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AN EMPIRICAL ANALYSIS OF THE DETERMINANTS OF FOREIGN DIRECT INVESTMENT INFLOW TO G-20 COUNTRIES: A CROSS-PERIOD ANALYSIS

Ain Bemisal Alavi[*1], Dr Imamuddin Khoso[2], Dr. Saima Kamran[3], Dr. Nizamuddin Channa[4]

[*1,2,3,4] *Institute of Business Administration, University of Sindh, Jamshoro.*

ABSTRACT

This study examines the critical determinants of foreign direct investment (FDI) inflows in G20 economies, focusing on renewable energy, carbon emissions, tourism, and population growth. G20 countries collectively attract a substantial portion of global FDI due to their economic size and policy influence. Using the Auto-Regressive Distributed Lag (ARDL) model, this research conducts a cross-period analysis over two distinct timeframes, 1996–2015 and 1994–2022, employing Zivot-Andrews (ZA) structural break unit root analysis to capture pre- and post-globalization dynamics and recent economic shifts, including the financial crisis and COVID-19 pandemic. Results reveal that renewable energy policies, tourism development, and population growth positively influence FDI inflows, while carbon emissions exhibit a limited impact. Notably, the cross-period analysis indicates consistent positive effects of renewable energy, tourism, and population across both timeframes, suggesting that these determinants hold stable importance in attracting FDI to G20 nations. These findings suggest that sustainable energy investments, tourism sector growth, and strategic demographic policies enhance FDI appeal in G20 nations. The study provides practical insights for policymakers aiming to foster sustainable economic growth through targeted, multidimensional FDI strategies aligned with environmental and demographic goals.

Keywords: *FDI Inflow, G20 Countries, Renewable Energy, CO_2 Emissions, Tourism, Population, ARDL Approach, Cross-Period Analysis.*

INTRODUCTION

The increase in global economic activity has stimulated regional cooperation groups, a defining feature of economic globalization and integration (Chen et al., 2021). Foreign direct investment (FDI) inflows are essential for establishing an open economy, substantially contributing to sustainable growth by promoting green technology, enhancing productivity, and reducing emissions (Vujanović et al., 2021). The G20 countries dominated foreign direct investment (FDI) in 2020, securing $6.24 trillion, which constitutes 59% of worldwide FDI, partially as a result of the pandemic's impact (Haudi et al.,2020). There is an increasing interest in comprehending the determinants of FDI inflows in certain economic regions (Hou et al., 2021), with current research highlighting the impact of institutional quality on economic openness (North, 1989). Despite the high FDI inflow in G20 nations, the connection between FDI determinants and institutional quality lacks empirical evidence. Massive expenditures in renewable energy technology would be necessary to mitigate climate change and reduce GHG emissions. In recent years, there has been a rise in foreign direct investments (FDI) in renewable energy (RE), which has helped RE spread around the world. A variety of policy

tools are available in the realm of climate policy with the goal of encouraging investments in energy produced from renewable sources (Samour et al., 2022).

This study fills this gap by analyzing key factors affecting FDI in G20 nations, including Renewable Energy, CO2 emissions, tourism, and population growth. This research uses the G20 nations as a sample which consists of 20 members including Argentina, Australia, Brazil, Canada, China, France, Germany, India, Indonesia, Italy, Japan, Mexico, Russia, Saudi Arabia, South Africa, South Korea, Turkey, the U.K. and the U.S., as well as the European Union providing practical insights, as they represent over 90% of global GDP and attract more than 60% of FDI. Being one of the largest cooperative groups, a study on FDI inflow determinants in the G20 features some valuable implications; however, most current research has failed to take the factors into consideration. This research examines the determinants of FDI inflow to G20 countries for the period 1996-2015 and 1994-2022. These periods of time are appropriate in allowing the assessment of selected variables renewable energy, CO2 emissions, tourism, and population, among others, in the pre-and post-phases of globalization, hence reflecting more of the developments over policies on economic growth and environment. The first time period, 1996-2015 is framed within the context of increased global orientation accompanied by early policy adoption in sustainable development (Sachs & Warner 1996), whereas the second period, 1994-2022 captures the aftermath of the financial crisis of 2008 and the subsequent efforts for recovery as well as the outbreak of the COVID-19 pandemic (Stiglitz, 2002). This bifocal timeframe adds value because it shows those in the global economy who managed to alter their structure with the moving force in policies, trade barriers, and environmental policy objectives, managed to bring in the FDI (Dreher, Gaston, & Martens, 2008). The findings provide guidance for policymakers in customizing FDI-attracting strategies for the varied G20 demographics, which together represent over 90% of global GDP and draw 60% of global FDI.

1. Literature Review

1.1 Renewable Energy and Foreign Direct Investment (FDI) Inflow to G-20 Countries

The notion that financing environmentally friendly energy projects would benefit them monetarily is attracting increased interest from foreign investors. According to Kittner et al. (2023), foreign direct investment (FDI) is higher in G-20 nations with developing economies that aggressively support policies and incentives related to renewable energy. beneficial regulatory frameworks in some nations draw in foreign investment by lowering risks associated with investing and boosting financial returns.

Furthermore, as Wang & Liu (2024) noted, the expansion of the renewable energy industry has the potential to have a substantial effect on the status of the national economy. According to studies, by firmly opting for clean power and enacting appropriate legislation, nations like Brazil and India have drawn large amounts of foreign direct investment (FDI) and contributed to the development of an environmentally conscious energy landscape. Additionally, the national generating plan's inclusion of solar and wind power projects strengthens its financial resilience. Investing in energy from plants could help diversified source of energy and lessen the effects of variations in the price of energy globally, according to Mehta & Singh (2024). As a consequence, economies may appear more stable and appealing to international investors.

1.2. Co2 Emissions and Foreign Direct Investment (FDI) Inflow to G-20 Countries

The inter-connectedness between the climatic issues and foreign direct investment has now become the hot topic for researchers driven by heightened key environmental factor that has major impact on environmental sustainability. Bundle of prior studies have suggested that carbon emissions reflecting the environmental degradation has substantial impact on the FDI (Cole, 2004). As natural conservation and global warming gain greater attention, governments and businesses are facing greater incentives to adopt greener procedures. According to Klein & Zwinkels (2014), businesses with high greenhouse gases may turn off financiers, particularly those with

strict ESG guidelines. This is due to the likelihood that these emissions will signal significant legal issues in the future or harm to the good name of the business. FDI may decline in countries which create carbon-based energy sources if investors are concerned about stricter ecological standards or harm to their brand.

Zhu et al. (2016) discovered that FDI reduces levels of pollutants in host nations using a quantile regression approach. Zhang & Zhou (2016) found an inverse association amongst FDI a surge and greenhouse gases pollutants using a linear panelist model, supporting the air-quality fringe concept. On the other hand, several studies have only looked at one nation. With the use of Malaysian historical data, Lee, Hitam, & Borhan discovered that FDI had a major impact on contamination and that higher FDI would result in higher CO2 emissions. The theory that pollution havens exist is supported by Acharyya's (2009) use of cointegration, the which revealed that foreign direct investment (FDI) in India significantly reduces CO2.

1.3. Tourism and Foreign Direct Investment (FDI) Inflow to G-20 Countries

Only periodically is the effect of tourism on FDI recognized. For instance, even though they could benefit greatly through such ventures, nations with uncertain political environments or inadequate infrastructure may find it difficult to draw in and keep foreign direct investment (FDI) in the tourism industry (Smeral, 2010). Furthermore, the level of political equilibrium and the caliber of the regulatory framework may have an impact on the advantages of foreign direct investment. Additionally, the type of tourism that FDI attracts—luxury, eco, or mass—can be influenced by the investment itself (F Fletcher, 1989). According to the eighth theoretical terms, tourism enables foreign direct investment (FDI) to enter the less developed countries of the Group of Twenty (G-20). A developing tourism business might draw in more foreign direct investment (FDI) depending on the investigation's findings. To take advantage of the market's potential and the increasing number of vacationers, foreign investors look into making investments in infrastructure and other businesses. Both empirical as well as theoretical data support this cycle (Sinclair & Stabler, 1997; Mazzarol & Soutar, 1995).

However, factors like a stable political climate, the legal system, and the caliber of the infrastructure assist counteract the negative effects of tourism on FDI. If nations successfully attract foreign direct investment (FDI), they must be able to utilize their tourist potential to the fullest and provide an investment climate conducive to company operations (Fletcher, 1989; Smeral, 2010).

1.4. Population and Foreign Direct Investment (FDI) Inflow to G-20 Countries

With a variety of effects on foreign direct investment flows (FDI), a nation's population frequently increases its attractiveness to overseas investors. The public's many benefits may conceivably draw foreign direct investment. Better infrastructure, accessibility, and telecommunication are the main drivers of business in urban locations (McGranahan & Satterthwaite, 2008). When improvements in infrastructure result in lower operating costs and increased productivity for multinational corporations, populous areas become additionally desirable as development places.

The ability to easily access greater in size, more crowded areas is an additional benefit of population development. As urbanized concentration of people rises, so do market opportunities and clientele. For companies looking to capitalize on expanding markets, this could be especially alluring (Brulhart & Matano, 2009). Most people believe that FDI is crucial to growth in the economy. Population health has gotten a lot of focus, despite the fact that it can affect FDI inflows. Consequently, this research looks quantitatively at whether concentrating on public health might prove a helpful strategy in Ghana's efforts to draw in more foreign direct investment. According to the examination, FDI inflows are highly influenced by all major population health indices (Immurana et al., 2021).

1.5. Theoretical Framework:

The key theoretical framework of this research is that FDI inflows are influenced significantly by structural factors, such as energy policies, environmental metrics, tourism, and demographic

growth, with each one reflecting broader economic and policy shifts. Grounded in North's original work in 1989 on institutional quality and economic openness, this paper examines how these aggregates line up within G20 economies in order to attract sustainable foreign investment. In addition, institutional factors such as renewable energy policies play an important role in determining investment attractiveness through the mitigation of environmental risks and the encouragement of returns in a sustainable manner. Similarly, theories of environmental economics, as depicted in the Environmental Kuznets Curve (EKC), also provide anchors on which our discussion on carbon emissions would be discouraging but yet an opportunity element of FDI (Bhattarai et al., 2000). This would therefore mean that within the G20 context, while high carbon emissions may be a deterrent to certain types of FDI, they would signal opportunities for green investment with a view towards environmental betterment. Thus, this framework serves a dual purpose: carbon emissions are both a potential deterrent and an avenue for growth-oriented FDI in sustainable technologies and infrastructure.

Empirically, this study synthesizes unit root tests for structural breaks and utilizes the FDI inflows ARDL model of Pesaran, Shin, & Smith (2001) in establishing short- and long-term relationships between renewable energy, carbon emissions, tourism, and population in two patently different periods. This approach provides a comprehensive view of how these factors interact in a dynamic economic landscape, enhancing the robustness of the analysis by addressing potential structural shifts and long-term equilibria in G20 economies (Stiglitz, 2002).

Together, these theoretical and empirical foundations support a multidimensional framework that addresses the increasing complexity of FDI determinants within an ever-changing economic environment. Such a framework brings together institutional, environmental, and demographic standpoints and enables an integrated approach toward understanding how the G20 countries can favorably manipulate the factors to position themselves increasingly attractive for sustainable foreign investment destinations.

2. Research Methodology

2.2. Data

Using yearly data for G-20 economies for two periods 1994 to 2022, and 1996-2015. This study examines the relationships between renewable energy, carbon emissions, tourism and population and FDI (Table 1). The chosen time spans present the estimation of selected variables like renewable energy, CO2 emission, tourism, and population, among others, with regard to pre- and post-globalization stages and thereby represent developments in policies pertaining to economic growth and the environment. The first period, 1996-2015, contextualized by increased global focus and early legislation related to sustainable development policies, while the subsequent period, 1994-2022, encompasses the repercussions of the 2008 financial crisis, recovery efforts, and the emergence of the COVID-19 pandemic (Stiglitz, 2002). This bifocal time frame employed in the study shows that those aspects of the global economy that changed their structures in response to evolving legislation, trade restrictions, and environmental

objectives established themselves as recipients of foreign direct investment accordingly (Dreher, Gaston, & Martens, 2008). This provides the foundation for the following econometric model:

$$FDI_{it} = \psi_0 + \psi_1 RE_{it} + \psi_2 CO2_{it} + \psi_3 TR_{it} + \psi_4 POP_{it} + \xi_{it} \quad \text{----------(3.1)}$$

Where foreign direct investment symbolized as FDI, represents the foreign direct investments, net inflows percentages of GDP. The term renewable energy RE refers to energy that is produced without depleting natural resources. CO2 emissions symbolized as carbon emissions that is presented by CO2 emissions (metric tons per capita). International tourism, receipts (% of total exports) establish with tourism which is denoted by TR. POP presents the population which is measured by population growth in percentage. The white noise is represented by ξ_it. In addition, the intercept is denoted as ψ_0, whereas the coefficients of the factors utilized in our investigation are ψ_1, ψ_2, ψ_3, ψ_4. Nonetheless, i and t denote the nation and time period of the data collected and utilized in the article, respectively.

Table 1 Description of data

Variable	Abbr	Unit	Source
Foreign Direct Investment	FDI	Foreign direct investment, net inflows (% of GDP)	WDI
Renewable energy	RE	Renewable energy consumption (% of total final energy consumption)	WDI
Carbon emissions	CO2	CO2 emissions (metric tons per capita)	WDI
Tourism	TR	International tourism, receipts (% of total exports)	WDI
Population	POP	Population growth (annual %)	WDI

Source: Authors

2.3. Econometric Model estimation:

3.2.1. Panel unit root estimator

In this respect, the current study has applied the Structural Break unit root tests in order to allow for possible breaks in the economic relationships between foreign direct investment, renewable energy, carbon emission, tourism, and population in G-20 economies. The importance of these tests lies in the fact that economic series over a long period usually exhibit structural breaks resulting from major events such as policy reforms, financial crises, or environmental regulations. It can bring structural breaks in the series, where the underlying trends or relationships between variables change abruptly.

Traditional unit root tests, like the Augmented Dickey-Fuller (ADF) test, were based on the assumption that the series is generated by a process that is stable over time; when there are structural breaks, traditional unit root tests can provide misleading results. The structural break unit root tests can indicate which variables are stationary, allowing for such shifts, hence providing a more realistic view of how the data actually behaves. In this respect, the inclusion of structural breaks in this study will allow us to capture the effects of significant economic, environmental, and policy-related events that might have taken place over two periods of time upon FDI flows, energy consumption, and carbon emissions across the G-20 economies. This approach further strengthens our econometric model by ensuring that it reflects real-world changes over time, and thus better equips us to present robust and reliable conclusions about the relationships among those variables.

$$\Delta Y_{it} = \Delta\varphi_{it} + \beta_i X_{it} + \delta_{it} + \sum_{j=1}^{n} \theta_{ij} \Delta X_{i,t-j} + \propto_{it} \text{ ----------(3.2)}$$

Where $\Delta\varphi_{it}, X_{it}, \Delta, T, \text{and } \propto_{it}$ denotes the intercept, operator for factor estimation, variance, period, and white noise, respectively.

2.4. Panel Cointegration estimator

In order to gauge the interdependence of the study's components across time, we used the "Kao cointegration test". Here is the Kao cointegration test's estimation equation:

$$\Delta Y_{it} = \emptyset' d_t + a_i\left(y_{i,t-1} - \gamma_i' X_{i,t-1}\right) + \sum_{j=1}^{pi} a_i \Delta y_{i,t-j} + \sum_{-qi}^{pi} \vartheta_i \Delta X_{i,t-j} \tau_{i,t} \text{ ----------(3.3)}$$

There are two parts to this test that evaluate the connection over time: G_a and G_t. To estimate the cointegration among the cross sections, the second component is P_a and P_t. Here are the two parts expressed as an equation:

$$G_a = \frac{1}{N}\sum_{i=1}^{N} \frac{\check{a}}{SE(\check{a}_i)} \text{ ----------(3.4)}$$

$$G_t = \frac{1}{N}\sum_{i=1}^{N} \frac{\check{a}}{\check{a}_i(1)} \text{ ---------- (3.4)}$$

$$P_t = \frac{\check{a}_i}{SE\check{a}} \text{ ---------- (3.5)}$$

$$P_a = T\check{a} \text{ ---------- (3.6)}$$

2.5. Auto Regressive Distributed Lag (ARDL) Model

The ARDL model in analyzing the determinants of FDI inflows in G20 nations, is used, as it is particularly suitable for the analysis of both short- and long-run relationships that exist among variables (Nkoro & Uko, 2016). The data can, therefore, be efficiently analyzed with regard to how renewable energy, CO2 emission, tourism, and population influence FDI across several periods of time. This model allows us to include the lagged values of FDI and the lagged and current values of independent variables, i.e., renewable energy, carbon emission, tourism, and population, in order to capture both the immediate, short-run effects and the cumulative, long-run impacts. The

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equation of this model includes a constant term, short-run coefficients on each variable, and the respective long-run coefficients reflecting equilibrium relationships between FDI and the explaining factors.

The ARDL model when the integration orders of the variables are assumed to be mixed so that some can be stationary at level I(0) and others integrated at I(1) (Pesaran, Shin, & Smith, 2001). In estimating the ARDL model, an error correction term (ECT) can be deduced which will give the speed at which the system returns to its equilibrium after any short-term shocks. It also ensures the best fit through the selection of appropriate lag lengths based on the AIC or BIC. The approach presents interpretability, since short-run coefficients capture immediate responses of FDI to changes in renewable energy, carbon emissions, tourism, and population. In contrast, long-run coefficients provide insight into steady-state relationships. The ARDL model, therefore, allows a comprehensive analysis of the factors' influences on FDI in various periods through such a setup and offers both immediate and equilibrium insights important for policy decisions and investment strategies for the G-20 economies:

$$\Delta FDI_{it} = \eta_0 + \eta_1 \Delta RE_{it} + \eta_2 \Delta CO2_{it} + \eta_3 \Delta TR_{it} + \eta_4 \Delta POP_{it} \psi_0 + \zeta_1 RE_{it} + \zeta_2 CO2_{it} + \zeta_3 TR_{it} + \zeta_4 POP_{it} + \xi_{it} \quad \text{---------- (3.7)}$$

Δ Denotes the first-difference operator, capturing the short-run dynamics. $\eta 0$ denotes intercept $FDI_{it}, RE_{it}, CO2_{it}, TR_{it}, POP_{it}$ denotes foreign direct investment, renewable energy consumption, carbon emissions, tourism, and population, respectively, for country i at time t. η_1 To η_4 are the slopes of short run. ζ_1 To ζ_4 are the slopes of long run and ξ is the error terms.

3. Analysis

The comparative analysis of FDI determinants across the periods 1994-2022 and 1996-2015 provides critical insights into how macroeconomic and demographic factors have influenced FDI inflows in G20 economies over time. Scrutinizing these periods provides a nuanced understanding of how globalization phases, economic policy shifts, and significant events, like the 2008 financial crisis and COVID-19 pandemic, may have framed FDI trends. A cross-period analysis not only describes temporal consistency in the drivers of FDI but also indicates changes in the relative importance of renewable energy, carbon emissions, tourism, and population growth as attractors of FDI across different economic contexts.

Against this background, Table 2 gives an overview of the two periods that capture similarities and deviations in FDI determinants. The analysis forms an empirical basis of the role of sustainable practices, tourism, and demographic growth in attracting FDI and, hence, forms a basis for strategic policy development in G20 countries.The mean value for FDI is 2.07 for 1994-2022 and 2.05 for 1996-2015 it simplifies and suggests that FDI inflow remained stable in both the periods. The Skewness values are 1.72 and 1.68 and kurtosis values 9.06 and 7.25 respectively that both periods signifies rightly-skewed sparked range of values. RE exhibits the normal average 14.1 and 13.2 and deviation values 13.1 and 12.5 that is equally close and skewness value 1.38 and 1.52 and kutosis value is 3.99 and 1.25 that is indicating that positive skewness and slightly peaked distribution. CO2 exhibits similar mean and standard deviation values in both the periods however the skewness and kurtosis values have been same as well the distribution is normal and symmetric. TR mean and standard deviation values (51.46 and 18.7 for 1994-2022 and 49.2 and 4.25 for 1996-2015) exhibits that there variances are consistent over the time including the skewness and kurtosis values are highlighting that there is normal distribution and after all PO has the consistent mean and standard deviation in both periods however the skewness value for both the periods highlighting the positive skewness and kurtosis values determined that the distribution is less peaked in both the periods.

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Table 2 Descriptive Analysis

	1994-2022				1996-2015			
Variables	Mean	Std. Dev.	Skewness	Kurtosis	Mean	Std. Dev.	Skewness	Kurtosis
FDI	2.07	1.82	1.72	9.06	2.05	1.32	1.68	7.25
RE	14.1	13.1	1.38	3.99	13.2	12.5	1.52	1.25
CO_2	8.39	5.04	0.40	2.23	8.66	4.25	0.24	1.58
TR	51.46	18.7	0.33	2.75	49.2	17.55	0.25	1.74
PO	0.84	0.70	0.67	5.05	0.78	0.51	0.41	2.25

Source: Authors Calculations

Table 3 presents covariance analysis, bringing forth relationships between FDI, renewable energy, carbon emissions, tourism, and population \\\for the periods 1994-2022 and 1996-2015. It has been observed that FDI and renewable energy are strongly related at 0.85 in the period of 1994-2022 while the same has been determined as 0.81 for the period of 1996-2015 which justifies that renewable energy investment does contribute to attracting FDI on a continuous basis in G20 countries. While carbon emissions relate to FDI at a moderate level, 0.55 and 0.58 in the two respective periods, it might reveal that though FDI applies a somewhat controlling influence on emissions, they do not outpace other factors such as renewable energies or tourism, as suggested by Zhu et al. (2016). Tourism has registered a high positive correlation with FDI in both periods, with coefficients of 0.52 and 0.51, respectively, reinforcing the fact that tourism is indeed a catalyst for growth, as argued by Sinclair & Stabler (1997). The population growth and FDI are also strongly related, standing at 0.74 and 0.70, respectively. This indicates that the size of the market and the potential workforce tends to attract investors. As McGranahan & Satterthwaite (2008) show, the stability of these relationships across periods suggests these factors remain central to G20 investment strategies, despite shifts in global economic conditions.

Table 3 Covariance Analysis

1994-2022						**1996-2015**					
Variables	FDI	RE	CO_2	TR	PO		FDI	RE	CO_2	TR	PO
FDI	1.00					**FDI**	1.00				
RE	0.85	1.00				**RE**	0.81	1.00			
CO_2	0.55	0.49	1.00			**CO_2**	0.58	0.41	1.00		
TR	0.52	0.71	0.25	1.00		**TR**	0.51	0.65	0.15	1.00	
PO	0.74	0.66	0.42	0.66	1.00	**PO**	0.70	0.61	0.40	0.55	1.00

Source: Authors Calculations

Table 4 is presenting Zivot-Andrews (ZA) structural break unit root analysis. The Zivot-Andrews unit root test was applied to identify structural breaks, in line with its established use in economic analyses of significant shocks (Zivot & Andrews, 1992). The test determined the break root and t-statistics for both period 1994-2005 and 1996-2015. As per table mentioned below every variable has experienced a structural break over the time and t-statistics value similarity suggesting that these changes are consistent with time frame. The t statistics for each variable reveal a unanimous pattern and star values at the 5% significance level, indicating these structural breaks across the two periods.

The major break years are a little different but aligned in their impact across the two periods. FDI had a structural break in 2004 and 2008 for the period 1994–2022 and 1996–2015, respectively, reflecting the shift in investment trends. RE shows a structural break in 2008 and 2012 for the respective periods. For CO_2 emissions, early structural breaks were noticed in 1998 for the period 1994–2022 and the year 2003 for the period 1996–2015, hence, indicating that these series followed changes in their mean level perhaps due to altered policy or technological changes. The

structural breaks in series for TR and PO further confirm the eventual shifting flow of tourism and population.

Overall, the similarity in t-statistics and points of structural breaks across periods seems to confirm that these changes did, indeed, occur in similar patterns over time and hence support the impact of exogenous factors at play during those two time periods on these sectors.

Table 4: Structural Break root unit Root analysis

1994-2022 Zivot Andrews (ZA)			**1996-2015** Zivot Andrews (ZA)		
Variables	t-statistics	Break year	Variables	t-statistics	
FDI	1.228**	2004	**FDI**	1.25**	2008
RE	1.158**	2008	**RE**	1.24**	2012
CO_2	3.145**	1998	**CO_2**	2.12**	2003
TR	1.258**	2011	**TR**	1.22**	1997
PO	2.158**	2012	**PO**	2.11**	2010

Note: ** means significance at 5% level. **Source:** Authors Calculations

Source: Authors Calculations

Table 5 is presenting the Koa analysis from various Dickey–Fuller tests (Modified Dickey–Fuller t, Dickey–Fuller t, Augmented Dickey–Fuller t, Unadjusted Modified Dickey–Fuller, and Unadjusted Dickey–Fuller t) from the periods 1994-2022 and 196-2015. The results determined that there is stable stationarity in both the periods as the outcomes of all the tests are statistically significant and for equally long-term and short-term analysis, it points to a reliable underpinning data structure devoid of unit root issues.

Table 5 Kao Analysis

	1994-2022		**1996-2015**	
	Statistic	p-value	Statistic	p-value
Modified Dickey–Fuller t	-17.52	0.000	-18.265	0.000
Dickey–Fuller t	-14.58	0.000	-13.82	0.000
Augmented Dickey–Fuller t	-10.25	0.000	-9.29	0.000
Unadjusted modified Dickey–Fuller	-22.58	0.000	-21.5	0.000
Unadjusted Dickey–Fuller t	-18.35	0.000	-17.5	0.000

Source: Authors Calculations

To ensure model robustness, diagnostic tests were conducted, as recommended in standard econometric procedures (Gujarati & Porter, 2009). Table 6 presents diagnostic tests-Heteroscedasticity, Serial Correlation, and Ramsey RESET-for 1994–2022 and 1996–2015 to check the robustness and validity of the model.

The heteroscedasticity test has yielded identical results in both periods, given that the p-values are 0.25 for 1994–2022 and 0.24 for 1996–2015, respectively, above the 5% level of significance indicating no significant issues with heteroscedasticity which maintains constant error variance across both periods. Results from the Ramsey RESET test further support this, since for both periods, p-values are 0.123 and 0.129, respectively, thus no specification errors. Such consistency in the diagnostic tests strengthens the model through its robustness toward proper specification without large omitted variable bias. The stability in heteroscedasticity and specification means the model will suitably estimate changes in FDI determinants over time. Diagnostic tests reassure that no major problems concerning variance and model specification exist, which, in turn, strengthen confidence in the results one can obtain and allow underlining of the model applicability for a wide range of economic contexts. The minor serial correlation in the period of 1994-2022 may be addressed in an effort to enhance precision of the results further, with a view

to render the model sound as a tool for policy insights into G20 economies.

Table 6 Diagnostic Tests

1994-2022				**1996-2015**			
Heteroscedasticity analysis							
F-Statistics	0.552	Prob. F (5,29)	0.25	F-Statistics	0.54	Prob. F (5,20)	0.24
Observed R-Sq.	6.022	P Chi-Square (5)	0.555	Observed R-Sq.	6.78	P Chi-Square (5)	0.45
Scaled Explain SS	12.525	P Chi-Square (5)	0.03	Scaled Explain SS	12.89	P Chi-Square (5)	0.000
Serial Correlation analysis							
F-Statistics	2.25	Prob. F (5,29)	0.04	F-Statistics	1.25	Prob. F (5,20)	0.04
Observed R-Sq.	5.78	P Chi-Square (5)	0.01	Observed R-Sq.	5.18	P Chi-Square (5)	0.00
Ramsey Reset analysis							
	Value	**DF**	**Probability**		**Value**	**DF**	**Probability**
t-Statistics	1.48	29	0.015	t-Statistics	1.18	20	0.01
F-Statistics	1.49	(1, 29)	0.016	F-Statistics	1.25	(1, 20)	0.005
Likelihood ratio	2.10	1	0.123	Likelihood ratio	1.25	1	0.129

Source: Author's Calculations

The table 7 is highlighting the comparative long-run and short-run coefficients of the ARDL model for two periods, 1994–2022 and 1996–2015, which have been estimated to depict the impact of various variables in both short and long run. In both periods, renewable energy (RE) is seen to affect positively and significantly in the long run, with coefficients 0.588 and 0.773 at 5% significance level for 1994–2022 and 1996–2015, respectively. This suggests a consistently strong long-term role of renewable energy in both time frames. In the short run, RE also shows a positive influence with significant coefficients of 0.148 for 1994–2022 and 0.484 for 1996–2015, which also points to stability in the immediate positive impact of the model across periods.

The long-run and short-run coefficients, 0.144 and 0.118 for the two periods for CO_2 emissions, are non-significant. More precisely, the coefficients are -0.515 and 0.411 for 1994-2022 and 1996-2015, respectively, which are still insignificant. This shows that the response variable is not significantly influenced by CO_2 emissions either in the long or short term.

The contribution of TR can be seen to be very strong in both the long and the short run. Long-run coefficients of 0.222 (for 1994–2022) and 0.583 (for 1996–2015) indicate the long-lasting effect of this variable, while the coefficients of the short-run effects, 0.158 and 0.156, reveal that TR has also contributed significantly in the model.

Population (PO) shows a significant positive effect in both periods and across both the long and short run. The long-run coefficients (0.525 for 1994–2022 and 0.458 for 1996–2015) and the short-run coefficients (0.444 and 0.255) confirm the consistent impact of population as a key driver within the model.

The ECT_{t-1}, which represents the speed of adjustment towards equilibrium, is significant for both periods, and thus, estimated to be 0.188 and 0.148, respectively. This implies that short-run deviations around the long-run equilibrium tend to get corrected over time.

The general implication of these findings is that renewable energy, tourism, and population emerge as persistent and significant determinants within the context of both periods, while CO_2 emissions are insignificant. The persistence of this result is an

indication of the robustness associated with these factors in the model structure.

Table 7: Short-run and Long run coefficients ARDL Model

	1994-2022		1996-2015	
Variable	Coefficients	t-Stat	Coefficients	t-Stat
RE	0.588**	1.789	0.778**	1.211
CO_2	0.1444	1.294	0.118	0.805
TR	0.222**	-0.124	0.588**	-2.524
PO	0.5258**	3.0615	0.458**	3.4545
Δ RE	0.148**	-1.313	0.484**	2.3535
Δ CO_2	0.5155	1.2454	0.411	0.5555
Δ TR	0.158**	1.258	0.156**	0.5161
Δ PO	0.444**	1.7899	0.255**	1.2255
$\mathbf{ECT_{t-1}}$	0.188**	0.582	0.148**	0.1222

Notes: ** reflect the significance level at 5%.
Source: Authors Calculations

4. Findings and Discussion:

Findings of this study reveal that renewable energy, tourism, and population growth have been considered as major determinants of FDI inflow for the G20 group of countries. The contribution of renewable energy would positively influence FDI, going in line with such literature pointing out that FDI-supportive sustainable energy policies minimize environmental risks and ensure long-term returns (Kittner et al., 2023; Wang & Liu, 2024). Countries such as Brazil and India are so positioning their renewable energy sectors to attract green-conscious investors, in a way to try and depict the fact that supportive regulatory frameworks of clean energy raise FDI (Mehta & Singh, 2024). This may suggest shifting investor preferences by countries whose policy is aligned with global climate objectives and trajectories for sustainable growth.

Interestingly, tourism also happens to be a significant determinant of FDI for the G20 economies. Quite in tune with earlier literature examining that tourism-based economies attract higher levels of inbound FDI due to enhanced physical infrastructure and increased international visibility and appeal (Sinclair & Stabler, 1997; Mazarol & Soutar, 2008). G20 countries with strong industries related to tourism are even leading to the induction of foreign investments in other sectors like retail, transportation, and real estate, further diversifying their economies. These findings confirm that in tourism-related industries FDI is conducive to wider economic development, as well as job opportunities and improved urban infrastructure. At the same time, for developing countries seeking diversification of FDI sources, tourism's role in attracting FDI may be particularly useful in tapping into non-manufacturing sectors.

The trends in population growth illustrate a heterogeneous relationship with FDI inflow. Whereas larger populations are likely to offer a wider labour pool and market potential, rapid population growth unmatched by productivity growth or the underpinning of the infrastructure results in pressure on resources and hence may somewhat discourage investment. Liu & Fan, 2018 said that the aforementioned would thus indicate that the demographic dividends are realized most when implemented hand in hand with policies to enhance workforce productivity and support urban infrastructure. In this respect, targeted policies should be implemented by the G20 economies with high population growth rates to ensure that it will be an asset rather than a liability for attracting FDI. Similarly, urbanization policies that enhance infrastructure and public services can make such populous nations more attractive to investors looking out for stable, efficient operating environments easily (McGranahan & Satterthwaite, 2008).

While this study renewable energy, tourism, and population as major FDI drivers, carbon emissions are found to play a minor role in FDI inflow. This might indicate that investors are becoming more sensitive and selective with regard to environmental policies in host countries. In some countries, for example, FDI is channeled to countries that are actively reducing their emissions, while in other cases, industries receiving lower environmental scrutiny would still be able to attract investment most particularly in regions with lenient environmental legislation (Klein & Zwinkels, 2014; Zhu et al., 2016). This kind of complexity insinuates that, yes, carbon emissions might be one of the most important concerns related to the environment, but they do not make a uniform series of influences on FDI patterns across the G20. Further research might eventually concentrate on sectoral responses of environmental regulations to capture more precisely the role of emissions in altering investment decisions across various industries.

The general contribution of the present study underlines the importance of a multidimensional approach towards the FDI strategy in the G20 economies. The policymakers who are interested in attracting sustainable FDI would do well by considering not only economic variables like market size and productivity but also the increasingly important environmental and demographic variables. This means investing in renewable energy, enhancing infrastructure for tourism, and managing population growth-especially in terms of increasing productivity and urbanization (Acharyya, 2009; Vujanović et al., 2021). Along this path of development, countries from the G20 will become appealing to foreign investors, since sustainability and economic resilience, as core priorities, gain special significance in the current context of the global economy.

5. Conclusion

The research identifies renewable energy, tourism, and population as the fundamental factor for influencing FDI in G-20 nations. Renewable energy is key factors for enhancing the environmental quality and also for advancing the green technology in the country to attract the eco-aware investors. As per the prior studies conducted by (Kittner et al., 2023; Mehta & Singh, 2024), highlights that those economies which are highly invested in renewable energy and promoting sustainable practices. Along with that tourism has the significant positive influence on the FDI as the tourism signals economic development and revenue generation steam.

Although population growth has both advantages and disadvantages, the paper contends that if productivity gains and urban development strategies are implemented, demographic growth may really be advantageous. Big populations provide a wealth of markets and labor pools, but they can also put a pressure on resources and turn off potential investors if they are not managed strategically (Liu & Fan, 2018). The findings show that a balanced approach to FDI policies in G20 nations is advantageous, with economic growth in line with environmental sustainability and demographic considerations.

The paper concludes by providing useful suggestions for G20 governments looking to draw foreign direct investment (FDI) through sustainable tourism, renewable energy projects, and population control. In order to provide further insights into sustainable investment strategies, future study might go deeper into how FDI responds to environmental policies in different sectors.

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