = 0.25$	$\tau = 0.50$	$\tau = 0.75$	Location parameters	Scale parameters	$\tau = 0.25$	$\tau = 0.50$	$\tau = 0.75$
LNIND	-3.6963* (0.4604)	-0.2163 (0.2524)	-3.5037* (0.4241)	-3.6752* (0.3303)	-3.9101* (0.4879)	-0.2274*** (0.1339)	0.0331 (0.0871)	-0.2573** (0.1064)	-0.2284* (0.0814)	-0.2012*** (0.1068)
LNIND2	0.5218* (0.0761)	0.0517 (0.0404)	0.4758* (0.0663)	0.5168* (0.0516)	0.5729* (0.0762)	0.1333* (0.0228)	0.0041 (0.0154)	0.1296* (0.0193)	0.1332* (0.0147)	0.1365* (0.0193)
LNLFF	0.0141* (0.0035)	0.0103* (0.0025)	0.0050 (0.0124)	0.0131 (0.0096)	0.0242*** (0.0142)	-0.1216* (0.0037)	-0.0075** (0.0031)	-0.1148* (0.0086)	-0.1214* (0.0066)	-0.1276* (0.0086)
LNGFCF	0.0218 (0.0452)	0.0920* (0.0211)	-0.0602 (0.0614)	0.0128 (0.0479)	0.1127 (0.0706)	0.1227* (0.0238)	-0.0817* (0.0109)	0.1963* (0.0320)	0.1250* (0.0245)	0.0581* (0.0322)
LNPRES	0.5840* (0.0295)	0.0747* (0.0130)	0.5175* (0.0303)	0.5767* (0.0237)	0.6578* (0.0349)	0.2470* (0.0137)	-0.0305* (0.0030)	0.2744* (0.0123)	0.2478* (0.0094)	0.2229* (0.0124)
IQ	0.0456** (0.0192)	-0.0006 (0.0047)	0.0461*** (0.0238)	0.0456** (0.0185)	0.0449 (0.0273)	-0.0097 (0.0061)	0.0176* (0.0056)	-0.0255* (0.0144)	-0.0102 (0.0110)	0.0042 (0.0145)
Constant	13.1445* (0.6206)	0.1619 (0.4120)				7.2996* (0.1995)	0.6780* (0.1336)			

Note. * $p < 0.01$, ** $p < 0.05$, *** $p < 0.1$, () shows standard error