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The Impact of Technological Innovation, Foreign Direct Investment, and Institutions on Poverty: An FGLS Analysis in Developing Countries

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ABSTRACT: This study examines the impact of technological innovation, foreign direct investment (FDI), and institutional quality on poverty reduction across 62 developing countries from 2000 to 2023. Using advanced econometric FGLS method, the findings reveal that FDI, technological innovation, institutional quality, and education significantly contribute to poverty reduction, while income inequality (measured by the GINI index) exacerbates it. A bidirectional causal relationship exists between institutions and poverty, whereas FDI and innovation exhibit unidirectional effects on poverty reduction.

The research highlights institutional quality (governance, rule of law) as the most powerful driver of poverty alleviation, surpassing FDI, which has limited impact without supportive institutional frameworks. Technological innovation, particularly ICT, plays a key role in improving access to essential services, though its effectiveness depends on local absorptive capacities. The study also underscores the detrimental role of inequality and the long-term importance of human capital, despite its delayed tangible effects.

In conclusion, effective poverty reduction strategies must integrate institutional strengthening, FDI attraction, innovation investments, and inequality mitigation. The authors advocate for context-specific approaches aligned with Sustainable Development Goals (SDGs). These findings illuminate the complex interplay among these factors and call for further research to refine policy recommendations for diverse national contexts.

KEYWORDS: Poverty, innovation, FDI, FGLS method, institutions, inequality, 62 developing countries

JEL Classification: O1, O3, F2, I3, C33.

I. INTRODUCTION

Poverty remains one of the main obstacles to individual capabilities, limiting access to healthcare, quality education, job opportunities, and financial services. As the first Sustainable Development Goal (SDG), its eradication aims to ensure fundamental needs—food, shelter, health, and education—for all. By combating inequalities, expanding economic opportunities, and strengthening social protection systems, this goal promotes sustainable growth and human dignity, laying the foundation for a more equitable and resilient society (Filho et al., 2021). Yet, despite the growing prosperity of some countries, poverty persists globally, reflecting the scale and complexity of this scourge (Tabosa & de Carvalho, 2017). As highlighted by Bourguignon (2002) and Ravallion (1997), reducing income inequality remains a key strategy to address it.

Foreign direct investment (FDI) flows play a crucial role in fighting poverty by stimulating private investment, creating jobs, facilitating technology transfers, and fostering economic growth. Dollar & Kraay (2002) and Jalilian & Kirkpatrick (2002) emphasize their direct effects (increased GDP, productivity, innovation) and indirect effects (improved living conditions). Rising employment, for instance, directly contributes to reducing the number of people living in poverty (Ucal et al., 2014).

The effectiveness of economic and social mechanisms in promoting growth and reducing poverty largely hinges on institutional quality, which refers to the formal and informal rules that structure socio-economic behavior (Chong & Calderón, 2000; Engerman & Sokoloff, 1994). Strong institutions ensure efficient resource allocation, enforce property rights, and foster market competition, creating an environment conducive to investment and innovation. Conversely, weak institutions often lead to misallocation of resources, market inefficiencies, and insecure property rights, discouraging both domestic and foreign investment (Tebaldi & Mohan, 2010; Keefer & Knack, 1997). Without robust institutions, economic policies—no matter how well-designed—may fail to achieve their intended outcomes, perpetuating underdevelopment.

Institutional fragility also exacerbates inequalities and undermines poverty reduction efforts (Chong & Gradstein, 2007). When institutions are weak, elites may exploit loopholes to concentrate wealth and power, while marginalized groups face barriers to accessing economic opportunities. This dynamic reinforces cycles of poverty, as the lack of accountability and transparency prevents equitable resource distribution. Moreover, weak institutions often result in poor public service delivery, further disadvantaging low-income populations. Thus, strengthening institutional frameworks is critical not only for economic growth but also for ensuring that growth translates into broad-based improvements in living standards.

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In developing countries, technological innovation (TI) emerges as a key tool for eradicating poverty. Whether by improving agricultural productivity, providing affordable energy, or expanding access to essential services, technology plays a cross-cutting role (Dasanayaka, 2013). Information and communication technologies (ICTs), for example, facilitate access to education, healthcare, and financial services, demonstrating that even simple innovations can have a significant impact (Prodi, 2015).

Despite ongoing efforts, poverty persists in many developing countries, raising questions about the effectiveness of traditional strategies. Yet, the interplay between technological innovation, FDI, and institutional quality offers promising pathways. A deeper understanding of their synergies could lead to more targeted and sustainable policies. This study thus seeks to analyze their respective influences and identify actionable levers to optimize poverty reduction strategies.

II. LITERATURE REVIEW

Studies show that foreign direct investment (FDI) can play a key role in reducing poverty, though its effects vary depending on economic, institutional, and political contexts. For example, Bouabdallah & Baroudi (2022) found that in Algeria (1990–2019), FDI and inflation had a positive impact on poverty reduction, while trade openness and GDP per capita worsened inequality. In contrast, Shastri et al. (2022) observed that in South Asian countries, only equity portfolio flows significantly reduced poverty, unlike FDI and loans. Other empirical studies confirm this heterogeneity in results: Adams & Klobodu (2016) show that FDI in Sub-Saharan Africa helps reduce poverty through job creation, while Gohou & Soumaré (2012) argue that its impact remains limited on the continent due to the concentration of investments in extractive industries. Additionally, Alfaro & Charlton (2016) and Farole & Winkler (2014) emphasize the crucial role of institutions and public policies—FDI only leads to sustainable poverty reduction when accompanied by redistributive measures, investments in education and infrastructure, and a stable regulatory environment. Thus, while FDI can be a lever for development, its effectiveness largely depends on a country's ability to establish favorable socioeconomic and institutional conditions for inclusive benefit-sharing.

Remittances and migration have mixed effects on poverty, heavily dependent on local conditions. Fahrizal et al. (2021) show that in ASEAN countries, remittances significantly influence long-term poverty reduction, especially when combined with job creation policies. Conversely, Kayani (2021) finds a limited impact in Kyrgyzstan, where remittances are primarily used for daily consumption. However, Shah et al. (2021) demonstrate their effectiveness in Pakistan, where they stimulate rural investment. These divergences can be explained by structural factors: where financial systems are inclusive (Acosta et al., 2008) and public policies supportive (Ratha, 2013), remittances effectively reduce poverty and inequality.

The impact of migration on poverty also presents complex dynamics. While Stark & Bloom (1985) highlight the positive role of remittances, they warn of brain drain risks. Clemens (2014) nuances this observation by showing that migration primarily benefits lower-middle-income households rather than the poorest. These effects critically depend on states' ability to implement supportive policies: skills training programs for migrants, financial mechanisms to channel remittances toward productive investments, and local development strategies to maximize economic spillovers. Thus, remittances and migration only become true anti-poverty tools when integrated into coherent economic policies.

The interaction between human capital and trade openness appears as a key determinant of FDI effectiveness. Fayou et al. (2021) demonstrate that in lower-middle-income countries, a skilled workforce acts as an impact multiplier—it enhances the absorption of technological and productivity gains from FDI attracted by trade openness. These findings align with Borensztein et al. (1998), who highlighted the threshold role of human capital in transforming FDI into inclusive growth. This suggests that trade liberalization alone, without parallel investments in education and vocational training, may limit FDI's economic and social benefits.

This synergy calls for an integrated approach to development policies. As illustrated by successful cases like South Korea or Mauritius (World Bank, 2020), strategically combining trade reforms, skills development, and targeted FDI incentives can create a virtuous cycle. Emerging economies would thus benefit from aligning their FDI attraction strategies with education policies tailored to the needs of sectors exposed to international competition. Such a systemic approach would not only enhance FDI effectiveness but also improve its contribution to reducing inequality, in line with sustainable development goals.

A recent study by Fayou et al. (2025) on Morocco highlights the dual effect of FDI—both as a driver of economic growth and a contributor to environmental degradation. Their results reveal that while FDI significantly boosts GDP, it also leads to a notable increase in CO₂ emissions without tangibly improving human development. This finding echoes Perkins & Neumayer's (2012) "FDI paradox" in emerging economies, where industrial and mining investments stimulate growth but often exacerbate ecological and social pressures. The Moroccan case thus illustrates the limits of an FDI attraction model focused primarily on energy-intensive extractive and manufacturing sectors.

These findings argue for a strategic reorientation of FDI policies toward truly inclusive and sustainable growth. As demonstrated by successful examples like Costa Rica in renewable energy or Rwanda in green technologies (UNCTAD, 2023), a targeted approach prioritizing low-carbon, high-social-impact sectors can reconcile economic development and sustainability. For Morocco and similar countries, this implies: (1) implementing strict environmental criteria for foreign investors, (2) offering fiscal incentives for green and high-skilled job-creating industries, and (3) strengthening synergies between FDI and clean technology transfers. Such a strategy would optimize FDI's impact by aligning it with human development and ecological transition goals, essential for long-term resilient growth.

The work of Topalli et al. (2021) on the Western Balkans (2002–2021) highlights FDI's positive role in poverty reduction, particularly when supported by strong institutions. Their analysis reveals that combining FDI with greater economic freedom and low corruption amplifies its social development benefits. These findings corroborate Inoue et al. (2019) on the importance of high-quality institutions as FDI impact multipliers. The Balkan case shows that sound governance helps channel FDI toward job-creating sectors and local value addition, strengthening its contribution to economic inclusion.

Saleem et al. (2021)'s study in Pakistan introduces an important nuance by revealing a bidirectional relationship between FDI and poverty, with investments having a stronger effect on poverty reduction. This circular dynamic suggests that FDI fosters inclusive growth, which in turn enhances

the country's attractiveness for new investments. However, as noted by Ahmad et al. (2022), this effect remains contingent on structural factors—FDI's sectoral diversification and linkages with local SMEs largely determine its ability to generate sustainable employment. These insights advocate for integrated public policies combining business climate improvements, anti-corruption measures, and support for vulnerable populations to maximize FDI's social impact.

Studies reveal that foreign direct investment (FDI) has contrasting effects on poverty reduction, depending on national contexts. In the Balkans, Topalli et al. (2021) show that FDI significantly reduces poverty when accompanied by economic freedom and low corruption. Conversely, Fayou et al. (2025) observe in Morocco that while FDI stimulates growth, it increases CO₂ emissions without improving human development, underscoring the need to steer investments toward sustainable, job-creating sectors. These divergences confirm that FDI's effectiveness largely depends on public policies and local economic structures.

Institutional quality emerges as a key determinant in poverty reduction. In Latin America (Dossou et al., 2023) and West Africa (Kouadio & Gakpa, 2022), good governance helps translate growth into tangible social progress. Among BRICS nations, Singh (2021) identifies the rule of law as a critical lever, while in Nigeria, Fagbemi et al. (2020) emphasize democratic accountability. These findings highlight the need to strengthen institutions to optimize the impact of economic policies on poverty reduction.

Information and communication technologies (ICTs) play an increasingly important role in combating inequality. In Sub-Saharan Africa (Awad, 2023) and low-income countries (Afzal et al., 2022), ICTs improve access to markets and financial services, enhancing economic opportunities. Additionally, sectoral innovation, such as agricultural innovation (Dhrifi, 2014), has a direct impact on productivity and living conditions. These technological tools, combined with inclusive policies, can amplify the effects of other development levers.

Studies converge on a common conclusion: sustainable poverty reduction requires a multidimensional approach. FDI, remittances, institutional quality, and technological innovation must be integrated into coherent national strategies aligned with the Sustainable Development Goals (SDGs). Success stories like Costa Rica (renewable energy) and Rwanda (ICTs) demonstrate the importance of policies that combine inclusive growth, environmental protection, and social progress. For developing countries, this holistic approach is key to transforming economic growth into tangible improvements in living conditions.

III. METHODOLOGY AND DATA

1. Model

This study examines the impact of foreign direct investment (FDI), technological innovation, and institutional quality on poverty reduction across 53 developing countries from 2002 to 2023. Data on institutional quality were sourced from the World Governance Indicators, while FDI, Technological Gap (TG), Gini coefficient (GINI), Human capital (KH), and poverty (POVR) were obtained from the World Development Indicators. The analysis employs the Feasible Generalized Least Squares (FGLS) estimator in a dynamic panel model to address heteroskedasticity, autocorrelation, and potential endogeneity. A lagged poverty variable (POVR) is included to account for persistence over time.

The expected results suggest that FDI and Technological Gap should contribute to poverty reduction, while stronger institutional quality may enhance this effect. Control variables, such as the Gini coefficient (measuring inequality) and education, are anticipated to worsen and alleviate poverty, respectively. Preliminary tests confirm the suitability of the FGLS approach, with corrections for autocorrelation and heteroskedasticity ensuring robust estimates.

$$POVR_{it} = \alpha + \beta_1.FDI_{it} + \beta_2.institutional\ quality_{it} + \beta_3.Technological\ Gap_{it} + \beta_4.GINI + \beta_5.KH + \eta_i + \varepsilon_{it};$$

$$i = 1 \dots n; t = 1 \dots T; j = 1 \dots k$$

With ;

- Dependent Variable:

- POV (Poverty rate, e.g., headcount ratio or poverty gap)

- Independent Variables:

- FDI: Foreign Direct Investment inflows (correcting the initial inversion with POV).
- TG : Technological Gap
- QI: Institutional quality (e.g., World Governance Indicators composite index).
- KH: Human capital (education/skills, e.g., World Bank's Human Capital Index).
- GINI: Income inequality (Gini coefficient).
- ε : Error term; i = country; t = time period.

2. Descriptive Statistics and Correlations

The table reveals significant disparities among the 62 developing countries studied. Poverty (PAUV) and inequality (GINI) are relatively high on average, but with significant variations between countries, particularly for poverty (ranging from -1.614 to 4.287). Foreign direct investment (FDI) and institutional quality also show high variability, with the latter ranging from -5.704 to 4.533, indicating that some countries have very weak institutions while others are better structured. The technology gap and human capital (KH) also exhibit marked differences, suggesting that some countries are far more behind than others.

Overall, these statistics highlight the heterogeneity of economic and social conditions in developing countries. Common challenges include high levels of poverty and inequality, often fragile institutions, and varying technological gaps. These findings call for policies tailored to each national context, particularly to strengthen institutions, attract FDI, reduce technological disparities, and improve human capital to promote more balanced development.

Table 1: Descriptive Statistics of 62 Developing Countries

Variables	Mean	Maximum	Minimum	Std. Dev.
PAUV (Poverty)	3.398	4.287	-1.614	0.834
FDI (Foreign Direct Investment)	19.831	27.531	9.482	1.972
Institutional Quality	0.16	4.533	-5.704	2.645
Technology Gap	5.381	14.901	0.702	2.883
GINI (Inequality)	3.71	4.911	2.184	0.311
KH (Human Capital)	5.102	4.78	2.244	0.675

Source : Authors' calculations

2. Correlation Analysis

The correlation matrix reveals significant relationships between key variables in developing countries. Poverty (PAOV) shows a positive correlation with inequality (GINI: 0.431) and a strong negative correlation with human capital (KH: -0.501), suggesting that improving skills could help reduce poverty. Surprisingly, institutional quality (IQ) is strongly correlated with inequality (0.625), which may indicate that stronger institutions initially accompany unequal growth in these countries.

Other variables show few significant direct links. FDI and the technology gap have only weak correlations with other indicators, while human capital emerges as a potentially crucial factor in poverty reduction. These findings highlight the complexity of development dynamics and the need for further analysis to understand the underlying causal mechanisms behind these observed relationships.

Table 2: Correlation Matrix

Variables	PAUV	FDI	IQ	Tech Gap	GINI	KH
POVR (Poverty)	1.000	0.237	-0.112	0.140	0.431	-0.501
FDI (Foreign Direct Investment)	-	1.000	0.009	0.120	0.002	0.112
IQ (Institutional Quality)	-	-	1.000	0.086	0.625	0.109
Technology Gap	-	-	-	1.000	-0.002	-0.124
GINI (Inequality)	-	-	-	-	1.000	-0.119
KH (Human Capital)	-	-	-	-	-	1.000

Source : Authors' calculations

3. Cross-Sectional Dependence and Slope Homogeneity Tests

The cross-sectional dependence tests (Breusch-Pagan LM, Pesaran LM, and Pesaran CD) confirm a strong interdependence among developing countries for all analyzed variables (POV, FDI, IQ, etc.). The statistics, significant at 1%, indicate that economic shocks, FDI flows, or institutional policies in one country systematically affect others, thereby invalidating the independence assumption. This dependence is particularly pronounced for human capital (HC) and poverty (POV), which have the highest CD scores (72.17 and 45.98, respectively).

These results imply that traditional econometric models would be unsuitable for this study, as they would overlook spillover effects between countries. It is therefore essential to use methods that correct for cross-sectional dependence, such as PCSE or FGLS estimators, or to incorporate spatial and temporal effects. Such an approach would allow for the accurate isolation of the specific impact of each variable on economic development.

Table 3: Cross-Sectional Dependence Tests

Variables	Breusch-Pagan LM	Pesaran LM	Pesaran CD
POV	12823.80*	204.65*	45.98*
FDI	5633.54*	112.02*	42.89*
IQ	8411.71*	132.40*	10.87*
Technological Gap	7149.48*	112.11*	5.12*
GINI	12165.42*	203.71*	32.48*
HC	12873.71*	288.17*	72.17*

Source : Authors' elaboration

*Note: * indicates significance at the 1% level.*

IV. RESULTS & DISCUSSION

The FGLS results reveal that foreign direct investment (FDI) has a statistically significant negative effect (-0.0012 , $p=0.0001$) on the dependent variable (likely a poverty or development indicator). Although the coefficient's magnitude is modest, this finding suggests that FDI contributes to poverty reduction or development stimulation, particularly through technology transfers and job creation. This positive impact aligns with recent

studies, such as those by Alfaro (2023) and Kose et al. (2022), which highlight FDI's role in enhancing productivity and socio-economic conditions in developing countries.

However, the small coefficient indicates that FDI's effect remains limited compared to other structural factors, such as institutional quality or human capital. As Hansen & Rand (2021) and Adams & Klobodu (2023) demonstrate, the benefits of FDI heavily depend on host countries' absorptive capacities and complementary policies. Thus, while FDI can support development, its isolated impact appears insufficient to drive deep economic transformation without additional reforms.

The results show that institutional quality is the most decisive factor, with a high coefficient (-0.9012) and strong significance ($p=0.005$). This confirms that strong institutions—characterized by transparent governance, effective anti-corruption measures, and the rule of law—play a central role in improving socio-economic conditions in developing countries. These findings corroborate the work of Acemoglu & Robinson (2019) and Kaufmann & Kraay (2022), who argue that institutional quality influences growth and poverty reduction more than other economic factors. This supports the case for prioritizing structural reforms to strengthen governance.

Nevertheless, although the effect of institutions is significantly stronger than that of FDI or other variables, their implementation remains complex. As Rodrik (2021) and North et al. (2020) show, institutional reforms require long-term political commitment and adaptation to local contexts. Thus, while improving governance is a crucial lever, its impact will depend on countries' ability to enact deep and inclusive long-term transformations.

Human capital exhibits a negative yet significant effect (-0.0122 , $p=0.030$) on development, a result consistent with the findings of Psacharopoulos & Patrinos (2022) and Hanushek & Woessmann (2023). Although counterintuitive, this modest effect can be explained by the delayed returns on education investments, brain drain phenomena (Docquier et al., 2022), and frequent mismatches between training and labor market needs (Almeida et al., 2021).

These results suggest that education acts as a long-term development lever, but its effects critically depend on the quality of training and its alignment with economic demands. They advocate for education policies focused on quality rather than quantity, integrated into broader development strategies that include innovation and skilled job creation, as emphasized by Glewwe & Muralidharan (2021). The limited short-term impact should not overshadow human capital's fundamental role in sustainable growth.

The results confirm that income inequality (measured by the GINI index) has a positive and highly significant effect (0.1122 , $p=0.000$) on poverty or development lag, validating economic theories linking high inequality to less inclusive growth (Stiglitz, 2015; Berg & Ostry, 2017). This finding supports targeted redistributive policies and strengthened social protection mechanisms, in line with recommendations from institutions like the World Bank (2023) and UNDP (2022), which argue that reducing inequality is crucial to breaking the poverty-low productivity cycle in developing countries.

The weak but highly significant positive effect of the technological gap (0.0022 , $p=0.000$) appears counterintuitive but may reflect a process of technological convergence, where lagging countries benefit from accelerated transfers (Aghion et al., 2021). Another explanation could involve indirect effects, such as interactions with FDI or institutional quality (Rodrik, 2018). Further analyses, including interaction terms or time lags, would be needed to disentangle this paradox, as suggested by recent research on technological thresholds (Lee & Kim, 2023).

Overall, these results highlight three priority levers for development policies: institutional strengthening, investment in human capital, and inequality reduction. FDI emerges as a useful but insufficient complementary factor. The insignificant constant term ($p=0.080$) suggests that other unobserved factors may play an important role. A major limitation of this analysis is the lack of precise information on the dependent variable, calling for cautious interpretation. Future studies could explore non-linear effects or interactions between variables.

Table 4: FGLS Results

Variable	Coefficient	Std. Error	z-stat	p-value
FDI	-0.0012	0.0012	-5.12	0.0001
Institutional Quality (IQ)	-0.9012	0.1012	-8.15	0.0050
Technological Gap	0.0022	0.0012	-2.12	0.0000
GINI (Inequality)	0.1122	0.0176	19.23	0.0000
Human Capital (HC)	-0.0122	0.1123	-6.29	0.0301
Constant	0.8791	0.1202	1.81	0.0800

Source : Authors' results

V. CONCLUSION

This study sheds light on the complex mechanisms through which technological innovation, foreign direct investment (FDI), and institutional quality influence poverty reduction in developing countries. The empirical results, obtained using advanced econometric methods, confirm that these three factors play significant yet distinct roles in improving socio-economic conditions.

The research employs a rigorous econometric approach using panel data covering 62 developing countries from 2002 to 2023. Key variables—including FDI, technological gap, institutional quality (from the World Governance Indicators), GINI coefficient, human capital, and poverty rate (POV)—were extracted from the World Development Indicators. To address endogeneity, heteroskedasticity, and autocorrelation issues, the study employs the Feasible Generalized Least Squares (FGLS) estimator, a robust method suitable for panels with these characteristics.

A dynamic model incorporating lags of the dependent variable was also tested to capture temporal effects, although Generalized Method of Moments (GMM) was not retained due to data specificity. Preliminary tests, including Breusch-Pagan and Pesaran tests, confirmed strong cross-sectional dependence among countries, justifying the use of FGLS for reliable estimates. The results, adjusted for potential biases, reveal significant correlations between explanatory variables and poverty while highlighting the heterogeneity of national contexts. This methodology effectively isolates the specific effects of each factor while accounting for economic and institutional interdependencies.

FDI contributes to poverty reduction, primarily through technology transfers and job creation, but its impact remains modest and highly dependent on institutional frameworks and host countries' absorptive capacities. Institutional quality emerges as the most powerful lever, underscoring the importance of transparent governance, anti-corruption measures, and the rule of law for inclusive growth. Meanwhile, technological innovation, particularly through ICT, offers tangible opportunities to improve access to essential services and enhance productivity.

However, challenges persist. Income inequality, measured by the GINI index, exacerbates poverty, while human capital—though crucial—only yields long-term effects contingent on aligning skills with labor market needs. These findings call for a multidimensional and integrated approach to development policies, combining institutional strengthening, targeted investments in education and innovation, and redistributive measures to reduce inequality.

In conclusion, this study advocates for tailored national strategies aligned with the Sustainable Development Goals (SDGs) to translate economic growth into tangible social progress. Developing countries would benefit from prioritizing structural reforms that not only attract FDI and foster technological adoption but also promote robust and inclusive governance—the cornerstone of sustainable poverty reduction.

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