

How Migration Fuels Informal Employment and the Transformative Role of Education Policy in Türkiye

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Abstract

Given its strategic geographical position, Türkiye serves both as a transit corridor and a destination for migrants, particularly from the Middle East, North Africa, and Asia, making it a key hub in global migration flows. This study examines the dynamic relationship between international migrant labour and informal employment from the perspective of the potential transformative power of education, using data for Türkiye for the period 2000–2023. To account for nonlinear dynamics and structural breaks that are uncertain in time and location, the fractional-frequency Fourier ARDL bounds testing method is employed. Findings indicate that informal employment is particularly highly sensitive and strongly responsive to changes in the migrant labour

force. Education expenditures significantly weaken the strong relationship between migrant labour and informal employment, whereas health expenditures have no significant effect on this relationship. These findings suggest that international migration may increase labour market vulnerabilities through informal employment, but strategic education policies can act as a structural lever to mitigate this negative effect.

Keywords: Informal Employment, International Migration, Education Policies, FA-ARDL Test.

JEL Codes: J46, J61, J68, C32

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1. Introduction

Informal employment refers to work that is not officially registered or is concealed from governmental authorities to circumvent compliance with environmental, health, social security, labour, or tax regulations, while remaining lawful in all other aspects (Williams & Windebank, 1998). Economic, financial, administrative, legal, social, psychological, and political reasons are thought to affect informal employment. In this context, economic and financial reasons are tax burden, social security premiums, high inflation, economic instability and crisis, inequality of income distribution, poverty, the weight of the agricultural sector, and firm size. Administrative and legal reasons are tax amnesties, corruption and bribery, inadequacy of tax audits, and bureaucracy. Social and psychological reasons are low education and skill level, lack of awareness, benefiting from aid programmes, rural-urban migration, refugees and migrants (Schneider & Enste, 2000; Güloğlu et al., 2003; Candan, 2007; Dereli, 2007; Pfau-Finger, 2009; Loayza & Rigolini, 2011; World Bank, 2010; Hazans, 2011; Yanici Erdal, 2019; Şenel & Öçal, 2021). Informal employment has negative effects on tax revenues, tax justice, wage level, unfair competition, social security system deficits and social security rights, and positive effects on employment, growth, inflation and competitiveness, although this is not certain (Mahiroğulları, 2017; Aslantürk & Erdem, 2018).

The flexible and cheap labour force required by economies is generally provided through informal employment. Consequently, migrants represent a significant labour force within informal economic activities, as well as vulnerable groups such as women, youth, and the elderly, especially those with low levels of education and skills, who are involved in such activities depending on the region and time. Migrants have limited or no rights as non-citizens in the host country, making them an important source of informal employment (Maroukis et al., 2011). It is quite common for migrants to turn to informal work in environments where legal regulations are inadequate or incomplete. Lack of work permits, invalidity of documents and certificates regarding their education, low skill level and language-based communication problems, etc., force migrants to work informally.

The International Labour Organisation (ILO) estimates that as of 2022, there are approximately 284.5 million migrants worldwide, of which 255.7 million constitute the migrant active population, consisting of individuals over the age of 15 and 167.7 million of them constitute the migrant labour force. About

155.6 million of this labour force is employed, while 12.1 million migrants are unemployed. The share of migrant employment in total employment worldwide is about 4.6%. Approximately 66.7% of the active migrant population is located in high, 17.4% in upper-middle, 12.3% in lower-middle and 3.6% in low-income countries (International Labour Organization, 2024).

Owing to its strategic geographical position, Türkiye functions as both a transit route and a destination for migrants, especially from the Middle East, North Africa, and Asia, establishing itself as a key centre in global migration flows. Also, due to the Syrian civil war that began in 2011, millions of refugees have sought asylum in Türkiye. According to the World Migration Report 2024, Türkiye was the largest host country in the world in 2022 (International Organization for Migration, 2024). As of 2025, Türkiye hosts approximately 4 million foreigners, including around 2.8 million Syrians (Presidency of Migration Management, 2025).

The educational composition of migrants is a critical variable in terms of which sectors labour is directed towards, labour force quality, and human capital effects. Figure 1 shows the distribution of the migrant labour force in Türkiye according to educational levels. This graph is significant in that it illustrates the quantitative and qualitative changes in the migrant labour force over time. The migrant labour force, which was approximately 104 thousand in 2000, increased to 981 thousand in 2023. This indicates that Türkiye's status as a country of immigration has strengthened since the 2000s and that the migrant population has become increasingly visible in the labour force. On the other hand, the rise in the number of migrants with advanced and intermediate levels of education over the years points to an upward shift in the qualitative composition of the migrant labour force. In particular, the sharp increase in the higher education category after 2015 indicates that the migrant labour force is becoming increasingly educated. However, the number of migrant workers with basic and less than basic education levels is higher than that of highly educated migrant workers. Considering the inverse relationship between education level and the tendency towards informality, it would not be wrong to say that this situation poses a serious risk in the context of the growth of the informal sector in Türkiye. It is almost a universal reality of the labor market that lower education levels result in weaker bargaining power, less qualified employment, and less security.

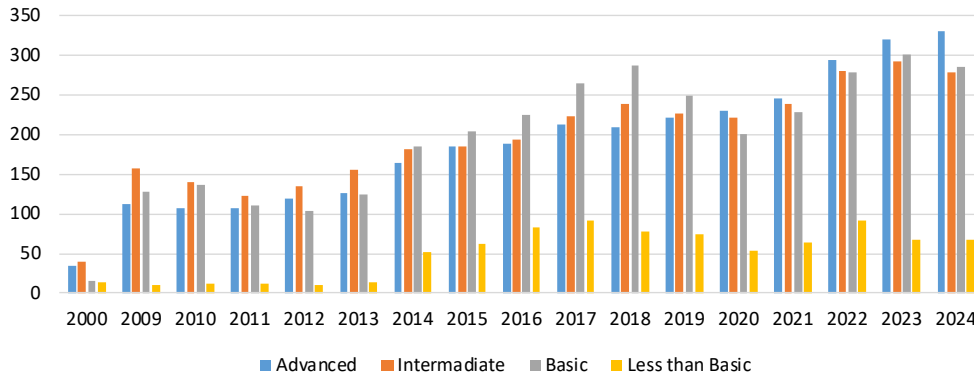


Figure 1. Migrant Labour Force by Education in Türkiye
Source: ILO-International Labour Migration Statistics

Figure 2 shows the trend in informal employment rates over time for different levels of education in Türkiye between 2000 and 2024. The figure is particularly noteworthy in that it clearly reveals the inverse relationship between educational attainment and the tendency towards informal work. Indeed, as educational attainment declines, informality rises markedly. In particular, while informal employment rates in the “Less than Basic” group remained at around 90% throughout the period, informality remained at the lowest levels among individuals with “Advanced” education levels.

The heterogeneous structure among education groups presents a particularly noteworthy picture in terms of informal employment rates. Informal emp-

loyment, which was high across all education levels in the early 2000s, has shown a marked decline over time; however, despite this improvement, the large gap between highly educated and low-educated groups has persisted. Indeed, the 2024 data clearly reveal this gap. While the informal employment rate in the “Basic” category is 42.1%, this rate is quite high at 76.5% in the “Less than Basic” category. On the other hand, these rates have fallen to 7.7% and 19.6% in the “Advanced” and “Intermediate” categories, respectively. These findings imply that the education factor provides a powerful mechanism for reducing informal employment and that education policies can therefore be transformed into a directly effective tool in the fight against informality.

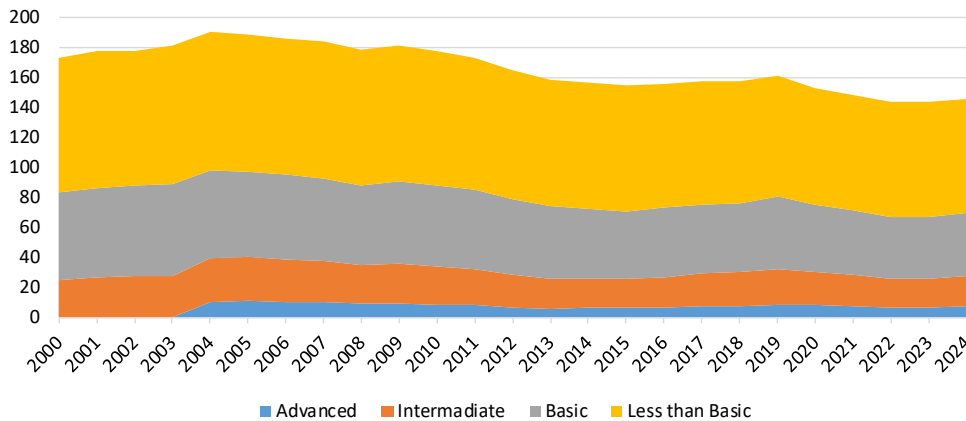


Figure 2. Informality Rates Across Educational Attainment Levels in Türkiye
Source: ILO-Labour Force Statistics

This result is of critical importance in the context of migrant labour. As clearly shown in Figure 1, the share of low-skilled migrant labour in the total migrant labour force is significant. Accordingly, it is inevitable that migration flows will exert upward pressure on informal employment in Türkiye. Conversely, education has the potential to mitigate this pressure by acting as a social lever for the migrant labour force. Therefore, the claim that education policies will function as a regulatory mechanism for the impact of migration on informality constitutes the fundamen-

tal research proposition to be empirically tested in this study.

To this end, the study examines the long-run relationship between the migrant workforce and informal employment in Türkiye and the moderating role of education policy in this relationship for the period 2000–2023. The selected time series data were analysed using the Fractional Frequency Fourier ARDL (FA-ARDL) method, an advanced econometric technique capable of accounting for sharp and smooth changes. The FA-ARDL methodology as-

sumes that the relationship between variables may not remain constant over time and may be subject to structural changes, aiming to obtain more robust and realistic results. Within this framework, the study seeks answers to three main research questions: i) What is the direction and strength of the effect of international migration on informal employment in Türkiye? ii) How effective are the education policies in reducing the tendency of the migrant labour force to move towards the informal sectors? iii) How is informal employment associated with economic instability and labour market dynamics? The findings of the study aim to provide valuable contributions to the literature by forming the basis for comparative analyses and policy recommendations for other developing economies facing high migration pressure and widespread informal labour market problems, such as Türkiye.

2. Theoretical Background and Literature Review

The relationship between education and the economy can be explained within the framework of human capital theory. Schultz (1961), who argued that human capital is the most distinctive feature of the economic system and that investments in human beings can shorten the development process. Becker (1964) demonstrated that the skills and knowledge individuals acquire through education and work experience positively affect their performance, enabling them to earn higher wages in the labour market. Mincer (1993) further noted that more educated workers enjoy advantages such as higher incomes and a lower probability of unemployment (i.e., more stable employment) compared to less educated workers. In this context, higher levels of education are associated with lower unemployment risk and shorter durations of unemployment (Maden Yenista & Yanık İlhan, 2015: 115).

The relationship between migration and employment can be explained through modern migration theories. In this context, according to Neoclassical Macroeconomic Theory, international labour migration is primarily driven by wage differentials between countries. This theory views labour markets as the main mechanism underlying international migration, with skilled labour playing a decisive role, particularly in human capital flows. According to Neoclassical Microeconomic Theory, individual characteristics such as language and vocational training that contribute to social capital, housing conditions in the destination country, age, gender, educational attainment, and work experience significantly influence international migration decisions (Massey et al., 1993: 433–435).

Stark & Bloom (1985) argue that migration decisions are not made by isolated individuals but are generally taken collectively by families in the New Eco-

nomics of Migration theory. These decisions focus not only on maximizing expected income but also on minimizing risks. Consequently, governments can influence migration rates not only through labour market policies but also through health, education, and social policies (Massey et al., 1993: 440). Empirical studies indicate that education level has a negative and statistically significant effect on migration. As educational attainment increases, individuals tend to improve their employment opportunities within their local regions, thereby reducing the need to migrate (Özşahin et al., 2025: 642).

Within the framework of Dual Labour Market Theory, Piore (1979) explains international migration through the labour demand of industrial societies. According to this theory, the labour market in industrial societies is divided into two segments: a primary, capital-intensive sector and a secondary, labour-intensive sector. The capital-intensive sector employs skilled labour with high levels of knowledge and expertise. Jobs in the primary sector are capital- and technology-intensive and require specialization, division of labour, and technical competence; therefore, firms cannot easily dismiss native workers employed in these positions. Owing to their high productivity and quality, employers are generally reluctant to lay off this segment of the workforce. In contrast, the labour-intensive sector lacks social prestige among native workers and fails to motivate in terms of both status and wage structures. As a result, secondary-sector jobs are largely filled by migrant workers recruited from abroad. Industrialized countries have a continuous demand for cheap and flexible labour; consequently, wages are kept low to ensure a steady supply of workers (Massey et al., 1993: 440–444; Demir, 2023: 1416). Migrants with lower levels of education are more likely to be employed in secondary labour markets and to participate in informal employment. Moreover, even highly educated migrants may be temporarily pushed into the informal sector due to factors such as non-recognition of diplomas and language barriers. In this context, alongside legal regulations, education policies can be considered a protective factor facilitating migrants' transition out of informal employment.

The migration phenomenon faced by the world and Türkiye requires an examination of the issue from sociological, economic, legal, etc., aspects. Examining the link between migration and informal employment is essential for developing coherent labour and migration policies, ensuring effective workforce governance, and promoting structural institutional reforms. However, the related literature on migration highlights a relatively limited focus on the informal employment dimension, largely due to the irregularity and insufficiency of migration-related data. As a result, some empirical studies rely on microdata to explore this relationship. For example, Marcelli (2007) investigated the informal employ-

ment of Mexican immigrants in casual and low-wage jobs in California for the period 1990–1999. Based on logistic regression analysis, the study finds that men, young individuals, those with low educational attainment, non-white ethnic and racial backgrounds, or foreigners, and those working in agriculture or mining are more likely to be informally employed.

Several macro-level studies have expanded the analysis across regions and countries. For instance, Hazans (2011) investigated the macro-level determinants of informal labour patterns across 30 European nations between 2004–2009. The study finds that migration increases informal employment in Eastern and Southern Europe and 27 EU member states. Additional findings reveal that higher public expenditures decrease informal employment in Western and Northern Europe, whereas the minimum wage increases informal employment in almost all countries. Similarly, studies in the US and Spain quantify how increases in immigrant shares contribute to rises in informal employment at the state and regional levels. According to Bohn & Owens' (2012) study of US states covering the period 2001–2006, every 1% increase in immigration in states with high immigrant density increased informal employment by 0.194%. Bohn & Farré (2013), in their study of Spain, found that a 1% increase in the share of immigrants in the region between 2000 and 2009 led to an increase in informal employment between 0.3% and 0.8%. Extending the scope to a global context, Goel et al. (2019) investigated the impact of foreign direct investment (FDI) inflows, incoming development assistance, and immigration on the informal sector using a cross-sectional analysis for over 100 countries and for the years 2006, 2007, 2012, and 2013. The findings suggest that both FDI and migration increase the informal economy, while incoming aid reduces it. While the statistical impact of migration is more robust, the impact of incoming aid is relatively weak. Inflation, on the other hand, reduces informality in some periods. More recently, Delgado-Prieto (2024) investigated the impact of Venezuelan immigrants on informality in Colombia between 2015 and 2019, finding that a 1% increase in immigration reduced local employment by between 0.9% and 1.3%. Furthermore, immigration reduces wages by 1.9% due to flexible wages in informal employment.

Turning to Türkiye-specific studies, Ceritoglu et al. (2017) performed a microdata analysis during the 2010–2013 period, covering a total of 29 provinces, including the reference group, to investigate the effect of Syrian refugees on Türkiye's labour market. Their findings indicate that the influx of refugees reduces the ratio of informal employment to the population by approximately 2.2%. This ratio is 3.3% among those with lower education levels. However, it has no significant impact on those with higher education. Complementary macroeconomic analyses by Çelik et al. (2021) and Aksu et al. (2022) further

elaborate on how economic growth, inflation, and migrant inflows affect informal labour markets in Türkiye, with particular emphasis on vulnerable worker groups. Çelik et al. (2021) used quarterly data for the period 2004–2020 in Türkiye, employing the ARDL to examine the relationship among growth, inflation, unemployment, and informal employment. According to the findings, a one-unit increase in economic growth and inflation rates results in a 0.23% and 0.03% decrease in informal employment, respectively, while a one-unit increase in unemployment rates results in a 0.99% increase in informal employment. Aksu et al. (2022) investigated the impact of the massive influx of Syrian migrants on the labour market using microdata for the period 2004–2015 and found that migrants negatively impacted domestic employment, particularly among temporary wage workers in the informal sector, young workers with low education, women working part-time or self-employed, and those working in agriculture and construction.

Recent cointegration studies, such as those by Erkişi & Çetin (2023) and Eralp (2024), contribute to understanding the dynamic relationship between migration flows, unemployment, and informal employment, highlighting both short-term and long-term effects. Erkişi & Çetin (2023) investigated the impact of regular and irregular migration on employment by the Johansen cointegration test for the period 2000–2022 in Türkiye. The findings indicate that regular and irregular total migration in Türkiye initially reduces unemployment, but the registered unemployment rate subsequently increases. Eralp (2024), in a study covering the period 2004–2020 for 26 regions in Türkiye, finds that the large size of the informal employment sector pushes the unemployed into informal jobs. Additionally, inflation is found to increase informal employment. Additionally, Gülek (2024), in his study covering the period 2004–2016, concluded that growth in the refugee/native ratio diminishes the formal and informal employment opportunities of low-skilled domestic workers. The researcher found that a 1% rise in the said ratio leads to a decline in formal wage employment by 0.13% and informal wage employment by 0.17% among low-skilled domestic workers.

3. Methodology

3.1. Data and Model

Migrants tend to work in the informal sector due to legal, bureaucratic, and socio-economic barriers that restrict their access to the formal labour market. This situation leads to an organic link between migration and informal employment. The structure, strength, and impact of this relationship constitute the main research topic of this study. In this context, the study investigates the relationship between in-

ternational migration and informal employment and the potential role of education for Türkiye, covering the years 2000–2023. The abbreviations, explanatory

information, and sources of data for the variables are outlined in Table 1.

Table 1. Explanations on Variables

Variables	Definitions	Data Sources
IE	Informal Employment Rate (%)	ILO-Labour Force Statistics
MWF	Migrant Labour Force Participation Rate (%)	ILO-International Labour Migration Statistics
MW	Minimum Wage (\$)	ILO-Wages and Working Time Statistics
UN	Unemployment (15)+	ILO-Sustainable Development Goals Labour Market Indicators
INF	Inflation (Annual % CPI)	World Bank
EDU	Education Expenditure (% GNP)	World Bank
HLT	General Government Domestic Health Expenditure (% GDP)	World Bank

In the study, the rate of informal employment (IE) is determined as the dependent variable. The primary independent variable representing international migration is the migrant labour force participation rate (MWF). In line with the findings of the literature review, it is accepted that the rate of informal employment is also influenced by macroeconomic factors such as economic instability and labour market dynamics. In this context, to enhance the robustness of our model, minimum wage (MW), unemployment rate (UN), and inflation rate (INF) are included as control variables. The inclusion of these control variables in the model supports the robustness of the established relationship, enabling a more accurate explanation of changes in informal employment,

particularly during periods of economic instability.

In this study, two separate models have been established to analyse the fundamental impact of migrant labour on informal employment and how education moderates this relationship. The first model examines only the direct impact of migrant labour, while the second model includes the interaction between education expenditure and migrant labour in the model, capturing the potential regulatory role of education on the propensity towards informality. Furthermore, considering that access to health insurance may also directly affect the propensity for informality, health expenditures were added to the analysis scope of the second model as an interaction variable.

$$IE_t = \beta_0 + \beta_1 MWF_t + \beta_2 MW_t + \beta_3 UN_t + \beta_4 INF_t + e_t \quad (1)$$

$$IE_t = \beta_0 + \beta_1 (EDU * MWF_t) + \beta_2 (HLT * MWF_t) + \beta_3 MW_t + \beta_4 UN_t + \beta_5 INF_t + e_t \quad (2)$$

In addition, a dummy variable representing the Syrian civil war has been added to both of the models. All variables are used in logarithmic form.

3.2. Method

The stationarity properties of the series are analysed employing the fractional frequency Fourier ADF (FADF) test. When required, conventional unit root tests are also applied for verification. Sharp break dates are determined using the Lee-Strazicich (2003) unit root test, which enables the endogenous detection of structural break periods. Subsequently, the relationships between informal employment and key explanatory variables—migrant labour force participation, minimum wage, unemployment rate, and inflation rate—are analysed under Model 1. This framework is extended by incorporating education and health expenditures through interaction terms

in Model 2. Both models are estimated using the FA-ARDL method.

Macroeconomic series are subject to many important structural changes over time, and these structural changes can sometimes be sharp and sometimes gradual. This situation causes traditional tests to be inadequate when the number, type, and location of structural breaks are unknown (Aydin, 2019). In order to overcome this weakness, Becker et al. (2004, 2006) proposed the integration of Fourier functions into unit root tests. This method produces more robust and reliable results thanks to its flexible structure, even if the break points cannot be estimated exactly (Gallant, 1981; Enders & Lee, 2012).

The FADF test emerged from modifications to the standard Dickey-Fuller procedure, as proposed by Enders & Lee (2012), Omay (2015), and Bozoklu et al. (2020), whereby Fourier approximations are used

to capture smooth structural shifts. In the FADF test, structural breaks are determined endogenously by sinusoidal functions thanks to Fourier components. Thus, it offers the advantage of modelling an infinite number of structural breaks by capturing gradual transitions, no matter whether they are large or small-scale changes (Bozoklu et al., 2020).

This method models the breaks in the series not as sudden changes but as gradual and smooth transitions, thus capturing the nonlinear properties of

the series better. In Fourier Functions, Enders & Lee (2012) use integer frequencies from 1 to 5 ($k=1,2,\dots,5$), while Omay (2015) tests frequencies starting from 1 up to 2 in 0.1 unit increments. Bozoklu et al. (2020) test all frequencies up to 5 with 0.1 unit increments starting from 1. In this study, the stationarity and nonlinearity properties of the variables are analysed with the method proposed by Bozoklu et al. (2020). Accordingly, the fractional frequency FADF test is expressed by Equation (3).

$$\Delta Y_t = \delta_0 + \delta_1 t + \delta_2 \sin\left(\frac{2\pi kt}{T}\right) + \delta_3 \cos\left(\frac{2\pi kt}{T}\right) + \delta_4 Y_{t-1} + \sum_{i=1}^p \alpha_i \Delta Y_{t-i} + v_t \quad (3)$$

where t denotes the trend term, T the number of observations, π the number Pi (3.1416), k the frequency value and p the optimal lag length, $\sin\left(\frac{2\pi kt}{T}\right)$ and $\cos\left(\frac{2\pi kt}{T}\right)$ the trigonometric terms. To overcome the autocorrelation problem, the optimal lag length is specified by the Akaike Information Criterion (AIC). Bozoklu et al. (2020) define the optimal frequency as the specific value that minimizes the Sum of Squared Residuals (SSR). In the first step of the analysis, the model in Equation (3) is estimated for each k value in increments of 0.1 within the range $0 < k \leq 5$, and the optimal frequency value (k^*) that minimizes the Sum of Squared Residuals is determined. A fractional optimal k value means that the effect of structural breaks on the series is permanent, while an integer value means that the breaks have a temporary effect on the series. In the next step, the joint significance of the trigonometric terms is tested with the standard Wald F test under the hypothesis $H_0 = \delta_2 = \delta_3 = 0$. If the Wald F-statistic obtained from the restriction test falls below the corresponding critical values, the null hypothesis cannot be rejected, suggesting that the trigonometric terms are not statistically significant. In such cases, it is advisable to proceed with the conventional linear Dickey-Fuller unit root test. Conversely, if the computed Wald F-statistic exceeds the critical threshold, the trigonometric components are deemed statistically significant. This significance provides empirical support for the presence of nonlinearity in the series (Yaya et al., 2020). In this case, the hypothesis $H_0 = \delta_4 = 0$ is tested for the unit root test by proceeding to the last step of the test. If the test statistic corresponding to the coefficient δ_4 falls below the critical values derived by Bozoklu et al. (2020) through Monte Carlo simulations, indicating that the series remains non-stationary.

It is noteworthy that there are cointegration tests involving Fourier functions developed by Tsong et

al. (2016), Solarin (2019), Yilanci (2019), and Yilanci et al. (2020) in the literature. This study is based on the procedure of Yilanci et al. (2020), which is called the Fractional Frequency Fourier ARDL (FA-ARDL) bounds test because it is the first method to consider both temporary and permanent breaks. FA-ARDL was developed by McNown et al. (2018) by adding Fourier functions to the augmented version (Augmented ARDL) with an additional F test of the ARDL bounds test proposed by Pesaran et al. (2001). In this regard, the FA-ARDL method makes it possible to analyse the cointegration relationship among variables integrated at different orders, namely, $I(0)$ and $I(1)$. Furthermore, the supplementary F-test introduced by McNown et al. (2018) offers more robust insights into the cointegration properties of the system. Because in the FA-ARDL method, with the addition of Fourier functions, sharp and soft breaks as well as multiple breaks of unknown number and location can be modelled (Becker et al. 2006). Moreover, the critical values obtained with the bootstrap method provide reliable coefficient and relationship estimates by minimizing the errors due to the normal distribution assumption for small samples. In this method, both fractional and integer values are taken into account when determining the optimal frequency value. Fractional frequencies are typically associated with structural breaks of a permanent nature, whereas integer frequencies correspond to transitory breaks (Christopoulos and Leon-Ledesma, 2011; Omay, 2015; Ersin & Kirca, 2024: 894). In conclusion, the FA-ARDL method provides a flexible and reliable framework to examine the relationships under the influence of structural breaks in this study. Equations (4) and (5) show the adjusted versions of Model 1 and Model 2 according to Yilanci et al. (2020):

$$\begin{aligned} \Delta IE_t &= \beta_0 + \gamma_1 \sin\left(\frac{2\pi kt}{T}\right) + \gamma_2 \cos\left(\frac{2\pi kt}{T}\right) + \delta_i \text{dum}_t + \beta_1 IE_{t-1} + \beta_2 MWF_{t-1} + \beta_3 MW_{t-1} + \beta_4 UN_{t-1} \\ &+ \beta_5 INF_{t-1} + \sum_{i=1}^{p-1} \theta'_i \Delta IE_{t-i} + \sum_{i=1}^{p-1} \phi'_i \Delta MWF_{t-i} + \sum_{i=1}^{p-1} \omega'_i \Delta MW_{t-i} + \sum_{i=1}^{p-1} \varphi'_i \Delta UN_{t-i} + \sum_{i=1}^{p-1} \delta'_i \Delta INF_{t-i} + e_t \end{aligned} \quad (4)$$

$$\begin{aligned} \Delta IE_t &= \beta_0 + \gamma_1 \sin\left(\frac{2\pi kt}{T}\right) + \gamma_2 \cos\left(\frac{2\pi kt}{T}\right) + \delta_i \text{dum}_t + \beta_1 IE_{t-1} + \beta_2 \text{EDU} * \text{MWF}_{t-1} + \beta_3 \text{HLT} \\ &* \text{MWF}_{t-1} + \beta_4 \text{MW}_{t-1} + \beta_5 \text{UN}_{t-1} + \beta_6 \text{INF}_{t-1} + \sum_{i=1}^{p-1} \theta'_i \Delta IE_{t-i} + \sum_{i=1}^{p-1} \phi'_i \Delta (\text{EDU} * \text{MWF})_{t-i} \\ &+ \sum_{i=1}^{p-1} \alpha'_i \Delta (\text{HLT} * \text{MWF})_{t-i} + \sum_{i=1}^{p-1} \omega'_i \Delta \text{MW}_{t-i} + \sum_{i=1}^{p-1} \varphi'_i \Delta \text{UN}_{t-i} + \sum_{i=1}^{p-1} \delta'_i \Delta \text{INF}_{t-i} + e_t \end{aligned} \tag{5}$$

where, $\beta_1-\beta_7$ refer to the parameters associated with the lagged values of the variables, $\theta, \phi, \alpha, \omega, \varphi, \delta, \sigma, \vartheta$ are lagged differenced regressor parameters, $t = 1 \dots T$ is the time series, Δ denotes the differencing operator, p denotes the lag length, and dum is a dummy variable, and e_t is assumed to be independently and identically distributed with a mean of zero and finite variance. The optimal lag length is determined using the AIC. The terms $\gamma_1 \sin(\frac{2\pi kt}{T}) + \gamma_2 \cos(\frac{2\pi kt}{T})$ in the model constitute a single-frequency Fourier approximation, designed to capture cyclical patterns or structural breaks within the time series. Here, k denotes a certain frequency, t denotes the period, T denotes the sample size, and π denotes the number Pi.

According to Yilanci et al. (2020), Equations (4) and (5) are estimated using all frequency values in the range $k=[0,1,\dots,5]$ in increments of 0,1 and the most appropriate frequency value (k) that minimises the AIC criterion is selected. Thereafter, the cointegration relationship is analysed at the appropriate frequency by testing three hypotheses proposed by Pesaran et al. (2001), McNown et al. (2018), and Sam et al. (2019) against their respective alternatives using the F_{Overall} , t_{IDV} , and F_{IDV} test statistics. The hypotheses are as follows;

$H_{0A}: \beta_1 = \beta_2 = \beta_3 = \beta_4 = \beta_5 = \beta_6 = \beta_7 = 0$, General F test based on lagged levels of dependent and independent variables (F_{Overall})

$H_{0B}: \beta_1 = 0$, t-test based on the lagged level of the dependent variable (t_{IDV})

$H_{0C}: \beta_2 = \beta_3 = \beta_4 = \beta_5 = \beta_6 = \beta_7 = 0$ F test based on lagged levels of independent variables (F_{IDV})

In order to test these hypotheses, F_{Overall} , t_{IDV} and F_{IDV}

test statistics are calculated respectively, and these are compared with the critical values obtained by bootstrap. If all three test statistics exceed their respective critical values, the null hypotheses are rejected, leading to the conclusion that a cointegration exists among the variables. Furthermore, the frequency parameter k selected within the model is crucial for accurately capturing the series' responsiveness to structural breaks. If k is an integer, structural breaks are interpreted as having a temporary effect; whereas if k is fractional, they are understood to have a permanent effect.

4. Results and Discussion

4.1. Unit Root Test Results

The results of the fractional frequency FADF unit root test are presented in Table 2. The Wald F test statistics indicate that trigonometric terms are statistically significant for IE, MWF, and INF in the model with a constant, and for HLT in the model with a constant and trend. These results indicate that the relevant variables exhibit non-linear characteristics. FADF test statistics are evaluated against their corresponding critical values. It is observed that only the INF variable is stationary at the level, whereas IE and MWF become stationary after first differencing. In the model with constant and trend, the trigonometric terms lose their significance when the HLT variable is differenced. On the other hand, the fact that the optimal frequency values (k) calculated for the relevant variables are fractional indicates that the impact of structural breaks on the series is persistent.

Table 2. Fractional Frequency Fourier ADF Unit Root Test Results

Constant Model						
Variables	k	Min. SSR	Wald F Stat. ^a	p	Fractional FADF Test Stat.	FADF Critical Value ^b
IE	3.10	0.01	10.50***	1.00	1.02	-3.05
MWF	0.90	0.01	8.22**	2.00	-3.52	-3.86
MW	0.50	0.30	5.89	1.00	-2.75	-3.93
UN	4.30	0.12	2.62	1.00	-2.52	-2.95
INF	0.10	2.05	14.64***	2.00	-4.17**	-3.88
EDU	0.50	0.05	4.32	1.00	-2.96	-3.93
HLT	1.70	0.07	6.09	1.00	-3.09	-3.37

ΔIE	3.20	0.01	9.01**	1.00	-3.01*	-3.03
ΔMWF	1.70	0.01	2.61	1.00	-3.92**	-3.37
ΔMW	1.10	0.39	2.85	1.00	-3.24	-3.74
ΔUN	4.30	0.16	4.02	1.00	-3.99	-2.95
ΔINF	0.10	3.09	8.64**	2.00	-5.36***	-3.88
ΔEDU	4.70	0.05	0.89	1.00	-4.93	-2.93
ΔHLT	0.10	0.07	3.24	1.00	-3.49	-3.88
Model with Constant and Trend						
Variables	k	Min. SSR	Wald F Stat. ^a	p	Fractional FADF Test Stat.	FADF Critical Value ^b
IE	3.10	0.01	3.95	2.00	-2.12	-3.75
MWF	1.80	0.01	3.10	2.00	-3.35	-4.14
MW	0.80	0.27	5.64	1.00	-3.10	-4.33
UN	4.30	0.12	2.34	1.00	-2.38	-3.59
INF	0.10	2.01	6.09	2.00	-3.48	-4.26
EDU	1.40	0.03	5.49	2.00	-2.98	-4.31
HLT	0.10	0.06	7.94*	2.00	-2.61	-4.26
ΔIE	3.30	0.01	9.96**	1.00	-3.38*	-3.71
ΔMWF	1.50	0.01	4.34	1.00	-4.68	-4.28
ΔMW	0.10	0.36	1.96	1.00	-2.50	-4.26
ΔUN	4.30	0.15	3.67	1.00	-3.93	-3.59
ΔINF	4.60	1.82	3.98	1.00	-4.05	-3.57
ΔEDU	4.70	0.05	0.53	1.00	-5.19	-3.56
ΔHLT	0.10	0.07	3.72	1.00	-3.78	-4.26

***, **, * denote 1%, 5%, and 10% statistical significance level respectively. Critical values for the F test are taken from Enders and Lee (2012:197). The critical values at 1%, 5%, and 10% levels in Table 1b and 1a are calculated as 10.35; 7.58, and 6.35 for the model with constant and 12.21; 9.14, and 7.78 for the model with constant and trend, respectively. Bozoklu et al. (2020:10-11) refers to the critical values at the 5% level of the Fourier ADF test calculated for the constant, with constant and trend models in Tables A and B. Source: Authors' calculation.

Table 3 presents the findings of the ADF and PP tests for variables with insignificant trigonometric terms. According to the findings, all these variables become stationary after first differencing.

Table 3. ADF and PP Unit Root Test Results

Variables	ADF		PP		ADF		PP	
	Level				First Difference			
	Cons.	Cons.& Trend	Cons.	Cons.& Trend	Cons.	Cons.& Trend	Cons.	Cons.& Trend
MW	-0.42	-1.16	-0.51	-1.21	-3.89***	-4.35**	-3.92***	-4.31**
UN	-3.48**	-3.35*	-3.93	-3.11	-3.52**	-3.56*	-3.52**	-3.51*
EDU	-1.83	-3.02	-2.83	-3.02	-5.36***	-5.83***	-7.86***	-11.51***
HLT	-1.53	-1.57	-1.80	-1.84	-3.50**	-3.39*	-3.49**	-3.31*

***, **, * denote 1%, 5%, and 10% statistical significance level respectively. Lag length is determined by AIC.

Source: Authors' calculation.

Table 4 shows the results of Lee-Strazicich's (2003) unit root test with structural breaks. According to the test results, the common breakpoint for the IE and MWF variables is identified as a meaningful year, 2011. As a matter of fact, the protests that started

against the government in Syria in March 2011, with the effect of the Arab Spring, turned into a civil war in a short time with the harsh intervention of the regime and started a great wave of migration to Türkiye.

Table 4. Lee-Strazicich Unit Root Test Results

Level					First Difference				
Variables	k	TB1	TB2	Min. Test Stat.	Variables	k	TB1	TB2	Min Test Stat.
IE	3	2011	2020	-4.87***					
MWF	8	2011	2021	-6.80***					
MW	8	2013	2017	-6.57***					
UN	1	2010	2019	-3.07	ΔUN	8	2010	2018	-4.21***
INF	1	2010	2017	-2.32	ΔINF	7	2015	2018	-6.33***
EDU	3	2015	2021	-3.03	ΔEDU	0	2010	2012	-5.41***
HLT	7	2015	2020	-4.68***					

*** denotes 1% statistical significance level

Source: Authors' calculation.

4.2. FA-ARDL Bounds Test Results

The relationships between IE and a number of macroeconomic and labour market variables, in particular the MWF, are analysed using the FA-ARDL method within the framework of Model 1 and Model 2 in Equations (4) and (5). In the first step of the FA-ARDL procedure, the long-run relationship between the variables for both models is investigated, and the findings are presented in Table 5. Firstly, the optimal frequency values (k) used in the Fourier functions were calculated for both models. These values, determined as 0.7 for Model 1 and 3.4 for Model 2,

provide important information about the nature of structural changes. Accordingly, fractional k values for both models indicate that structural changes have a permanent effect on the cointegration relationship.

Table 5 shows that the $F_{Overall}$, t_{IDV} and F_{IDV} test statistics calculated for both models exceed the critical values obtained by the bootstrap method. The rejection of all three null hypotheses in both models clearly confirms the existence of a cointegration relationship between the series.

Table 5. FA-ARDL Bounds Test Results

Tests	Model 1 (2 2 2 2 2) k=0.7				Model 2 (3 1 0 1 0 0) k=3.4			
	Test Statistics	Bootstrap Critical Values			Test Statistics	Bootstrap Critical Values		
		%1	%5	%10		%1	%5	%10
$F_{Overall}$	16.73**	26.6	13.2	9.9	15.8*	25.5	17.4	12.5
t_{IDV}	-5.46***	-3.9	-2.4	-1.6	-4.61***	-4.5	-3.2	-2.4
F_{IDV}	19.13**	19.6	8.8	6.3	19.03**	20.1	11.3	8.5

***, **, * denote statistical significance levels of 1%, 5% and 10%, respectively. Bootstrap critical values are generated by 1000 simulations.

Source: Authors' calculation.

Table 6 presents the estimated coefficients for both the long-run and short-run dynamics derived from the error correction model, as well as the diagnostic test results. Firstly, for Model 1, it is noteworthy that the effects of all variables, except for (INF_t), on informal employment are positive and statistically significant in relation to informal employment. The long-run coefficient of (MWF_t), which is considered the main explanatory variable, is estimated at 3.04.

This finding indicates that a 1% increase in MWF participation is associated with a 3.04% increase in IE in the long run. The magnitude of the coefficient suggests that the long-run association between the variables is highly elastic, meaning that IE exhibits a strong sensitivity to variations in MWF within the estimated framework. Regarding the short-run coefficients, a 1% increase in the MWF in the current period is associated with a 0.6% increase in IE, while

a 1% increase in the previous period corresponds to a 1.01% increase. These results are consistent with Hazans (2011), Bohn & Owens (2012), Bosh & Faré (2013), Goel et al. (2019) and Çelik et al. (2021). Overall, the findings point to a strong and persistent long-run association between migrant labour force participation and informal employment, with short-run dynamics that appear gradual and cumulative within the model specification.

According to the theoretical literature, the minimum wage level is frequently discussed as an important determinant of informal employment. Increases in the minimum wage are theoretically associated with higher labour costs for employers, which may coincide with a stronger tendency toward informal employment. In the empirical results, the long-run coefficient of (MW_t) is estimated to be positive and statistically significant, in line with theoretical expectations. Specifically, a 1% increase in MW is associated with a 0.27% increase in IE in the long run. In the short run, a 1% increase in the current value of MW increases IE by 0.12% and decreases it by 0.07% with a one-period lag. These results are broadly con-

sistent with Hazans (2011). Similarly, the coefficient of (UN_t) is positive and significant. The theoretical literature suggests that higher unemployment rates tend to coincide with increased informal labour market participation, as greater difficulty in finding formal employment may encourage individuals to seek opportunities in the informal sector. Empirically, a 1% increase in UE is associated with a 0.48% increase in IE in the long run, while the corresponding short-run associations are 0.28% and 0.16% for the current and lagged periods, respectively. These findings are in line with Eralp (2024) and Çelik et al. (2021). When the inflation variable is examined within the framework of Model 1, the long-run coefficient of (INF_t) is not statistically significant. In the short run, it is observed that a 1% increase in the current and lagged values of INF increases IE by 0.06% and 0.02%, respectively. Overall, the results indicate that inflation is weakly associated with informal employment in the short run, while no statistically significant long-run relationship is identified within the estimated model. This finding is consistent with the evidence reported by Çelik et al. (2021).

Table 6. FA-ARDL Estimation Results

Model 1				Model 2			
Variable	Coefficient	t-Stat.	Prob.	Variable	Coefficient	t-Stat.	Prob.
Long Run Coefficients							
MWF_t	3.04***	6.87	0.00	$EDU*MWF_t$	-0.15***	-6.16	0.00
MW_t	0.27**	7.32	0.02	$HLT*MWF_t$	-0.02	-0.45	0.67
UN^t	0.48***	3.83	0.00	MW_t	0.27***	5.37	0.00
INF_t	-0.04	-1.61	0.18	UN_t	0.31**	2.70	0.03
C	-10.79***	-6.88	0.00	INF_t	0.05	1.71	0.13
				C	1.94**	3.27	0.01
Short Run Coefficients							
ΔIE_{t-1}	-0.38**	-5.51	0.01	ΔIE_{t-1}	-0.68***	-7.78	0.00
ΔMWF_t	0.36**	3.56	0.02	ΔIE_{t-2}	-0.21**	-2.88	0.02
ΔMWF_{t-1}	1.01***	-7.68	0.00	$\Delta EDU*MWF_t$	-0.04***	-5.17	0.00
ΔMW_t	0.12***	9.32	0.00	ΔMW_t	0.08***	6.30	0.00
ΔMW_{t-1}	-0.07**	-5.18	0.01	D2011	0.04***	-9.05	0.00
ΔUN_t	0.28***	17.88	0.00	ect_{t-1}	-0.50***	-15.15	0.00
ΔUN_{t-1}	0.16***	-9.26	0.00				
ΔINF_t	0.06***	7.39	0.00				
ΔINF_{t-1}	0.02**	3.58	0.02				
D2011	0.04***	-8.61	0.00				
ect_{t-1}	-0.95***	-13.97	0.00				
Fourier Coefficients							
$COS(k=0.7)$	0.29***	13.23	0.00	$COS(k=3.4)$	-0.01***	-5.15	0.00
$SIN(k=0.7)$	0.19***	11.38	0.00	$SIN(k=3.4)$	-0.05***	-9.64	0.00

Diagnostic Tests Results				
Breusch-Godfrey LM	5.84	0.14	6.08	0.09
ARCH Test	0.03	0.84	0.04	0.98
Jarque-Bera Test	0.11	0.94	0.30	0.86
Ramsey RESET Test	0.26	0.63	1.15	0.30
Csum	Stable		Stable	
Csum ^Q	Stable		Stable	
Adj. R2	0.97		0.94	

***, **, * denote statistical significance levels of 1%, 5% and 10%, respectively.

Source: Authors' calculation.

The findings for Model 2 show that the short- and long-run coefficients of the education interaction variable (EDU * MWF) are negative and statistically significant. This suggests that the previously identified positive long-run association between migrant labour force participation and informal employment becomes weaker as education expenditures increase. Quantitatively, a 1% increase in the interaction term is associated with a 0.15% decrease in IE in the long run and a 0.04% decrease in the short run. In line with theoretical expectations, these results suggest that education expenditures may mitigate the positive association between migrant labour force participation and informal employment within the estimated framework. Accordingly, improvements in the qualitative and quantitative dimensions of education investment may be considered as a potential policy channel in addressing informal employment. By contrast, the interaction coefficient between health expenditures and migrant labour (HLT * MWF) is negative but statistically insignificant, indicating that health expenditures do not exhibit a statistically significant moderating role in the relationship between migrant labour and informal employment. The statistical insignificance of the interaction term between migrant labour and health expenditures can be interpreted within the institutional structure of the Turkish labour and social security system. In Türkiye, access to comprehensive public healthcare services is largely tied to formal employment through social security registration. Since a significant portion of migrant labour is employed informally, increases in aggregate public health expenditures may not directly translate into improved effective access to healthcare for informal migrant workers. Therefore, unlike education spending, which directly contributes to human capital accumulation and formal labour market integration, higher health spending may not substantially alter the structural incentives linking migrant labour to informal employment. While the coefficient estimates for UE and INF remain broadly consistent with Model 1, the positive association between MW and IE appears relatively weaker in this specification. These findings reinforce the stability of the estimated relationships within the model framework.

Considering that the Syrian civil war triggered a large wave of migration to Türkiye, the statistical significance of the 2011 dummy variable points to a structural shift in informal employment around this period. This finding suggests that civil unrest and geopolitical tensions in neighbouring countries are closely associated with changes in informality in Türkiye. Overall, the results indicate that informal employment dynamics in Türkiye appear to move in conjunction with major geopolitical developments within the estimated framework.

In this study, the inclusion of Fourier terms in the models allows capturing the effects of nonlinear dynamics, cyclical patterns and smooth transition breaks. The statistically significant Fourier terms in both models confirm the existence of periodic oscillations in informal employment that can be attributed to cyclical or policy-induced fluctuations. Therefore, by including Fourier functions in the models, even sensitive breaks are not neglected and stronger findings are obtained. Finally, the negative and statistically significant error correction coefficient in both models indicates that short-run deviations are corrected over the long run. The diagnostic test results indicate that there are no autocorrelation or heteroskedasticity problems, the error terms are normally distributed, and the model specifications are correctly specified. The dynamic stability of the estimated Fourier ARDL models was examined using the inverse roots of the AR characteristic polynomial. For both Model 1 and Model 2, the analysis confirms that the modulus of all characteristic roots, which represent the lagged dynamics of the dependent variable, lie within the unit circle. These findings verify that both the short-run and long-run estimates of the models are structurally stable and reliable. Consequently, the robustness of the model specifications is statistically confirmed.

5. Conclusion

In recent years, Türkiye has placed growing emphasis on combating informal economic activity, with informal employment representing a significant challenge in the labour market and constituting a key

component of this policy agenda. Informal employment can be influenced by a wide range of factors, ranging from economic indicators to social, political, and geopolitical developments. Among these determinants, international migration holds particular importance. Wars, famine, natural disasters, and economic crises in neighbouring countries have exposed Türkiye to large-scale migration waves. Covering the period 2000–2023, this study examines the impact of migrant labour on informal employment in Türkiye in a comprehensive, multidimensional, and flexible framework using the FA-ARDL method. In doing so, it accounts for the transformative role of public policy variables, namely education and health expenditures, alongside macroeconomic and labour market dynamics.

According to the findings, migrant labour is positively and strongly associated with informal employment. However, the positive association between migrant labour and informal employment is reversed with education expenditures. This suggests that education spending plays a moderating role in the migrant labour–informal employment nexus and may serve as an important policy instrument for the transformation of employment patterns. On the other hand, it is found that health expenditures do not bring about a significant transformation in relation between migrant labour and informal employment. This divergence provides important implications regarding the relative effectiveness and prioritisation of public expenditure policies. In addition, the minimum wage and the unemployment rate are positively and significantly associated with informal employment, whereas the inflation rate does not display a statistically significant effect in the long run.

In light of these findings, the following policy recommendations can be made. Firstly, strategic investments in education should be increased to encourage the transition from informal to formal employment. In this context, vocational, social, and cultural training programs and language courses that will facilitate technical and social adaptation to the formal labour market should be made more widespread and easily accessible, especially in regions where migrants live in large numbers. The mechanism through which education expenditures reduce informality operates primarily by enhancing human capital and reducing information asymmetry in the labor market. Vocational training, language courses, and certification recognition programs directly increase the marginal productivity of migrants, making them more attractive candidates for formal employment. Given that vocational education generally begins at earlier stages of working life and often covers occupations in which informal employment is concentrated, it may function as an earlier institutional bridge toward registered employment compared

to higher education. By providing measurable skills and recognized qualifications, these educational investments serve as a 'signaling' mechanism that lowers the perceived risks and adaptation costs for formal employers. Consequently, higher education spending does not merely increase general outlays; it facilitates a transition by bridging the technical and social gap between the migrant workforce and the formal sector's requirements, thereby internalizing the costs of integration that would otherwise deter formal hiring. Secondly, the incentive effect of minimum wage increases on informal employment should be mitigated by balancing the cost pressure on employers through tax exemptions, exceptions, and various incentive policies. Thirdly, a migrant mentoring mechanism should be established, especially in regions with high migration, to provide free guidance and counselling services to migrants with easy access. Legal and bureaucratic arrangements should be introduced to facilitate the transition to formal employment by simplifying legal work permit processes. Lastly, migrant integration centres, which provide proactive solutions against sudden waves of migration, should be made widespread, and the processes of migrants learning language, social and cultural adaptation, finding a job, receiving legal and psychological support, should be monitored, and integration processes should be accelerated. Informal employment should be prevented through the comprehensive support and supervision network provided by these integration centres for migrants.

This study examines the impact of migrant labour on informal employment in Türkiye through a unique empirical approach by taking into account the regulatory role of public policies. In doing so, it aims to fill an important gap in the existing literature. The study is expected to make a modest yet meaningful contribution to public policy processes concerning international migration and informal employment in this aspect.

Author Contribution Statement

Aslı Güler: Conceptualization, project administration, data collection, methodology, empirical analysis, interpretation of results, validation, visualization, writing – original draft, writing – review and editing

İbrahim Al: Conceptualization, theoretical background and literature review, visualization, writing – review and editing.

Limitations and Future Research

In this study, education and health policies are represented by macro-level aggregate expenditure data. Future research focusing on sectoral heterogeneity, particularly in migrant-intensive sectors such as

agriculture, construction, and services, will provide deeper insights into how migration affects informal employment and how education transforms this relationship. Such extensions will enable more targeted and policy-relevant findings.

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