

Foreign Direct Investment, Education, and Gender Inequality in Middle-Income Nations: An Empirical Analysis Using a Panel Autoregressive Distributed Lag Approach

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Abstract

Background and Objectives: Gender equality is a cornerstone of the United Nations Sustainable Development Goals (SDG 5). Despite rapid economic transformation, persistent disparities continue to characterize many middle-income nations. Over the past two decades, these economies have become primary recipients of global foreign direct investment (FDI) while achieving significant progress in educational attainment, particularly in female primary enrollment. However, these advancements have not translated proportionately into reduced gender inequality, suggesting deeper structural constraints. This study examines the dynamic and potentially non-linear relationships between FDI, education, and gender inequality in middle-income countries. It specifically investigates whether FDI and education exert diverging short-run and long-run effects and explores the mechanisms through which these factors interact during the transition toward skill-intensive economic structures.

Methodology: The analysis utilizes a balanced panel dataset of 18 middle-income countries from 2000 to 2023, totaling 432 annual observations. Gender inequality is measured via the Gender Inequality Index, capturing disparities in reproductive health, empowerment, and labor market participation. Key explanatory variables include FDI inflows (as a percentage of GDP) and female primary school enrollment as a proxy for education, alongside controls for female labor force participation, life expectancy, and political rights. To capture both short-run dynamics and long-run equilibrium, the study employs the Pooled Mean Group (PMG) estimator within a panel Autoregressive Distributed Lag (ARDL) framework. This approach accommodates mixed orders of integration and allows for heterogeneous short-run adjustments while imposing long-run homogeneity. The robustness of the specification is confirmed through unit root and panel cointegration tests, followed by panel Granger causality tests to determine the directionality of the relationships.

Key Findings: The results reveal a clear divergence between short-run and long-run effects. In the short run, neither FDI nor education has a statistically significant impact on gender inequality, indicating that structural changes require a longer gestation

period. The short-run coefficient for education is positive but insignificant, consistent with an "opportunity cost" mechanism where increased school enrollment temporarily reduces female labor force participation. Similarly, FDI inflows do not yield immediate effects, reflecting time lags in labor market transmission. Conversely, long-run estimates show that both FDI and education significantly reduce gender inequality. FDI facilitates improved outcomes through formal employment creation and the diffusion of inclusive labor practices, while education enhances human capital and decision-making capacity. Female life expectancy also emerges as a pivotal factor in reducing disparities. Sub-sample analysis indicates that the equalizing impact of FDI is more pronounced in upper-middle-income countries, highlighting the role of institutional quality. Finally, bidirectional Granger causality confirms a mutually reinforcing relationship between gender equality, FDI, and education.

Policy Implications: The findings suggest that FDI and education are not immediate policy levers but long-term structural drivers requiring supportive institutional frameworks. First, policymakers should implement targeted interventions to mitigate the short-run opportunity costs of education, such as scholarships and conditional cash transfers for female students. Second, governments should adopt a "quality-oriented" FDI strategy, prioritizing sectors that promote formal employment and gender-inclusive practices rather than focusing solely on capital volume. Third, sustained investment in women's health is essential for long-term empowerment and labor market participation. Finally, given the bidirectional causality, gender equality should be treated as a strategic economic asset; enhancing gender parity can attract higher-quality investment and further reinforce human capital development. Achieving progress requires a coordinated policy approach that integrates education, investment, and social development within a long-term framework.

Keywords: Gender Inequality; Foreign Direct Investment; Education; Human Capital; Middle-Income Countries

JEL Classification Codes: F21; I25; J16; O15

1. Introduction

Gender equality has garnered global prominence as the fifth of the United Nations' seventeen Sustainable Development Goals (SDG 5). While international frameworks set the overarching agenda, the specific socio-economic dynamics within middle-income nations demand urgent empirical attention. Over the past two decades, these nations have emerged as primary destinations for global capital, attracting approximately 50% of total foreign direct investment (FDI) inflows (Saha et al, 2022). However, scholars such as Blanton and Blanton (2015) and Bui et al. (2018) argue that FDI often gravitates toward labor-intensive manufacturing and export-oriented sectors. This trend frequently creates a "sticky floor" effect, where female workers remain disproportionately confined to low-wage, vulnerable roles despite overall gains in employment. Concurrently, the education sector in these nations has achieved substantial progress; female primary enrollment rates have surged to 85–90%, nearly converging with male levels due to extensive public investment in human capital (Cin et al., 2020; Polat, 2017). Paradoxically, despite massive capital inflows and educational advancements, gender inequality remains structurally persistent. As highlighted by Ho et al. (2025) and Van der Ham et al. (2021), women in middle-income economies still face significant disparities, with labor force participation often lagging that of men by more than 20%. This discrepancy points toward a structural

mismatch between educational output and the evolving demands of FDI-driven industries. Consequently, this study focuses on middle-income nations to examine the complex interplay between FDI and education during the delicate transition from labor-intensive to skill-intensive economic structures.

The prevalence of gender inequality in middle-income nations reflects deep-seated disparities in rights and opportunities (Jayachandran, 2015; Van der Ham et al., 2021). In these contexts, the gendered nature of work is often reinforced by conservative societal attitudes toward women's participation in the formal labor market. Societal stigma and restrictive gender norms exert differential pressures on men and women, often resulting in fewer employment and educational pathways for the latter (Menéndez-Espina et al., 2020). Furthermore, women are more likely to earn lower wages, a situation compounded by the heavy burden of unpaid domestic labor and caregiving responsibilities (Heise et al., 2019).

Prior research offers mixed evidence on whether FDI mitigates gender inequality. On one hand, FDI can promote equality by fostering economic growth and creating new employment avenues. For instance, Anyanwu (2016) found that narrowing the gender gap in primary education, coupled with FDI inflows, is positively associated with reduced inequality in youth employment. Similarly, Fernandes and Kee (2021) observed that local firms affiliated with foreign enterprises tend to employ significantly more women in administrative roles, thereby fostering empowerment. On the other hand, FDI may inadvertently exacerbate disparities. Fernandes and Kee (2021) also reported that technology transfers aimed at automating production can lead to higher unemployment and lower wages for female workers. Additionally, FDI-driven shifts may disadvantage women who lack the work-schedule flexibility required by modern industries due to disproportionate family obligations.

Education serves as another critical determinant of gender outcomes (Chang, 2018; Mujahid & Begum, 2021). Longitudinal evidence from Taiwan suggests that the expansion of higher education has been instrumental in mitigating gender gaps (Chang, 2018). In Pakistan, a consistent negative relationship was observed between educational attainment and the gender inequality index (Mujahid & Begum, 2021). Furthermore, targeted reforms—such as the implementation of single-sex education—have been shown to alleviate educational disparities in certain contexts (Cin et al., 2020; Polat, 2017). Nevertheless, some critics argue that education policies often fail to address the underlying socio-cultural constraints that limit girls' actual capabilities (Cin et al., 2020).

This study extends the existing literature on middle-income nations in several key dimensions. First, the synergistic impact of FDI and education remains underexplored. Most existing studies isolate the effects of FDI (Anyanwu, 2016; Ho et al., 2025) or education (Chang, 2018; Polat, 2017) rather than examining their combined influence within middle-income contexts. Second, while previous research has predominantly utilized Generalized Method of Moments (GMM) or Pooled OLS (Anyanwu, 2016; Bui et al., 2018), this study employs a panel Autoregressive Distributed Lag (ARDL) approach. This methodological shift allows for a nuanced distinction between short-run fluctuations and long-run equilibrium relationships, providing a more comprehensive view of how FDI and education drive structural change. Additionally, we utilize Granger causality tests to establish the directionality of these relationships.

The theoretical contributions of this research enhance existing frameworks within the context of middle-income development. Our findings suggest that while FDI is often equated with development, it may exacerbate inequality in the long run. This extends Dunning's (2000) Eclectic Theory by framing gender inequality as a "location-

specific" factor that investors may exploit to minimize labor costs. Specifically, by relying on low-cost female labor in manufacturing, FDI may perpetuate existing disparities (Blanton & Blanton, 2015; Bui et al., 2018). Furthermore, this study enriches Human Capital Theory (Becker, 1994) by identifying the diverging temporal effects of education. While socio-cultural barriers may cause education to appear less effective in the short term, it serves as a vital engine for long-term empowerment by facilitating women's entry into high-level decision-making roles (Flashman, 2013). By accounting for these contradictory dynamics, this study offers a more refined framework for understanding the complex drivers of gender equality.

The remainder of this paper is structured as follows. Section 2 reviews the related literature. Section 3 describes the data and methodology. Section 4 presents and discusses the empirical results. Section 5 concludes the paper, and Section 6 outlines the policy implications.

2. Literature Review

2.1 Theoretical Framework

The eclectic theory, widely recognized as the OLI paradigm developed by Dunning (2000), provides a robust framework for analyzing the determinants of foreign direct investment (FDI) through ownership (O), location (L), and internalization (I) advantages. Within middle-income nations, this framework effectively explicates the "trilogy" between FDI, education, and gender inequality. Specifically, location-specific advantages—such as educational infrastructure, the enforcement of gender parity policies, and the prevailing labor market structure—shape the attractiveness of host countries. Multinational enterprises (MNEs) may be drawn to regions where gender inequality is institutionalized and where education creates a surplus of underutilized female labor with restricted bargaining power (Anyanwu, 2016; Bui et al., 2018). This structural dynamic allows firms to minimize labor costs and bypass regulatory constraints, particularly in manufacturing and textiles. Domestic educational levels may exacerbate this imbalance by limiting women's upward mobility, thereby reinforcing gendered labor segmentation. Consequently, the OLI paradigm demonstrates that FDI decisions are deeply embedded in the host country's socio-educational fabric, where gender and educational inequalities become functional components of the location advantage (Blanton & Blanton, 2015; Brzozowski, 2013).

Modernization theory conceptualizes development as a linear, evolutionary process where societies transition from traditional to modern states through structural transformations (Ynalvez & Shrum, 2015). Rostow (2013) modeled this process through five distinct stages of economic growth, progressing toward high mass consumption (Ish-Shalom, 2006; Ynalvez & Shrum, 2015). From a political lens, Lipset (1959) suggests that industrialization, urbanization, and education weaken authoritarian regimes and facilitate democratic transitions (Przeworski & Limongi, 1997). Unlike Dependency Theory, Modernization Theory views Western technology as an objective catalyst that enables developing nations to shorten their development trajectory (Ish-Shalom, 2006; Ynalvez & Shrum, 2015). Regarding reproductive health, Golkhandan (2017) posits that FDI facilitates long-term health improvements by reducing infant mortality through technology transfer and income generation. Simultaneously, industrialization drives a structural shift that pulls women into the formal workforce, fostering the economic independence required to challenge patriarchal norms and demand political representation (Inglehart & Norris, 2003). This

shift also alleviates household budget constraints, incentivizing families to prioritize female secondary education over domestic labor.

To identify the transmission mechanisms involved, this study integrates human capital theory (Becker, 1994) with the theory of skill-biased technological change (SBTC) (Berman et al., 1994; Berman et al., 1998). Human capital theory suggests that economic outcomes are primarily dictated by investments in education and skills. However, systemic barriers in middle-income nations often hinder women's access to quality education compared to men (Cin et al., 2020). The SBTC hypothesis clarifies why pre-existing education levels matter; FDI inflows typically introduce advanced technologies that shift labor demand toward skilled workers. Due to pre-existing educational inequality, women may be structurally ill-prepared for these high-skilled roles. Consequently, the skill premium generated by FDI often accrues to the male workforce, while women remain in low-skilled sectors or face displacement (Braunstein & Brenner, 2007). Thus, the impact of FDI is filtered through the host country's educational landscape (Blanton & Blanton, 2015). Furthermore, gendered labor norms may hinder advancement even when qualifications are comparable, particularly in STEM fields (Broyles, 2009). This combination of SBTC and educational constraints acts as a structural barrier that reinforces labor stratification and impedes broader social advancement for women.

2.2 The Nexus Between FDI and Gender Inequality

Empirical evidence on the relationship between FDI and gender outcomes remains divided. Some scholars identify a positive association, suggesting that globalization improves gender equality by generating employment (Anyanwu, 2016; Fernandes & Kee, 2021; Richards & Gelleny, 2007). Richards and Gelleny (2007) found that FDI and international trade generate significant employment opportunities for women. Similarly, Anyanwu (2016) utilized OLS methods to show that increased FDI reduces gender inequality in African youth employment by 0.55 percentage points. Firm-level data from Bangladesh further supports this, indicating that foreign-owned enterprises hire significantly more female administrative and production workers than domestic firms (Fernandes & Kee, 2021).

Conversely, Blanton and Blanton (2015) utilized GMM methods to identify a mixed relationship, where aggregate FDI is positively associated with women's political rights but negatively linked to economic rights. Bui et al. (2018) also found a mixed relationship across 27 developing Asia-Pacific economies. Given that most prior studies rely on GMM or OLS (Bui et al., 2018; Blanton & Blanton, 2015), this study utilizes the ARDL method to examine both short-run and long-run causalities. In middle-income nations, where FDI drives growth (Duong et al., 2022), it is essential to determine if this translates into improved gender outcomes (Richards & Gelleny, 2007).

Hypothesis 1a: In the short run, the FDI negatively impacts gender inequality.

Hypothesis 1b: In the long run, the FDI negatively impacts gender inequality.

2.3 The Nexus Between Education and Gender Inequality

Extensive literature demonstrates that education serves as a fundamental driver of gender parity (Chang, 2018; Flashman, 2013; Mujahid & Begum, 2021; Polat, 2017). Polat (2017) observed that the equitable distribution of universities increases enrollment regardless of socio-economic background, thereby reducing disparities. Longitudinal data from Taiwan confirms that the expansion of higher education is essential for advancing gender parity (Chang, 2018).

However, Cin et al. (2020) argue that educational reforms often overlook underlying gender issues and practitioners' perspectives, leaving girls' capabilities

restricted. Furthermore, in resource-constrained middle-income nations, traditional norms may cause families to prioritize male education, extending existing inequalities (Lee, 2014). While various models have examined this relationship (Chang, 2018; Lee, 2014; Polat, 2017), the use of the ARDL framework remains limited. This study addresses this gap by utilizing updated data from 2000 to 2023 across 18 middle-income nations. Human capital theory predicts that increased market competition and trade expansion will eventually reduce discrimination and lead to greater equality (Black & Brainerd, 2004).

Hypothesis 2a: Education negatively impacts gender inequality in the short run.

Hypothesis 2b: Education negatively impacts gender inequality in the long run.

3. Data and Methodology

3.1 Data

The empirical analysis utilizes a dataset initially comprising 6,676 annual observations from 185 nations spanning the period 1990 to 2023, derived entirely from the World Bank Database (WDI) and Our World in Data (OWID). This sample was subsequently refined by restricting the analysis to middle-income countries and narrowing the study period to 2000–2023 to ensure the statistical robustness of the panel data estimation. This temporal scope is fundamentally determined by the availability of the dependent variable, the Gender Inequality Index (GEN). Comprehensive and consistent GEN data for the selected middle-income economies is largely unavailable prior to 2000.

While missing data could theoretically be addressed through listwise deletion, the extent of the gaps in the pre-2000 period would result in a substantial reduction in sample size. Furthermore, such an approach could introduce selection bias, as data availability remains uneven across different nations. Alternatively, interpolating the dependent variable would necessitate extensive imputation, thereby introducing significant measurement errors and potential estimation bias. Consequently, this study excludes the pre-2000 period to preserve the integrity and reliability of the empirical results. The year 2023 serves as the final year of the sample, as it represents the most recent period for which complete GEN data are accessible.

Following the methodological precedents established by Ho et al. (2025), Nguyen et al. (2024), and Le et al. (2023), nations with significant missing values during the 2000–2023 timeframe were excluded from the analysis. By retaining only those countries with complete data across all selected variables for this specific period, the final sample comprises a balanced panel of 432 annual observations from 18 middle-income countries. A complete list of the sampled countries is provided in Appendix A.

3.2 Variable Definitions

The Gender Inequality Index (GEN) is operationalized following the frameworks established by Permanyer (2013), Nguyen et al. (2024), and Ho et al. (2025). The GEN aggregates disparities between men and women across three core dimensions—reproductive health, empowerment, and labor market participation—into a single composite score where higher values signify greater gender inequality. This index is particularly suitable for this study as its multidimensional design aligns with contemporary theoretical treatments of gender inequality as a compound phenomenon that cannot be captured by a single indicator. Furthermore, it improves construct validity by operationalizing conceptually distinct yet policy-relevant domains and addresses methodological critiques of earlier measures by integrating previously under-

represented aspects. Its composite form preserves analytical parsimony while enabling cross-country and longitudinal comparability, which is essential for the panel analysis conducted herein.

Following Anyanwu (2016) and Nghiem et al. (2024), Foreign Direct Investment (FDI) is measured as the percentage of net inflows relative to GDP. This approach is widely regarded as efficient for economic studies in middle-income nations, as it standardizes FDI according to the size of the economy, facilitating meaningful cross-country comparisons. This metric effectively captures the relative economic impact of FDI, reflects a country's openness to foreign capital, and adjusts for scale effects inherent in economies with diverse structures and varying development levels. Additionally, this measurement aligns with established empirical methodologies, ensuring consistency when analyzing how FDI influences key outcomes such as educational attainment and gender equality.

Education (EDU) is measured following Brzozowski (2013) using the ratio of female enrollment in primary schooling. In many middle-income nations, primary education remains a critical barrier for girls due to persistent socio-cultural norms, poverty, and limited access to infrastructure. Focusing on female enrollment rates allows this study to reflect early-stage educational inclusion, which carries long-term implications for skill development, labor market participation, and overall gender parity.

In line with Nguyen et al. (2024), the variable Labor (LAB) is defined as the female labor force participation rate. This is measured as the percentage of women aged 15 and above who are economically active—either employed or actively seeking employment—relative to the total female population in that age group. Labor market participation is a fundamental channel for advancing gender equality, as greater economic engagement enhances women's income-generating capacity, strengthens their bargaining power within households, and increases their visibility in formal markets. As Girmay (2018) argues, access to stable and adequately remunerated employment is critical in narrowing the gender gap.

Health (HEL) is proxied by female life expectancy at birth, serving as a comprehensive indicator of women's overall health status. This variable captures the cumulative effects of healthcare access, nutrition, general living standards, and broader socio-economic conditions on the female population. Finally, Women's Political Rights (POL) are measured following Blanton and Blanton (2015) using the Women's Business and the Law Index. This metric gauge legal and political rights on a scale from 0 to 100, where an increasing score indicates substantive progress toward women acquiring democratic and legal rights.

3.3 Estimation Methodology

Following the frameworks of Mujahid and Begum (2021) and Abbas et al. (2022), this study utilizes the panel ARDL framework to examine the dynamic interaction between FDI, education, and gender inequality for several strategic reasons. First, the research question seeks to determine whether FDI and education exert transient or fundamental long-term effects on gender inequality. The PARDL model provides a uniform error-correction representation that identifies both short-term adjustments and long-term equilibrium relationships, which is central to the theoretical suggestion that structural transformations caused by FDI may be gradual rather than instantaneous. Second, as confirmed by panel unit root tests, the variables are integrated at mixed levels—I(0) and I(1)—while none exhibit I(2) properties. PARDL effectively addresses these mixed integration properties by directly testing for co-integration, ensuring valid inference without imposing restrictive assumptions regarding the data's random properties. Third, the model accommodates cross-country heterogeneity in

short-term dynamics and adjustment rates while maintaining stable long-term relationships, a flexibility that is essential given the institutional and structural differences among middle-income nations.

To ensure the appropriateness of the ARDL methodology, unit root tests are first conducted to verify the stationarity of all variables. This stage is critical to confirm that no variables are integrated at the second difference, $I(2)$, as such a series would render the ARDL technique invalid. For this purpose, the study utilizes the Pesaran CIPS and the Westerlund (2007) co-integration test. Subsequently, following Nghiem et al. (2024), the optimal lag length for the PARDL model is determined based on the Akaike Information Criterion (AIC) to adequately capture the dynamic adjustment process and prevent serial correlation. After establishing the lag structure, the existence of a long-run relationship is examined through the significance and sign of the error correction term (ECT). A negative and statistically significant ECT coefficient confirms the presence of co-integration and indicates the speed at which short-run deviations converge back to long-run equilibrium. This framework allows for the simultaneous estimation of both short-run dynamics and long-run coefficients within a unified specification, enabling a clear distinction between temporary adjustments and long-term equilibrium relationships.

A significant challenge in macro-panel data studies is endogeneity arising from inverse causality and omitted variables, as evidenced by the bidirectional causal relationship identified in our Granger causality analysis. The panel ARDL framework helps mitigate these concerns; according to Pesaran et al. (2001) and Pesaran (2007), by incorporating sufficient lags of both dependent and independent variables, the model absorbs residual series correlations and renders the regression variables weakly exogenous. Consequently, PMG-ARDL estimates yield consistent, unbiased, and asymptotically normal long-run coefficient estimates, even in the presence of endogenous regressors. As noted by Chudik et al. (2016), this structural advantage eliminates the need to use traditional instrumental-variable (IV) or GMM methods to address endogeneity in long-term estimations. Finally, the Granger causality test is implemented to explore the directionality and nature of the interactions, providing insight into whether changes in FDI or shifts in educational inequality precede movements in the other variables. This stage complements the ARDL analysis by enriching the understanding of the short-run causality mechanisms underpinning the observed long-run associations.

3.4 Model Construction

Building upon established empirical research, this study develops a panel ARDL model to analyze the impact of determinant variables on gender inequality. Following the frameworks utilized by Matthew et al. (2020), Bui et al. (2018), and Mujahid and Begum (2021), the following model is proposed:

$$\begin{aligned} \Delta GEN_{i,t} = & \varphi_i (GEN_{i,t-1} - \theta_{1i} FDI_{i,t-1} - \theta_{2i} EDU_{i,t-1} - \theta_{3i} LAB_{i,t-1} - \\ & \theta_{4i} HEL_{i,t-1} - \theta_{5i} POL_{i,t-1}) + \Sigma \beta_{1ij} \Delta FDI_{i,t-j} + \Sigma \beta_{2ij} \Delta EDU_{i,t-j} + \\ & \Sigma \beta_{3ij} \Delta LAB_{i,t-j} + \Sigma \beta_{4ij} \Delta HEL_{i,t-j} + \Sigma \beta_{5ij} \Delta POL_{i,t-j} + \mu_i + \varepsilon_{it}. \end{aligned}$$

where i and t denote country and year, respectively. $\Delta GEN_{i,t}$ represents the first difference of the Gender Inequality Index (GEN), capturing year-to-year changes in gender inequality. FDI is foreign direct investment, measured as net inflows as a percentage of GDP. EDU is education, proxied by the female primary school enrollment rate. LAB is measured as the percentage of women aged 15 and above who are economically active, defined as either employed or actively seeking employment,

relative to the total female population aged 15 and above. HEL is a female health condition, measured by female life expectancy at birth. POL is Women's political rights, proxied by the Women's Business and the Law Index (0–100 scale), where higher values indicate stronger legal and political rights for women. The coefficients θ_{1i} to θ_{5i} represent the long-run elasticities of gender inequality with respect to each explanatory variable. φ_i is the error-correction coefficient, which measures the speed at which deviations from long-run equilibrium are corrected and is expected to be negative and statistically significant. β_{kij} are the short-run coefficients for lagged first differences of the independent variables. μ_i is Country-specific fixed effects, and ε_{it} is the residual term. Detailed definitions and data sources for all variables are documented in Appendix B.

4. Empirical Results and Discussion

4.1 Descriptive Statistics and Correlation Analysis

Table 1 reports the descriptive statistics of the sample. The average gender inequality index (GEN) is 0.39, reflecting a moderate level of gender inequality across middle-income countries during the period 2000–2023. The mean value of FDI is 4.22, indicating a steady inflow of foreign investment relative to GDP, while the average female primary school enrollment rate (EDU) stands at 55.78%.

Table 2 presents the Pearson correlation matrix. All correlation coefficients remain below the conventional threshold of 0.7, suggesting the absence of serious multicollinearity concerns among the explanatory variables. This supports the reliability of the subsequent econometric estimations.

Table 1. Descriptive Statistics

Variables	Obs.	Mean	Std. Dev.	Min	Max
GEN	432	0.3925	0.1205	0.1070	0.7450
FDI	432	4.2266	6.1938	−37.1727	55.0729
EDU	432	55.7808	45.6158	0.0000	99.9956
POL	432	71.7260	13.8067	38.1250	95.0000
HEL	432	73.3103	6.5236	44.8490	82.0980
LAB	432	49.0460	12.2208	19.5840	72.2050

Source: Authors' calculations.

Note: Table 1 reports the sample descriptive statistics. All variable definitions are documented in Appendix B. Data is collected from the World Bank and the OWD.

Table 2. Pearson Correlation Matrix

Variables	GEN	FDI	EDU	POL	HEL	LAB
GEN	1.000					
FDI	−0.150*** (0.0018)	1.000				
EDU	−0.108** (0.0253)	−0.012 (0.7980)	1.000			
POL	−0.303*** (0.0000)	0.114** (0.0181)	−0.045 (0.3528)	1.000		
HEL	−0.668*** (0.0000)	0.050 (0.3006)	−0.144*** (0.0027)	0.263*** (0.0000)	1.000	
LAB	−0.106** (0.0280)	0.209*** (0.0000)	−0.127*** (0.0081)	0.395*** (0.0000)	−0.115** (0.0165)	1.000

Source: Authors' calculations.

Note: Table 2 presents the sample Pearson correlation matrix for the independent variables. All variable definitions are reported in Appendix B. The data are collected from the World Bank and the OWD. The symbols ***, **, and * denote significance at the 1%, 5%, and 10% levels, respectively. P-values are provided in parentheses.

4.2 Unit Root and Cointegration Results

Table 3 reports the results of the Pesaran (2007) CIPS panel unit root test. The findings indicate a mixed order of integration, with GEN, FDI, HEL, and POL being stationary at levels, while EDU and LAB become stationary after first differencing. Importantly, no variables are integrated of order two, confirming the suitability of the panel ARDL framework.

Table 4 presents the Westerlund (2007) panel cointegration test, where the null hypothesis of no cointegration is rejected. This confirms the existence of a stable long-run equilibrium relationship between gender inequality and its determinants.

Table 3. Panel Unit Root Test Results

Variable	Level CIPS	Order of Integration
GEN	-2.286**	I(0)
FDI	-3.244***	I(0)
EDU	-2.016	I(1)
HEL	-2.682**	I(0)
POL	-2.238**	I(0)
LAB	-1.704	I(1)
Δ EDU	-4.771***	I(0)
Δ LAB	-3.888***	I(0)

Source: Authors' calculations.

Note: Significance level: *** (1%) = -2.38; ** (5%) = -2.20; * (10%) = -2.11.

Table 4. Panel Co-integration Test

Westerlund (2007) Test	Statistic	p-value
Variance ratio	2.2094**	0.0136

Source: Authors' calculations.

Note: ***, **, and * denote statistical significance at the 1%, 5%, and 10% levels, respectively.

4.3 Lag Selection and Model Specification

Based on the Akaike Information Criterion (AIC), Table 5 indicates that an ARDL (2,2,2,2,2,2) specification is optimal. This specification captures the persistence and delayed effects inherent in macroeconomic relationships across heterogeneous middle-income economies.

Table 5. Optimal ARDL Lag Selection

Unit	GEN	FDI	EDU	POL	HEL	LAB
1	2	0	1	2	2	2
2	2	2	0	1	0	2
3	2	2	0	2	2	2
4	2	2	2	2	2	2
5	2	2	2	2	1	0
6	2	2	2	2	2	2
7	2	0	2	2	0	2
8	1	0	0	0	2	2

Unit	GEN	FDI	EDU	POL	HEL	LAB
9	1	0	1	2	1	2
10	2	1	1	2	2	2
11	2	0	0	0	0	0
12	1	2	1	2	2	1
13	2	2	2	2	1	0
14	2	2	1	1	2	1
15	2	2	2	2	1	2
16	2	1	2	1	2	2
17	1	0	0	2	2	0
18	1	2	2	2	2	1

Source: Authors' calculations.

Note: Selected Model: ARDL (2,2,2,2,2,2)

4.4 Short-Run Dynamics and Long-Run Estimates

Table 6 presents the short-run dynamics from the PMG-ARDL model. The results show that none of the key explanatory variables—including FDI, education, political rights, health, and labor force participation—have a statistically significant effect on gender inequality in the short run. This suggests that structural changes require time to materialize and are not immediately reflected in gender inequality outcomes.

The error correction term (ECM) is negative and statistically significant, confirming the presence of a stable long-run equilibrium. Approximately 19.5% of short-run deviations are corrected in each period, indicating gradual adjustment toward equilibrium.

In contrast, Table 7 reports the long-run coefficients, revealing that FDI, education, and female health have statistically significant negative effects on gender inequality. These findings imply that over time, increased foreign investment, improved educational attainment, and better health outcomes contribute to reducing gender disparities.

Table 6. Short-Run Dynamics and Error-Correction Results from the PMG-ARDL Model

Variable	Coefficient	Std. Error	t-statistic	p-value
ECM(−1)	−0.1951***	0.0689	−2.83	0.005
ΔGEN(−2)	−0.0951	0.0951	−1.00	0.317
ΔFDI	−0.00005	0.0008	−0.06	0.953
ΔFDI(−2)	−0.0013	0.0017	−0.75	0.453
ΔEDU	0.0001	0.0001	1.34	0.181
ΔEDU(−2)	−0.00006	0.00008	−0.84	0.402
ΔPOL	−0.0002	0.0006	−0.43	0.670
ΔPOL(−2)	0.0003	0.0005	0.52	0.602
ΔHEL	−0.0004	0.0011	−0.41	0.683
ΔHEL(−2)	0.0030	0.0041	0.72	0.469
ΔLAB	0.0048	0.0069	0.69	0.492
ΔLAB(−2)	−0.0072	0.0057	−1.25	0.210
Constant	0.1717***	0.0634	2.71	0.007

Source: Authors' calculations.

Note: Δ denotes first differences. ECM is the error-correction term derived from the long-run relationship. The symbols ***, **, and * represent significance levels of 1%, 5%, and 10%, respectively.

Table 7. Long-Run Estimates from the PMG-ARDL Model

Variable	Coefficient	Std. Error	z-statistic	p-value
FDI	−0.0052***	0.0009	−5.33	0.000
EDU	−0.0005***	0.0001	−4.84	0.000
POL	−0.0004	0.0002	−1.54	0.124
HEL	−0.0053***	0.0008	−6.53	0.000
LAB	−0.0007	0.0007	−0.96	0.340

Source: Authors' calculations.

Note: The dependent variable is the first difference of gender inequality (Δ GEN). Long-run coefficients are derived from the error-correction term (ECM) in the PMG-ARDL framework. ***, ** and * represent significance levels of 1%, 5% and 10%, respectively.

4.5 Interpretation of Short-Run Dynamics

The absence of significant short-run effects can be explained by structural and behavioral adjustment mechanisms. For education, the positive but statistically insignificant coefficient suggests a potential “opportunity cost” effect: increased school enrollment may temporarily reduce female labor force participation, thereby not immediately improving gender equality indicators (Cin et al., 2020; Lee, 2014). In resource-constrained households, the immediate financial burden of schooling may also crowd out resources that would otherwise support women’s empowerment.

Similarly, the insignificant short-run effect of FDI indicates that foreign capital inflows require a gestation period before influencing labor markets and institutional structures. In many middle-income economies, FDI initially concentrates in capital-intensive or export-oriented sectors, which generate limited employment opportunities for women and offer weak spillovers into female-oriented services (Lee, 2014).

Taken together, these findings highlight that without complementary institutional reforms—such as strengthening education governance, enforcing gender-inclusive labor regulations, and directing FDI toward more inclusive sectors—neither education nor foreign investment alone can produce immediate improvements in gender equality (Cin et al., 2020; Lee, 2014).

4.6 Interpretation of Long-Run Relationships

In contrast to short-run results, the long-run estimates reveal that both education and FDI act as structural drivers of gender equality. From a human capital perspective, investments in female education enhance productivity, skill acquisition, and access to higher-quality employment. Over time, this accumulation of human capital strengthens women’s bargaining power within households and labor markets and facilitates participation in formal and higher-paying sectors (Becker, 1994).

Importantly, the divergence between insignificant short-run effects and significant long-run impacts suggests that education operates through gradual structural transformation rather than immediate adjustment. This dynamic underscores the presence of transition costs, labor market rigidities, and occupational segmentation that delay observable outcomes.

The negative and statistically significant coefficient of FDI further suggests that, over time, foreign investment contributes to reducing gender inequality. While multinational enterprises may initially rely on low-cost female labor in labor-intensive industries, their long-term presence generates a “modernization effect.” Through technology transfer, adherence to global labor standards, and integration into

international value chains, multinational firms tend to promote more formal and less discriminatory employment practices (Blanton & Blanton, 2015; Bui et al., 2018). This finding is also consistent with modernization and eclectic theories, which emphasize the role of foreign investment in facilitating structural transformation toward more inclusive economic systems.

Health (HEL) also exerts a significant negative effect on gender inequality, reinforcing the multidimensional nature of human capital development. Improved female life expectancy enhances long-term labor force participation and career continuity, thereby contributing to sustained empowerment (Brzozowski, 2013). Overall, these findings are consistent with prior empirical studies documenting the long-run equalizing effects of education and FDI on gender inequality (Blanton & Blanton, 2015; Bui et al., 2018).

4.7 Model Selection, Sub-Sample Analysis, and Robustness

Table 8 presents the Hausman test results, which confirm the appropriateness of the PMG estimator. The findings indicate that long-run coefficients are homogeneous across countries, while short-run dynamics remain heterogeneous. This is consistent with the structural similarities among middle-income economies, despite differences in short-term policy responses and institutional settings (Ho et al., 2025).

To further examine heterogeneity, the sample is divided into lower-middle-income and upper-middle-income countries. The results, reported in Table 9, reveal that the equalizing impact of FDI is more pronounced in upper-middle-income economies. This suggests that stronger institutional frameworks and higher absorptive capacity enhance the ability of these economies to translate foreign investment into inclusive labor market outcomes.

Education continues to exhibit a consistent negative effect on gender inequality across both sub-samples, reinforcing its role as a fundamental long-term driver. In contrast, short-run effects remain statistically insignificant across both groups, supporting the conclusion that structural variables operate primarily through long-term channels.

Table 8. Hausman Tests for Model Selection

Panel A. Hausman Test: Mean Group (MG) vs. Pooled Mean Group (PMG)				
Variable	MG	PMG	Difference (MG – PMG)	Std. Error
FDI	–0.0182	–0.0052	–0.0130	0.0073
EDU	–0.0008	–0.0005	–0.0003	0.0006
POL	–0.0015	–0.0004	–0.0011	0.0038
HEL	0.0243	–0.0054	0.0297	0.0221
LAB	–0.0194	–0.0008	–0.0186	0.0116
Panel B. Hausman Test: Dynamic Fixed Effects (DFE) vs. Pooled Mean Group (PMG)				
Variable	DFE	PMG	Difference (DFE – PMG)	Std. Error
FDI	–0.0019	–0.0052	0.0032	0.0012
EDU	–0.0002	–0.0005	0.0004	0.0002
POL	–0.0021	–0.0004	–0.0016	0.0014
HEL	–0.0097	–0.0054	–0.0043	0.0045
LAB	–0.0024	–0.0008	–0.0016	0.0024

Source: Authors' calculations.

Note: Panel A: Hausman statistic: $\chi^2(5) = 6.61$, p -value: 0.2514. Panel B: Hausman statistic: $\chi^2(5) = 19.05$, p -value: 0.0019

Table 9. PMG–ARDL Estimates for Gender Inequality

Variable	Lower middle income	Upper middle income	Full sample
Panel A. Long-run coefficients			
FDI	−0.0042*** (−2.87)	−0.0057*** (−3.07)	−0.0052*** (−5.33)
EDU	−0.0002*** (−3.49)	−0.0002** (−2.04)	−0.0005*** (−4.84)
POL	−0.0001 (−0.34)	−0.0015** (−2.34)	−0.0004 (−1.54)
HEL	−0.0129*** (−13.23)	−0.0143*** (−4.55)	−0.0053*** (−6.53)
LAB	−0.0086*** (−10.72)	0.0036*** (2.93)	−0.0007 (−0.96)
Panel B. Short-run dynamics			
ECM(−1)	−0.4195* (−1.76)	−0.1889** (−2.02)	−0.1951*** (−2.83)
ΔGEN(−2)	0.0254 (0.12)	−0.1204 (−0.92)	−0.0951 (1.00)
ΔFDI	0.0017 (0.39)	0.0002 (0.57)	−0.00005 (−0.06)
ΔFDI(−2)	−0.0066 (−0.93)	−0.00007 (−0.07)	−0.0013 (−0.75)
ΔEDU	0.0003 (0.88)	0.00001 (0.09)	0.0001 (1.34)
ΔEDU(−2)	−0.00004 (−0.53)	−0.00006 (−0.55)	−0.00006 (−0.84)
ΔPOL	0.0015 (1.63)	−0.0009 (−1.18)	−0.0002 (−0.43)
ΔPOL(−2)	0.0013 (0.75)	0.0012** (2.01)	0.0003 (0.52)
ΔHEL	0.00006 (0.02)	−0.0004 (−0.28)	−0.0004 (−0.41)
ΔHEL(−2)	−0.0086 (−1.09)	0.0030 (0.52)	0.0030 (0.72)
ΔLAB	0.0168 (1.09)	−0.0036** (−2.13)	0.0048 (0.69)
ΔLAB(−2)	−0.0114 (−1.07)	−0.0017 (−1.35)	−0.0072 (−1.25)
Constant	0.7232* (1.64)	0.2703* (1.95)	0.172*** (2.71)

Source: Authors' calculations.

Note: Z-statistics in parentheses. ***, **, and * denote significance at the 1%, 5%, and 10% levels, respectively.

4.8 Causality Analysis

Table 10 reports the results of the panel Granger causality test. The findings indicate bidirectional causality between gender inequality and key variables such as FDI, education, health, political rights, and labor force participation.

This suggests that gender equality is not only an outcome of economic development but also a driver of it. Improvements in gender parity can enhance human capital formation, attract higher-quality investment, and foster more inclusive growth dynamics. This reinforcing relationship underscores the importance of proactive policymaking, as economies cannot rely solely on growth to resolve inequality but must actively leverage education and investment channels. These findings align with prior studies emphasizing the mutually reinforcing relationship between gender equality, investment, and development outcomes (Blanton & Blanton, 2015; Brzozowski, 2013).

Table 10. Granger Causality Results

Null Hypothesis	Z-bar	p-value	Causality
FDI → GEN	2.3108**	0.0208	Yes
GEN → FDI	2.6606***	0.0078	Yes
EDU → GEN	1.6501*	0.0989	Yes
GEN → EDU	2.5673**	0.0103	Yes
EDU → FDI	1.2067	0.2276	No
FDI → EDU	0.1410	0.8879	No
HEL → GEN	11.0750***	0.0000	Yes
GEN → HEL	5.7862***	0.0000	Yes
POL → GEN	4.9810***	0.0000	Yes
GEN → POL	2.4138**	0.0158	Yes

Null Hypothesis	Z-bar	p-value	Causality
LAB → GEN	3.5533***	0.0004	Yes
GEN → LAB	2.3894**	0.0169	Yes

Source: Authors' calculations.

Note: ***, **, * denote significance at the 1%, 5%, and 10% levels, respectively.

5. Conclusions

This study examined the impact of foreign direct investment (FDI), education, and key macro-social factors on gender inequality in middle-income countries using a panel ARDL framework over the period 2000–2023. The findings reveal a clear distinction between short-run dynamics and long-run structural relationships.

In the short run, neither FDI nor education exerts a statistically significant effect on gender inequality, suggesting that improvements in gender equality do not occur instantaneously and are constrained by transitional dynamics, including labor market rigidities and adjustment costs.

In contrast, the long-run estimates demonstrate that both FDI and education significantly reduce gender inequality. These findings indicate that gender equality improvements are primarily driven by gradual structural transformation rather than immediate policy shocks. Education contributes through human capital accumulation, enhancing women's productivity, labor market participation, and bargaining power, while FDI promotes modernization through formal employment creation, technology transfer, and the diffusion of less discriminatory labor practices.

The results further confirm the importance of complementary dimensions of human capital, particularly health, in sustaining gender equality outcomes. Moreover, the bidirectional causality between gender inequality and key explanatory variables suggests a reinforcing relationship, where improvements in gender equality not only result from development processes but also contribute to them.

Overall, this study contributes to the applied economics literature by demonstrating that gender inequality in middle-income countries is shaped by long-run structural forces, with limited responsiveness to short-term fluctuations. The findings emphasize the importance of adopting a long-term perspective when designing policies aimed at promoting inclusive growth and gender equality.

Despite these contributions, this study acknowledges several limitations. First, the analysis is restricted to middle-income economies, which may limit the generalizability of the findings to other income groups. Second, the use of aggregate macro-level data and a composite gender inequality index may mask within-country heterogeneity and overlook important dimensions such as informal employment and unpaid care work. Third, although the PMG-ARDL framework effectively captures dynamic relationships, macro panel data may still be subject to potential endogeneity concerns.

Future research could address these limitations by employing micro-level data, distinguishing between different types of FDI and education, and applying alternative econometric approaches to provide more granular and causally robust insights into the determinants of gender inequality.

6. Policy Implications

The findings of this study carry several important implications for policymakers in middle-income countries.

First, the absence of significant short-run effects suggests that policies aimed at reducing gender inequality should be designed with a long-term perspective. Short-term interventions alone are unlikely to produce immediate outcomes without sustained institutional support and structural reforms.

Second, the strong long-run impact of education underscores the need for continued investment in female education, not only in terms of access but also in quality and completion rates. Policymakers should focus on reducing structural barriers—such as financial constraints and gender-based disparities in schooling—to ensure that educational gains translate into improved labor market outcomes.

Third, while FDI contributes to reducing gender inequality in the long run, its benefits are not automatic. Governments should implement targeted strategies to channel FDI into sectors with higher female employment potential and enforce labor market regulations that promote gender-inclusive hiring practices.

Fourth, the significant role of health highlights the importance of adopting a multidimensional policy approach. Expanding access to healthcare and improving female well-being can enhance long-term labor force participation and productivity, thereby reinforcing gender equality outcomes.

Finally, given the bidirectional relationship between gender equality and economic development, gender-inclusive policies should be treated as a central component of development strategy. Improving gender equality can enhance human capital formation, attract higher-quality investment, and support more inclusive and sustainable economic growth.

7. Ethics Statement

This study used secondary data from publicly available sources and did not involve human participants, personal identifiable information, or primary data collection. Therefore, ethics committee approval was not required.

8. References

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9. Appendix

Table 11. List of Selected Middle-Income Nations

Number	Country Name	Country Code
1	Albania	ALB
2	Armenia	ARM
3	Azerbaijan	AZE
4	Bangladesh	BGD
5	Belize	BLZ
6	Bolivia	BOL

Number	Country Name	Country Code
7	El Salvador	SLV
8	Georgia	GEO
9	Indonesia	IDN
10	Lesotho	LSO
11	Malaysia	MYS
12	Mauritius	MUS
13	Mongolia	MNG
14	Morocco	MAR
15	Peru	PER
16	Thailand	THA
17	Tunisia	TUN
18	Uzbekistan	UZB

Source: Authors' compilation.

Table 12. Variable Definitions

Variables	Notation	Variable Descriptions	Source
Dependent Variable			
Gender Inequality Index	GEN	The gender inequality index measures discrimination against women across three dimensions: reproductive health, empowerment, and the labor market. Scores range from 0 to 1, with higher values indicating greater inequality. (Permanyer, 2013)	Our world in data
Independent Variables			
Foreign direct investment (%)	FDI	Foreign direct investment refers to net direct investment inflows in an economy (Anyanwu, 2016; Ho et al., 2025; Le et al., 2023; Le et al., 2024; Nghiem et al., 2024)	World Bank
Education (%)	EDU	Education is measured by the female enrollment rate in primary schooling (Brzozowski, 2013).	World Bank
Control Variables			
Health	HEL	Female life expectancy at birth is used as a proxy for female health conditions (Brzozowski, 2013).	World Bank
Women's Political Rights	POL	Following Blanton and Blanton (2015), the Women's Business and the Law Index is a metric that gauges Women's Political Rights, with a scale ranging from 0 to 100. An increase in the score indicates progress towards women acquiring democratic rights. If women hold fewer than 5% of the seats in the national legislature or essential cabinet positions, their representation in central elected office is virtually nonexistent.	World Bank
Labour (%)	LAB	LAB is measured as the percentage of women aged 15 and above who are economically active, defined as either employed or actively seeking employment, relative to the total	World Bank

Variables	Notation	Variable Descriptions	Source
		female population aged 15 and above (Dalemans et al., 2008; Nguyen et al., 2024).	

Source: Authors' compilation.