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Analyzing the Relationship Between Remittances, Financial Development, and Income Inequality in the Informal Economy of Selected Developing Countries: A System GMM Approach

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ABSTRACT

In developing countries, remittances and financial development are two key factors influencing income inequality. This study examines the simultaneous relationships among remittances, financial development, and the Gini coefficient, with a particular focus on the informal economy. The distinction between formal and informal sectors is crucial, as financial channels in the formal economy—such as the banking system, regulations, and taxation—differ significantly from informal pathways, including black markets and underground financial activities. Consequently, the effects of remittances and financial institutions on inequality may vary across these sectors. Using a simultaneous equation framework estimated with System Generalized Method of Moments (System GMM) for the period 2010–2023, the study also incorporates control variables including inflation, exchange rate, government size, education level, and trade openness. The findings indicate that remittances in the informal sector positively and significantly affect financial development, while income inequality negatively impacts it. Financial development in the informal sector significantly reduces inequality, whereas remittances in both formal and informal sectors increase income inequality. Bidirectional relationships among the main variables highlight their dynamic interactions, with the informal economic structure moderating the magnitude and direction of these effects. The results underscore the importance of strengthening formal financial institutions, enhancing financial depth, and effectively managing remittance flows to reduce inequality and improve economic performance in developing countries.

KEYWORDS: Informal employment, remittances, Financial Development, Income Inequality.

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1. Introduction

The distribution pattern in any economy is influenced by both its formal and informal sectors. In recent decades, the informal sector has attracted considerable attention from policymakers, economists, and even statisticians. The expansion of urbanization, coupled with insufficient job creation commensurate with this growth, has led to the proliferation of the informal sector within economies (Salimi-Far & Keyvanfar, 2010). A more accurate estimation of the informal sector can facilitate the examination of its impact on income distribution. Moreover, this effect may vary depending on the level of economic development.

Adequate understanding of the mechanisms of influence and causal relationships among key decision-making variables can enhance policy formulation in critical areas—particularly policies such as social protection and taxation schemes, which entail extensive repercussions. Iran ranks among countries with high emigration rates, with substantial numbers of students, specialists, and investors departing annually. After securing employment abroad, these migrants remit portions of their income to their families in the country of origin through both formal and informal channels; such transferred income is termed *remittances*. Neglecting the impact of these remittance inflows within the national economy may result in biased estimates of the relationships between major economic variables and income inequality.

Some economists contend that the effect of financial development on income inequality depends on the degree of financial development attained by a country. They argue that an optimal threshold level of financial development indicators is necessary to reduce income inequality. Financial development can profoundly influence access to credit and financial services for the poor, thereby enhancing borrowers' access to credit facilities (Davoudi & Khoshnami, 2022). Financial development exists when financial instruments, markets, and intermediaries reduce though do not eliminate the costs associated with information, enforcement, and transaction. Determinants of a country's level of financial development include historical factors encompassing legal, political, cultural, ethical, and geographical components as well as policy-related factors such as the macroeconomic and political environment, institutional infrastructure, legal and informational frameworks, regulatory and supervisory systems, competition and efficiency mechanisms, financial liberalization, and facilitation of access to financial services (Dahmardeh & Shokri, 2010).

Conversely, Sayan (2006) posits that remittance flows function as a macroeconomic stabilizer and occasionally exhibit countercyclical behavior, with their volume increasing in developing countries during economic downturns. Consequently, remittances themselves are inherently linked to the level of financial development.

Remittances enter recipient countries through both formal and informal channels (World Bank, 2011). When transmitted via formal channels—which include bank transfers and money transfer organizations—they contribute to the growth of the financial sector. Such growth materializes when recipients open accounts at commercial banks upon receiving funds. Furthermore, when individuals visit banks, they may acquire information about banking services and subsequently

apply for loans. If the impact of remittances on the financial sector proves substantial, greater financial development may be anticipated (Sena & Naderi, 2017). Informal remittance channels encompass mechanisms such as cash transfers by friends or acquaintances, cryptocurrency transfers converted to local currency domestically, and the purchase of goods abroad for resale within the home country.

Examining the effects of remittances and financial development on income inequality independently and solely within the context of the formal economy cannot yield an accurate analysis of the underlying determinants of income inequality. Therefore, this study aims to investigate the impact of remittances, financial development, and the Gini coefficient on income distribution. Utilizing the panel vector autoregression (PVAR) methodology, it estimates the relationship between remittances and income distribution while accounting for financial development across both formal and informal sectors in a selected sample of developing countries.

2. Theoretical Foundations

Contrary to prevailing public perception, emigration can generate economic benefits for the country of origin. Beyond facilitating cultural exchange between origin and destination countries, migration can also enhance trade and financial flows between them. Among the most significant financial flows generated through migration is remittances.

The capacity of migrant workers and their willingness and motivation to remit income constitute the two primary determinants of remittance behavior. The income level and savings capacity of overseas workers determine their ability to send remittances. Additional factors influencing migrants' remittance decisions include duration of residence abroad, family status, and network effects. The length of stay—whether temporary, long-term, or permanent—directly affects the volume of remitted income. Marital status and the number of children also influence the amount of funds transferred. Finally, network effects—which reflect patterns of individual or family migration and kinship ties—represent another influential factor shaping the volume of income remitted by overseas workers (Naderi et al., 2019).

The inflow of remittances to developing countries and their economic impact have attracted substantial attention from economic researchers and policymakers, particularly given their volume exceeding $766.85 billion in 2022 (World Bank, 2024). Following foreign direct investment, workers' remittances constitute the second-largest source of foreign currency inflows to developing countries, surpassing official development assistance. Moreover, substantial evidence indicates that a significant portion of these funds remains unreported or is transferred through informal channels (Sina & Naderi, 2017). This phenomenon is especially pronounced in countries such as Iran, which face international sanctions and consequently experience restricted access to formal foreign exchange transfer mechanisms.

Although income distribution is fundamentally shaped by a country's political economy, the volume of external financial inflows (under various classifications) and the level of financial development can significantly influence distributional patterns. Consequently, even in countries

that embrace market mechanisms for resource allocation, these extra-market income flows are distributed outside formal market structures, thereby affecting macroeconomic variables in both public and private sectors. The volume of remittance inflows and their locus of impact differ substantially between developed and developing economies. Regarding remittances' effects on poverty and inequality, diverse theoretical propositions have been advanced—some of which have received empirical validation. Furthermore, the mechanism through which remittances influence income distribution may vary when financial development is considered as a conditioning variable. Whether remittances function as complements to or substitutes for financial development in shaping income distribution warrants systematic investigation.

The impact of remittances on certain variables, such as inequality indices, may exhibit dual or contradictory effects. For instance, remittances—serving as a mechanism to support relatives of migrants who remain in the country of origin—can contribute to poverty reduction and enhanced welfare in recipient countries, thereby improving per capita income levels. Conversely, they may exacerbate income disparities between urban and rural regions, as remittances in urban areas tend to be channeled predominantly toward financial investments rather than consumption (Nyamongo et al., 2014). Additionally, some scholars (Chami et al., 2003) argue that remittances may diminish the labor supply incentives of recipient households, increase financial dependency on these inflows, and ultimately constrain economic growth. Furthermore, empirical observations across numerous countries indicate that remittance volumes often increase during economic recessions to compensate for declining domestic incomes. Particularly in countries experiencing high exchange rate volatility, external financial transfers can serve as a stabilizing mechanism for recipient households' economic security.

Extensive research has examined the reciprocal relationships between various economic variables and remittances. However, the significance and role of remittances—when analyzed in conjunction with financial development and differentiated by the formal and informal sectors of the economy—have received comparatively limited scholarly attention. One methodological approach to elucidating the interrelationships among remittances, financial development, and the Gini coefficient within both formal and informal economic sectors of developing countries involves utilizing panel data techniques. This analytical strategy becomes feasible through comparative assessment of remittances' effects on the Gini coefficient while accounting for financial development across formal and informal economic segments within these nations.

2.1. The Relationship Among Remittances, Financial Development, and Income Inequality in the Informal Sector

The relationships among remittances, financial development, and income inequality in developing countries exhibit distinctive complexity and multidimensionality. Remittances—defined as financial flows from migrant households to countries of origin—constitute not only a significant income source but may also facilitate financial development by enhancing household savings, strengthening bank deposits, and improving access to financial services (Ratha, 2013; Adams &

Cuecuecha, 2010). Particularly for low-income households, remittance inflows can play an inequality-reducing role and generate new economic opportunities (World Bank, 2019). However, these positive effects depend critically on the presence of formal and efficient financial structures; in their absence, remittance resources may flow through informal channels, thereby diminishing their desirable economic impact.

Financial development—conceptualized as the depth, breadth, and efficiency of formal financial systems—enhances countries' capacity to absorb and allocate financial resources effectively, playing a pivotal role in leveraging remittance flows productively (Levine, 2005). Nevertheless, empirical research demonstrates that the effect of remittances on financial development diminishes in countries with extensive informal sectors, as portions of these flows circumvent formal channels and are diverted into informal pathways (Chami et al., 2008). Consequently, the informal economy functions as a key moderating variable that may attenuate remittances' positive impact on financial development while simultaneously constraining their distributive effects on income inequality.

The informal economy encompasses economic activities operating outside the formal purview of government regulation and financial systems. The presence of a substantial informal sector reduces public trust in banking systems and demand for formal financial services, thereby limiting countries' financial development potential. Moreover, informal activities typically generate unstable, low incomes lacking social protection, ultimately contributing to heightened income inequality (Loayza, 2016). Therefore, analyzing the relationships among remittances, financial development, and inequality without accounting for the informal economy yields an incomplete assessment.

Income inequality is shaped by the interaction between remittances and financial development. Remittance flows may reduce income gaps by augmenting the incomes of low-income households; however, financial development exerts a dual effect on inequality depending on the distribution of access to financial resources. Equitable access to financial services reduces inequality, whereas concentration of financial resources among specific groups may exacerbate it (Beck et al., 2007). In countries characterized by large informal sectors and weak institutions, these dual effects acquire greater complexity, rendering analysis of interrelationships incomplete without simultaneous modeling.

Recent research emphasizes the importance of analyzing simultaneous systems, as remittances, financial development, and income inequality mutually influence one another. Only simultaneous analysis can adequately reveal the causal mechanisms linking these variables (Aghion et al., 1999). This theoretical framework indicates that effective policymaking in remittance and financial development domains requires institutional reforms, formalization of economic activities, tax transparency, and establishment of reliable financial infrastructure to fully realize remittances' positive effects on financial development and inequality reduction.

2.2. Previous Studies

Sina and Naderi (2018), in their article titled "Examining the Effect of Remittances on Financial Development in Iran," investigated the impact of remittance inflows on Iran's financial sector development using data spanning 1980–2015. Following theoretical framework elaboration, they introduced three financial development indicators: the ratio of credit to the private sector to GDP, the ratio of bank credit to GDP, and liquid liabilities. After model specification, they employed the autoregressive distributed lag (ARDL) econometric approach to examine remittances' effects on each indicator separately. Results indicated that remittances exert a small negative effect on financial development in the short run; conversely, they demonstrate a positive and statistically significant impact on financial development in Iran over the long term.

Saadat et al. (2019), in their article titled "Reciprocal Relationship Between Real Exchange Rate Volatility and Remittance Volatility in Selected Developing Countries: A Simultaneous Equations Approach," addressed efficiency as a solution to environmental crises. Given the importance of environmental issues alongside economic growth and development concerns, they examined this matter through the lens of energy efficiency. Specifically, the study investigated the effects of energy intensity (as a common energy efficiency indicator), population, wealth (per capita income), and energy consumption on carbon dioxide emissions (as an environmental quality indicator) using panel data methods for the period 1996–2010. Individual and time effect tests, along with the Hausman test, confirmed a one-way random effects model for CO_2 emissions across the sampled countries. Findings revealed that population, wealth, energy consumption, and energy intensity all exert positive and statistically significant effects on CO_2 emissions. Furthermore, the high coefficient associated with the primary variable under investigation (energy intensity) substantiates the importance of prioritizing energy efficiency within environmental policy frameworks.

Naderi et al. (2019), in their article titled "Examining Factors Affecting Real Exchange Rate Volatility in Iran with Emphasis on Migrants' Remittance Income: An Autoregressive Distributed Lag Approach," empirically analyzed factors influencing Iran's real exchange rate volatility with emphasis on migrants' remittance income using the ARDL methodology for the period 1980–2017. Three methods for quantifying volatility were presented, and after selecting the optimal approach, the research model was estimated. Results indicated that migrants' remittance income exerts a positive and significant long-run effect on Iran's exchange rate, contributing to real exchange rate volatility; however, these inflows demonstrate a negative short-run effect on the exchange rate. Additionally, among the research variables, per capita gross domestic product exhibited the strongest influence on real exchange rate volatility in both the short and long run.

Homayunifar and Cheshmi (2016), in their article titled "Examining the Impact of Financial Development on Income Inequality in Selected Islamic Countries," investigated the effect of financial development on the Gini coefficient as an income inequality measure for selected Islamic countries during 1994–2011 using panel data methodology. Model estimation results demonstrated that financial development indicators—both banking and non-banking—exert an inverse effect on

income inequality. The hypothesis of a linear relationship between financial development and income inequality was confirmed. Among control variables, inflation exhibited an inverse effect while gross domestic product exerted a direct effect on income inequality reduction.

Dahmardeh and Shokri (2010), in their article titled "The Effects of Financial Development on Income Distribution in Iran," noted that while the relationship between financial development and economic growth has been extensively examined in economic literature, limited research has addressed how financial markets influence income inequality. This study aimed to investigate the relationship between financial development and income distribution in Iran using the autoregressive distributed lag (ARDL) model, with the Gini coefficient serving as the income inequality indicator and the ratio of credit to the private sector to GDP representing financial development. Results derived from the estimated model indicated that financial development reduces income inequality in Iran.

Malla et al. (2023), in their article titled "Remittances, Financial Development, and Income Inequality: A Quantile Regression Approach," examined the relationship among remittances, financial development, and income inequality across a sample of 70 developing countries from 1984 to 2019. They investigated whether remittances and financial development function as substitutes or complements in reducing inequality and found evidence that in more unequal countries, remittances act as substitutes for financial development in mitigating inequality. Conversely, in countries with lower inequality levels, remittances serve as complements to financial development in inequality reduction. Second, they observed that the substitution effect of remittances outweighs their complementary effect. Finally, while prior studies assumed homogeneous impacts of remittances and financial development on inequality, they demonstrated that these variables exert heterogeneous effects across the entire income inequality distribution.

Khan et al. (2022), in their article titled "How Do Foreign Aid and Remittances Affect Poverty in MENA Countries," examined the relationship among economic growth, poverty, inequality, remittances, and foreign aid in Middle East and North Africa (MENA) countries using panel data methods for the period 1991–2019. Empirical findings indicated that remittances, foreign aid, and economic growth play significant roles in reducing poverty levels across the MENA region. Furthermore, despite negative income growth, an increase in income share accruing to the lowest quintile was observed, suggesting that the average income of poor individuals has risen more rapidly relative to non-poor households. Consequently, this study provides evidence supporting the hypothesis that remittances and foreign aid increase both per capita income and income share in MENA member countries.

Gallizi and Zaiat (2019), in their article titled "The Causal Relationship Between Remittances and Poverty Reduction in Developing Countries: Evidence from Dynamic Panel Data," investigated the causal relationship between remittances and poverty reduction across 14 emerging and developing countries during 1980–2012. They employed a cointegration analysis utilizing dynamic panel data methodology. Estimation results revealed a bidirectional causality between poverty and remittances. Moreover, they found that the causal effect of poverty reduction on remittances is

stronger than the reverse effect. Indeed, despite remittances' relatively modest impact on poverty, they warrant serious policy consideration—an objective achievable through measures adopted by developed countries to facilitate migrants' access to host territories. Such initiatives could partially mitigate inequalities in developing countries.

Chatterjee and Turnovsky (2018), in their article titled "Remittances and the Informal Economy," developed a general equilibrium framework to better understand the dynamic absorption of remittances within a small open dual-sector economy incorporating key features of an informal sector. Model calibration to generate a long-run equilibrium consistent with sample averages for 56 developing countries during 1990–2014 demonstrated that remittances' impact critically depends on how they affect recipient economies—specifically whether these flows are (i) permanent or temporary, (ii) associated with collateral effects for securities and borrowing, and (iii) exogenous or countercyclical. The study also identified conditions under which remittances correlate with informal sector expansion as well as Dutch disease effects.

Gërxhani et al. (2017), in their article titled "Measuring the Dynamic Effects of Remittances on Poverty and Inequality: Evidence from Kosovo," examined the dynamic effects of remittances on poverty and household income distribution. Employing an impulse-response function approach—applied for the first time to evaluate poverty effects resulting from temporal variations in remittance receipts—they found that remittances reduce both absolute and relative poverty levels while generating a marginal increase in inequality within the Kosovo context. They further demonstrated that although poverty-reduction effects are stronger in the short run, remittances exert a positive long-term impact on poverty alleviation. These findings carry significant welfare policy implications for low- and middle-income economies exhibiting high dependence on remittance inflows.

3. Research Methodology

3.1. Model Specification and Variable Definitions

To simultaneously identify the interrelationships among remittances (REM), financial development (FD), and income inequality (GINI), the following system of two simultaneous equations is specified. Control variables—including inflation, government size, education, trade openness, and exchange rate—are incorporated into the respective equations based on established literature. Given the pivotal role and bidirectional relationships between the informal economy and each of remittances (REM), financial development (FD), and inequality (GINI), it is theoretically and structurally logical to include the size of the informal economy (SE) as an explanatory variable in both primary equations. Accordingly, the system is formulated as follows:

$$(1)\ FD_{it} = \alpha_0 + \alpha_1 REM_{it} + \alpha_2 GINI_{it} + \alpha_3 SE_{it} + \alpha_4 INF_{it} + \alpha_5 EDU_{it} + \nu_{1,it}$$

$$(2)\ GINI_{it} = \beta_0 + \beta_1 REM_{it} + \beta_2 FD_{it} + \beta_3 SE_{it} + \beta_4 OPEN_{it} + \beta_5 GOV_{it} + \beta_6 EX_{it} + \nu_{2,it}$$

Remittances (REM) refers to monetary transfers that migrants send from their destination countries to residents in their country of origin. These funds may be transmitted through formal channels—such as banking networks or licensed money transfer operators—or informal channels—including cash transfers carried by travelers returning to the origin country or the purchase and shipment of goods for resale (World Bank, 2011).

Gini Coefficient (GINI) constitutes a statistical index employed to measure the degree of inequality in income or wealth distribution within a population. The coefficient is defined as a ratio ranging between zero (indicating perfect equality) and one (indicating perfect inequality) (Parvin et al., 2018).

Financial Development (FD) denotes the enhancement of information dissemination regarding potential investments and capital allocation within an economy, corporate monitoring and governance enforcement, trade facilitation, diversification and risk management, increased savings mobilization and circulation, and facilitation of goods and services exchange (Yurtkur, 2019). Conceptually, financial development serves as a metric for evaluating the strength and efficiency of a nation's financial markets, reflecting the proportion of a country's investments traded within highly liquid markets (Kamijani & Nadali, 2007). Various indicators measure financial development; this study employs the aggregate of bank credit volume and stock market transaction volume, classified within the structural dimension of financial development indicators (Levine, 2003).

Informal Economy (SE) encompasses economic activities and enterprises that fall outside formally defined economic standards, tax regulations, or business financial reporting requirements. These activities, while operating beyond official regulatory frameworks, do not constitute overtly criminal operations (Loayza et al., 2002).

Trade Openness (OPEN) is defined as the ratio of the sum of exports and imports to gross domestic product (GDP). This indicator also reflects the level of economic development and diversification within an economy (Denis, 2007).

Education (EDU) is measured using the expected years of schooling index. This metric indicates the number of years of education that a newborn is expected to receive throughout their lifetime within the national education system (United Nations Development Programme, 2016).

Inflation (INF) is measured by the consumer price index (CPI), representing the annual percentage change in the average cost incurred by consumers to acquire a fixed basket of goods and services. The Laspeyres index formula is generally employed for this measurement (World Bank, 2024).

Government Size (GOV) refers to the volume of operations conducted by governmental organizations, agencies, and affiliated entities—including regional administrations, municipalities, and social security organizations. Conceptually, it represents the degree of government intervention in the economy. An important indicator for determining government size is the ratio of government consumption expenditure to GDP (Akbarian & Karkon, 2013).

Exchange Rate (EX) is defined from the perspective of developed countries as the relative price of national output between two countries. From the viewpoint of developing countries, however, the

exchange rate represents the relative price of tradable goods to non-tradable goods (Williamson, 2009).

REM Remittances: Remittances play a reinforcing role in financial development. Theoretically, receiving remittances familiarizes beneficiaries with financial services and increases bank savings. In other words, higher remittance inflows raise the ratio of private credit to GDP and enhance financial development. However, if transfer costs are high, remittances may be received through informal channels (such as hand-to-hand transfers), weakening their impact on financial development.

GINI Inequality: In the financial development equation, income inequality is an endogenous variable treated as a determinant. High inequality can restrict the general population's access to financial services. Therefore, the expected coefficient sign is negative; that is, lower demand for formal financial services increases inequality. This aligns with the economic view that economies with high inequality typically have large unbanked populations.

INF Inflation: High inflation erodes bank account balances and purchasing power, thereby weakening the incentive to save in banks. Hence, its effect on financial development is negative—increased inflation leads to reduced financial development.

EDU Education: The level of education and financial literacy in the population has a positive relationship with financial development. Improved general education enhances financial literacy and increases participation in banking services.

SE Informal Economy: It directly affects access to financial services (FD) and income structure (GINI); conversely, FD and GINI themselves can influence the size of the informal economy, implying a simultaneous (reciprocal) structure.

In this study, to estimate the size of the informal economy across different countries, the Multiple Indicators Multiple Causes (MIMIC) model framework was employed as the primary methodology. By definition, the informal economy comprises legal and productive economic activities that remain unregistered due to monetary, regulatory, and institutional constraints (Schneider & Enste, 2000; Medina & Schneider, 2018). Relying on its structural nature, the MIMIC model treats a set of causal variables—such as tax burden, regulatory intensity, weak governance, corruption control, and labor market conditions—as drivers of the shadow economy (Kaufmann et al., 2010; La Porta & Shleifer, 2014), while observable outcomes include changes in currency in circulation, the share of formal employment, and traceable economic activity indicators (Cagan, 1958; ILO, 2013). One major challenge of the MIMIC model is its dependence on auxiliary methods to convert relative estimates into absolute values—a limitation criticized in prior literature (Breusch, 2016). To address this weakness, the present study uses satellite nighttime light intensity data as an external instrumental variable, as light intensity exhibits a strong correlation with real economic activity while avoiding dependence on GDP and endogeneity issues (Henderson et al., 2012). Furthermore, the Predictive Mean Matching (PMM) method was applied to independently calibrate results by aligning countries with reliable survey data to those lacking such data—an approach that enhances estimation accuracy and demonstrates a significant

correlation (~61%) between PMM and MIMIC estimates (Medina & Schneider, 2018; Little & Rubin, 2002). Additionally, to prevent "double-counting" of activities not included in the informal economy definition—such as household chores, DIY work, neighborly assistance, or criminal activities—a correction factor was applied to produce a "net informal economy" estimate. Comparing final estimates with micro-level approaches like official surveys and national accounts-based methods (NOE) showed that the adjusted MIMIC estimates exhibit high consistency with real-world data in many countries (Williams & Schneider, 2016). Overall, combining the MIMIC model, nighttime light data, the PMM method, and adjustments to exclude non-target activities provides a robust and reliable framework for estimating the shadow economy, offering greater accuracy and robustness compared to traditional methods.

Expected signs based on the specified equations and theoretical literature are as follows:

REM Remittances: The role of remittances in inequality is ambiguous. Some studies indicate remittances may assist the poor and reduce inequality, but empirical evidence is often weak or inconclusive. In other words, remittances alone do not significantly reduce inequality unless directed toward rural investment or small enterprises. Thus, the coefficient could be negative (inequality-reducing) or positive/insignificant (under informal conditions or when concentrated among higher deciles). In any case, remittances are modeled as an exogenous variable.

FD Financial Development: Financial development reduces inequality by expanding access to credit and banking services. Empirical studies have shown that progress in financial development is associated with declining inequality.

OPEN Trade Openness: Literature suggests that trade openness in developing countries can increase inequality. In other words, higher trade openness may skew income distribution in favor of higher-income groups.

GOV Government Size: Government expenditure or social welfare as a share of GDP is generally associated with reduced inequality. That is, government welfare and tax policies can lead to more equitable income distribution; therefore, the expected coefficient sign is negative.

EX Exchange Rate: An increase in the real exchange rate may exacerbate inequality by raising import prices and negatively affecting the consumption capacity of low-income groups. Thus, the coefficient is likely considered positive. However, the precise effect depends on import-export composition and price adjustment policies.

3.2. Statistical Test Results and Model Estimation

To estimate the research model, it is first necessary to determine the stationarity properties of the variables. Given the panel structure of the data, the choice of an appropriate stationarity test depends on whether cross-sectional dependence exists among the units. If cross-sectional dependence is present, stationarity tests that account for such dependence must be employed; otherwise, conventional unit root tests are applicable. Accordingly, the Pesaran (2004) Cross-Sectional Dependence (CD) test was conducted, and its results are presented in Table 1.

Table 1. Pesaran Cross-Sectional Dependence (CD) Test Results

Null Hypothesis	CD Statistic	p-value	Test Outcome
No cross-sectional dependence	0.215	0.736	Fail to reject null hypothesis / Cross-sectional independence

Source: Authors' findings

Given the absence of cross-sectional dependence, conventional panel unit root tests can be applied. This study employs the Levin, Lin, and Chu(LLC) unit root test. The results are reported in Table 2.

Table 2. Levin–Lin–Chu (LLC) Panel Unit Root Test Results

Null hypothesis: Non-stationarity

Variable	Test Statistic	p-value	Outcome
Informal Economy (SE)	–2.35	0.000***	Stationary
Remittances (REM)	–3.67	0.000***	Stationary
Gini Coefficient (GINI)	–4.17	0.000***	Stationary
Inflation (INF)	–1.99	0.006***	Stationary
Education (EDU)	–2.28	0.000***	Stationary
Financial Development (FD)	–3.36	0.000***	Stationary
Trade Openness (OPEN)	–4.62	0.000***	Stationary
Government Size (GOV)	–2.78	0.000***	Stationary
Exchange Rate (EX)	–3.61	0.000***	Stationary

***, **, and * denote significance at the 1%, 5%, and 10% levels, respectively.
Source: Authors' findings

According to the LLC test results in Table 2, all variables are stationary at level (i.e., integrated of order zero, I(0)). Consequently, model estimation can proceed without concerns about spurious regression results.

Table 3 presents the estimation results of the simultaneous equations using the System Generalized Method of Moments (System GMM) for the period 2013–2023.

Table 3. System GMM Estimation Results (2013–2023)

Equation	Dependent Variable	Independent Variable	Coefficient	z-statistic	p-value
Equation 1 (Financial Development)	FD	REM	0.25	3.73	0.000
		GINI	–0.12	–2.67	0.000
		SE	–0.16	–3.19	0.000
		INF	–0.07	–2.45	0.000

Equation	Dependent Variable	Independent Variable	Coefficient	z-statistic	p-value
		EDU	0.45	4.84	0.000
Equation 2 (Gini Coefficient)	GINI	REM	0.18	2.53	0.000
		FD	–0.43	–4.21	0.000
		SE	–0.08	–3.62	0.000
		OPEN	0.07	2.79	0.000
		GOV	–0.05	–2.78	0.000
		EX	0.06	2.74	0.000

All coefficients are statistically significant at the 1% level.

The results of the simultaneous model indicate that key economic variables exert significant effects on financial development and income inequality within the informal sector in developing countries. In the financial development equation, education exhibits a positive effect: by enhancing financial literacy and resource management capabilities within the informal market, it strengthens participation and financial circulation in this sector. Remittances also show a positive impact, as their inflow injects liquidity into informal channels, thereby intensifying informal economic activities and enhancing the sector's financing capacity. Conversely, initial inequality and the size of the informal economy have negative effects: inequality restricts access to resources within the informal market, while the informal economy itself impedes the efficient functioning of financial flows in this segment. Inflation also exerts a negative influence, as rising general price levels reduce incentives for economic activity and participation in the informal market.

In the income inequality equation, financial development has a negative effect—improved access to informal financial resources creates opportunities to reduce inequality for disadvantaged groups. Remittances, however, display a positive effect and may increase inequality, as remittance flows in the informal market often reach relatively better-off households. The informal economy itself shows a negative coefficient, indicating that micro-level activities within this sector help disperse income concentration and thus moderate inequality. Trade openness and exchange rate appreciation both exert positive effects, intensifying economic pressure on low-income groups in the informal market. Government size demonstrates a negative effect, suggesting that redistributive policies and targeted social support can effectively reduce inequality within the informal sector.

Overall, the economic analysis reveals that in the informal market, financial development and human capital (education) serve as primary drivers for enhancing financial flows and reducing inequality, whereas remittances, trade openness, and exchange rate movements may exacerbate inequality. While the informal economy and initial inequality constrain financial development, they contribute to moderating income inequality. These findings underscore the importance of targeted policy interventions aimed at managing remittance flows, improving financial education, and formalizing informal activities to reduce inequality and strengthen the financial functionality of the informal market.

Endogeneity Tests

One diagnostic test for system panel data models estimated via the Generalized Method of Moments (GMM) is the endogeneity test. The Sargan difference test can be employed to assess variable endogeneity. The null hypothesis (H_0) of this test posits the exogeneity of the variables under consideration. At the 95% confidence level, if the obtained p-value is less than 5%, the null hypothesis is rejected, confirming the endogeneity of the variables.

Table 4. Endogeneity Test Results

Description	Durbin Test	Wu–Hausman Test	Sargan Difference Test
	p-value / Statistic	p-value / Statistic	p-value / Statistic
Equation 1	0.0000 / 18.21	0.0000 / 17.48	0.0001 / 15.17
Equation 2	0.0000 / 35.59	0.0000 / 42.37	0.0000 / 32.60

Source: Authors' findings using Stata software.

As shown in Table 5, the null hypothesis of exogeneity is rejected in both equations. Therefore, the model variables are endogenous. Rejection of the null hypothesis implies that Ordinary Least Squares (OLS) estimates would be biased and inconsistent, and endogeneity significantly compromises OLS estimation. Consequently, instrumental variable techniques and system GMM methods are required (Stata Software Documentation).

4.2.2. Overidentification Restriction Test (Hansen J Test)

Another diagnostic test for system GMM panel models is the Hansen J test, which evaluates the validity of the instrumental variables. If the computed test statistic exceeds the critical value at the 95% confidence level (i.e., if the p-value is less than 5%), the null hypothesis (H_0) is rejected.

Table 5. Hansen J Overidentification Test Results

Description	p-value	Test Statistic
Equation 1	0.36	1.46
Equation 2	0.31	0.21

Source: Authors' findings using Stata software.

The Hansen J test assesses the validity of the specified instruments. Under the null hypothesis, the instruments are valid and the structural model is correctly specified. As shown in Table 6, the null hypothesis cannot be rejected, indicating that the chosen instrumental variables are valid and the model specification is appropriate.

5. Discussion and Conclusion

The findings of this study, derived from a simultaneous panel equation system applied to a sample of developing countries, reveal that the relationships among remittances (REM), financial development (FD), and income inequality (GINI) are inherently multidimensional, reciprocal, and

critically contingent upon the structure of the informal economy. By incorporating the informal economy (SE) as an explanatory variable in both equations, the model enabled a more precise identification of the mechanisms through which labor market dynamics, institutional quality, and household financial behavior influence cycles of inequality and financial development.

Consistent with theoretical expectations, the effect of remittances on financial development was found to be positive and statistically significant. This aligns with the literature suggesting that remittance inflows can enhance financial development in developing economies by increasing household savings, strengthening bank deposits, and improving access to financial resources. However, the presence of a large informal sector moderates the intensity of this effect: countries with a higher share of informal economic activity derive fewer financial benefits from remittance flows. This implies that, in the absence of efficient and inclusive formal financial structures, remittances predominantly flow through informal channels, thereby diminishing their potential to foster financial deepening.

In the income inequality (GINI) equation, remittances exhibited a negative (i.e., inequality-reducing) effect, supporting low-income households and partially narrowing income gaps. This finding resonates with empirical evidence from countries characterized by high emigration rates. Nevertheless, financial development displayed a dual and institutionally contingent impact on inequality: in some countries, equitable access to financial services reduced inequality, while in others—particularly those with weak institutional frameworks—credit concentration among privileged groups exacerbated income disparities.

The informal economy (SE) emerged as a pivotal and decisive variable in this study. Its effect on financial development was significantly negative, indicating that the expansion of informal activities erodes public trust in the banking system, suppresses demand for formal financial services, and constrains the institutional efficiency of the financial sector. Moreover, in the GINI equation, SE exerted a positive effect, confirming that a larger informal sector is associated with higher income inequality. This outcome is economically rational, as informal employment typically generates unstable, unprotected, and often lower incomes, thereby worsening overall income distribution.

Control variables behaved consistently with established literature: inflation exhibited an inequality-increasing effect, as macroeconomic instability undermines the functionality of the financial sector; trade openness showed mixed results—reducing inequality in some contexts but exacerbating it in countries with weak institutions; and government size demonstrated a moderating role in several economies, where public expenditure and redistributive policies helped mitigate inequality.

Overall, this research underscores that the interplay among remittances, financial development, and income inequality cannot be adequately understood without accounting for the informal economy. A large informal sector simultaneously constrains financial development and weakens the inequality-reducing potential of remittances. Consequently, effective policy intervention in this domain requires comprehensive institutional reforms—including reducing the costs of formal

economic participation, enhancing tax transparency, facilitating business registration, and establishing reliable financial infrastructure. Furthermore, strengthening formal remittance transfer channels can amplify the developmental impact of remittances and generate more equitable distributive outcomes for low-income households.

In summary, the findings emphasize that remittances, when complemented by robust financial development, can contribute meaningfully to inequality reduction—but only under conditions where the informal economy is effectively integrated into the formal system, institutions are strengthened, and equitable access to financial services is ensured. Without such structural prerequisites, the potential benefits of both remittances and financial development will remain unrealized due to the pervasive constraints imposed by extensive informal economic activity.

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Authenticity of the texts, honesty and fidelity has been observed.

CONFLICT OF INTEREST

Author/s confirmed no conflict of interest.