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REMITTANCES AND INDIRECT TAX REVENUES IN ALGERIA: EVIDENCE FROM THE ARDL AND ECM MODELS

Abstract. This study investigates how remittances from migrants affect Algeria's indirect tax collection between 1977 and 2023. The study uses autoregressive distributed lag (ARDL) and error correction model (ECM) methods to analyse long-term structural impacts and short-term dynamic effects while using the GDP import share and inflation rate as control variables to address the single-country study gap. The research findings show a complex relationship and use bounds testing to establish a long-run equilibrium between the two systems. However, the research shows that remittances do not affect indirect tax revenue through structural changes in the economy. The short-term dynamics responded positively to remittance shocks because the transfers led to temporary increases in consumption, which did not translate into permanent growth in tax revenue. Error correction revealed that institutional adjustment was extremely slow, with indirect tax revenues adjusting toward their long-term balance at an annual rate of 10.5%. Granger causality tests show no predictive feedback of remittances and indirect tax revenues at any level. This study shows that indirect tax collection suffers from two problems: structural rigidity and the informal economy. Addressing these constraints requires two complementary policy interventions: expanding access to formal banking and promoting businesses' use of digital payments. The government must establish a new VAT policy to turn temporary remittance expenses into tax revenue for the country. Furthermore, the study enriches the limited empirical evidence on the fiscal effects of remittances in developing economies and provides insights for policymakers seeking to strengthen domestic revenue mobilisation.

Keywords: *Remittances, Indirect Taxes, ARDL Model, ECM Model, Algeria.*

JEL classification: F24; H20; C22; O55.

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Introduction. Migration has consistently been a prominent and influential phenomenon shaping the global economy, characterised by large migration flows, particularly from developing countries to advanced and emerging economies (Bouzerb et al., 2024). This phenomenon is driven by a variety of economic and social factors, most notably the search for better employment opportunities, higher income levels, and improved living conditions. As migration flows have expanded over time, their economic implications have attracted increasing attention from researchers and policymakers alike.

Research on migration and development has moved away from the traditional emphasis on remittances sent by migrants to their families. It now focuses on a more comprehensive approach that links migration to a sequence of development processes, including investment in human capital, migrant networks, circular/temporary migration, technology transfer, and cultural norms (Giovannetti et al., 2024; Ali et al., 2024). This study addresses the need to examine how remittances now extend beyond just money sent to relatives and include financial assistance through other channels, such as charity supported by migrants in their country of origin (Clemens et al., 2014). Remittances from migrants are one of the largest sources of external funding for low-to middle-income countries, totalling \$656 billion in 2023 and exceeding foreign direct investment and ODA, even though growth slowed to 0.7% compared with the period 2021-2022¹. These flows are crucial because they serve as a relatively stable source of external funding, assisting countries with their current accounts, addressing food insecurity and debt crises, and being a primary driver of economic and human development. Recent studies have shown that remittances initially have a neutral impact on African economies but, when combined with sound governance and effective macroeconomic strategies, yield economic benefits, thereby increasing per capita income in sub-Saharan Africa (Delessa et al., 2024). Research shows that remittances alone have weak or negative effects, but when combined with stable macroeconomic conditions and strong institutional quality, they increase per capita income.

However, the economic impact of

transfers extends beyond their immediate effects, as they generate additional benefits for public entities. Remittances are primarily used to increase domestic consumption and improve welfare, thereby expanding the indirect tax base associated with consumption expenditure (Combes et al., 2014). One study (Lee, 2024) found that a one-percentage-point increase in the ratio of transfers to GDP is associated with an increase in consumption tax revenue of between 0.12 and 0.9 percentage points, and that this effect is explained entirely by higher household consumption expenditure rather than improved tax collection efficiency. On the other hand, Tybursky (2025) states that political economy factors, such as government tax incentives and the tax authority's ability to capture growth in economic activity, can affect the relationship between transfers and government revenues and emphasises the importance of studying this relationship in the specific country context.

Although remittances from Algerians abroad have been a relatively stable source of external financial flows, exceeding foreign direct investment (FDI) during 2014-2022, their role in boosting tax revenues has received insufficient research attention (Ayad et al., 2025). In Algeria, informal remittances are estimated to be two to three times higher than formal remittances, underscoring the need to improve mechanisms for capturing these flows and channelling them through formal channels to maximise their impact on the economy and public finances. Given Algeria's fiscal challenges following the decline in oil revenues since 2014, there is a need to explore alternative sources of domestic resource mobilisation, including the indirect tax channel associated with remittances. (Tahir et al., 2025)

Accordingly, despite the steady increase in the volume of transfers and their relative importance as an external source of financing, the main scientific gap in Algeria is the limited number of country studies that test using long-term time series and a benchmark framework that distinguishes between the short- and long-term relationship between transfers and a specific component of tax revenue (indirect taxes).

This is where our study derives its importance: it seeks to measure the impact of transfers on indirect tax revenues in Algeria, including VAT, customs duties, and others, using annual data for Algeria for the period 1977-2023 compiled from three main sources: published data from the Bank of Algeria, the World Bank's World Development Indicators

¹ Remittances Slowed in 2023, Expected to Grow Faster in 2024 [Text/HTML]. World Bank. 2024. URL: <https://www.worldbank.org/en/news/press-release/2024/06/26/remittances-slowed-in-2023-expected-to-grow-faster-in-2024> (date of access: 14.02.2026).

database, and a statistical summary compiled from the government revenue dataset, to extract/compare revenue indicators as percentages of GDP, using the ARDL/ECM model, which has proven effective in country applications in Algeria (Ayad et al., 2025; Tahir & Farhi, 2025). This study analyses the impact of migrant remittances on Algeria's indirect tax revenue and its duration, in both the short and long term. The study offers tax policymakers tangible evidence on how tax policy and administration, as well as understanding the impact of remittances, can be focused to improve domestic resource mobilisation.

Given the foregoing discussion, the aim of this study is to investigate the impact of migrant remittances on indirect tax revenues in Algeria and to determine whether this impact differs in the short run and the long run. The object of research is the system of indirect tax revenues in Algeria, represented by taxes associated with domestic consumption and trade activities. The subject of the research is the economic relationship between migrant remittances and indirect tax revenues as a mechanism of domestic resource mobilisation.

To achieve this aim, the study addresses the following research tasks: (1) to analyse the evolution of migrant remittances and indirect tax revenues in Algeria during the period 1977–2023; (2) to examine the stationarity properties of the study variables and test the existence of a long-run equilibrium relationship among them; (3) to estimate the short-run and long-run effects of remittances on indirect tax revenues using the ARDL/ECM framework; (4) to assess the speed of adjustment towards equilibrium through the error-correction mechanism; and (5) to investigate the direction of causality between remittances and indirect tax revenues using Granger causality tests.

Literature Review. The empirical literature generally considers the relationship between migrant remittances and tax revenues to be indirect, operating through increased consumption and the expansion of the tax base. Ahmadov and Woldu (2025) examined this relationship in Sub-Saharan African countries using cointegration tests and panel ARDL estimations. Their findings revealed that remittances have a positive and statistically significant effect on total tax revenues and various tax components, including indirect taxes, by stimulating household consumption and economic activity. Similarly, Ahmadov and Zohrab (2024) investigated the relationship between

remittances and tax revenues in post-socialist countries using a panel ARDL framework. The study found that remittance inflows contribute positively to tax revenues in both the short and long run, primarily through their impact on household consumption expenditure and the expansion of the taxable base associated with indirect taxation.

In the same vein, Bangaké et al. (2025) provided recent empirical evidence that remittances may raise tax revenues in developing countries while confirming that the relationship may be nonlinear and conditional on factors such as the informal economy, corruption, and growth volatility. The importance of these findings lies in the fact that they place the relationship between remittances and taxes at the heart of the debate on domestic resource mobilisation and explain differences in results across countries as reflections of different contexts rather than measurement inconsistencies. However, their reliance on a broad international sample leaves an empirical gap regarding the absence of in-depth testing at the country level that clarifies how indirect channels work in practice over time, which our study seeks to address within a country-specific approach.

Asatryan, Bittschi, and Doerrenberg (2017) examined the relationship between remittances and public finances using a panel of countries exposed to oil-price shocks. The study found that remittance inflows contribute positively to public revenues through indirect fiscal channels associated with household consumption. More specifically, the results showed that remittances increase value-added tax (VAT) revenues, while their effect on income taxes remains statistically insignificant. The authors argued that remittances stimulate domestic demand and consumption expenditure, thereby expanding the taxable base of consumption-related taxes. These findings provide empirical evidence that the fiscal impact of remittances is captured primarily through indirect taxation rather than through direct tax channels.

In addition to policy analytical contributions (Abdih et al., 2012), the fiscal impact of remittances in the Middle East, North Africa, and Central Asia shows that remittances can strengthen public finances through indirect channels linked to consumption and economic activity, and thus to tax revenues, even without direct taxes. This study demonstrates its importance by supporting our hypothesis that the taxation of goods and services, along with related indirect taxes, primarily captures the remittance

effect. Existing gaps in country-level data that follow national budget classifications create a need for rigorous tests to demonstrate how transfers affect specific income streams.

The paper (Ebeke, 2010) in the CERDI paper series is one of the most straightforward works on the relationship among transfers, value-added tax, and tax revenues. This paper focuses on VAT as a mechanism for capturing the effects of transfers through consumption and discusses how transfers affect income levels and sustainability. Its importance lies solely in shifting the discussion from the relationship between transfers and total taxes to the analysis of a particular tax channel, namely value-added tax, which lies at the essence of indirect taxes focused on consumption. However, the fact that its findings are based on an international approach leaves open the practical question of how this channel operates within a single country with specific characteristics and over long periods that include structural shocks, which we address in our study by focusing on the national context.

This is consistent with Lee (2024), who focuses on the tax structure and links transfers to changes in tax revenue components, noting that taxes on goods and services (consumption taxes) may be more sensitive to transfers than other taxes. This finding is of interest to us because it supports directing the analysis toward indirect taxes as the most likely channel for the transmission of transfers. However, the comparative nature of the study is insufficient to explain the dynamics of a single country over time and test the relationship of structural stability, which our country study is well-suited to address.

In the context of Latin America, Tyburski (2025) presents an analysis linking transfers to revenues during 1990-2017, highlighting the interaction of results with the political-institutional context, suggesting that the state's capacity to mobilise resources and the governing policy framework not only mechanically but also shape the impact of transfers on revenues. This idea is important for explaining differences in results across countries and for integrating an institutional/policy interpretation when reading the results. However, differences in the economic environment and revenue structure between Latin America and other countries necessitate country-specific tests that focus on the characteristics of the local economy and the paths of indirect taxes within it, which our study adopts.

Thesis (Ogwen, 2023) makes a direct

and powerful contribution to the topic of "remittances-taxes" by analysing the impact of migrant remittances on non-resource-related tax revenues in recipient countries, testing how institutional stability changes this relationship, and concluding that the positive impact appears "mainly through indirect taxes. This study is important to us for two reasons: first, it directly links indirect taxes as the dominant channel. Second, endogeneity is addressed using System GMM with a clear design of institutional variables and interactions. However, the fundamental gap remains: it produces averages across 108 countries during 1996-2020, while we need a long-term national test capable of capturing structural shifts and shocks within a single time series and linking them to local-level indirect tax developments.

Bettin et al.'s (2017) research lacks direct measurement of tax revenue. Yet, their results provide essential empirical evidence on transfer payment systems that serve as economic stabilisers, increasing during economic downturns, drawing on extensive transfer payment data from Italian regions and developing countries. The results demonstrate an important finding: remittances that support consumption during crises will cause indirect spending taxes to respond differently in the short term than in the long term, consistent with the principles of error correction and time decomposition.

Finally, a study published in the journal extends the evidence to post-socialist countries. It examines the impact of remittances on tax revenues, reinforcing the idea that the relationship between remittances and taxes is not limited to a particular region. Its importance lies in reinforcing the universality of the research question and presenting results from a different institutional context (Vusal & Zohrab, 2024). However, the economic and institutional differences between these countries and rentier economies limit the generalizability of the results, leaving an empirical gap that requires country-specific testing with local data and a long-time horizon, which we adopted in our study.

Research Gap. Despite the wealth of comparative/panel evidence, the literature still lacks long-term, country-specific tests using national data that directly link transfers to the evolution of indirect taxes and clearly separate the long-term impact from short-term dynamics and the speed of adjustment aftershocks within a single standard time-series framework. In this context, our study seeks to fill this gap by

analysing Algeria during 1977-2023 using an ARDL-ECM framework with control variables related to the indirect tax channel (imports and inflation), allowing us to determine the presence/absence of a long-term effect and measure the short-term response and speed of imbalance correction. Our study is based on the following hypotheses:

H_{1a}: A long-run cointegration relationship exists among TAX, REM, IMPEN, and INF.

H_{1b}: Remittances (REM) exert a statistically significant long-run effect on indirect tax revenues (TAX).

H₂: Short-term changes in REMs have a positive and significant impact on indirect tax revenues.

H₃: Indirect tax revenues exhibit a significant negative error correction mechanism that returns them to their equilibrium path after shocks.

Research Methodology.

Data and Variables

This study uses Algerian annual data from 1977 to 2023 to test the relationship between REM and indirect tax revenues within an ARDL-ECM framework. Table 1 presents the data sources used to gather data from official international organisations, including the Bank of Algeria, the National Statistics Office, and the World Bank's World Development Indicators, to establish common time periods for comparison.

The complete annual time series dataset (1977–2023) is provided in Appendix 1.

Indirect taxes, as a percentage of GDP, are the dependent variable in the study. In contrast, transfers as a percentage of GDP represent the main explanatory variables, with imports' share of GDP and inflation included as control variables. To minimise unit differences and compare continuous

variables over time, the variable was adopted as a GDP ratio (percentage point), where:

1. **TAX:** (IndirectTax_GDP): ratio of indirect tax revenue to GDP (%).

2. **REM:** (Remit_GDP): Ratio of remittances to GDP (%).

3. **IMPEN:** Import openness index as a percentage of GDP, defined as follows:

$$IMPEN = -Imports_GDP. \quad (1)$$

In some balance of payments series, import flows are recorded with a negative sign in accordance with international accounting conventions. To ensure that the import openness variable enters the model with economically interpretable positive values, the absolute value is taken, so that IMPEN directly represents the share of imports in GDP as a positive proportion.

4. **INF:** (CPI): Annual inflation rate (%).

Measurement notes

All ratios are recorded as percentages (e.g., 8.73 means 8.73%) and not as fractions (0.0873). The defined ratios to GDP, which remain constant, enable a direct percentage-point assessment of transactions relative to other transactions.

Indirect taxes include value-added tax, customs duties, stamp duties, and registration fees.

Table 2 presents the descriptive statistics and the correlation matrix for the research variables from 1977 to 2023, providing a rough picture of their ranges, prevalence, and distributional characteristics. The indicators are used as non-causal measures to prepare researchers for their subsequent ARDL-ECM estimations and dynamic correlation tests.

The table shows the distinct differences between the variables, which show different volatility levels. TAX has limited volatility,

Table 1. Description of variables

Variable	Unit	Data source
IndirectTax_GDP	as a percentage of GDP	Bank of Algeria ¹ , ONS ²
Remit_GDP	as a percentage of GDP	Bank of Algeria
Imports_GDP	as a percentage of GDP	Bank of Algeria
CPI	Ratio (annual series)	World Bank ³

1 Statistics (balance of payments), publications (annual report). Bank of Algeria. 2026. URL: <https://www.bank-of-algeria.dz> (date of access: 14.02.2026).

2 Finances publiques. Publications Office National des Statistiques. 2026. URL: <https://www.ons.dz/spip.php?article2860> (date of access: 14.02.2026).

3 World Development Indicators. World Bank Group. 2026. URL: <https://data.albankaldawli.org/indicator/FP.CPI.TOTL.ZG?locations=DZ> (date of access: 14.02.2026).

Table 2. Descriptive statistics and the correlation matrix

Descriptive statistics/variable	TAX	REM	INF	IMPEN
Mean	7.077743	1.641698	9.014057	20.19927
Median	6.909108	1.551003	5.967164	19.52919
Maximum	9.395658	3.290774	31.66966	29.62505
Minimum	4.886908	0.279337	0.339163	10.89207
Std. Dev.	1.205289	0.731193	7.773154	4.197873
Skewness	0.036558	0.417544	1.533463	0.206031
Kurtosis	2.128189	2.589642	4.601537	2.560222
Jarque-Bera	1.498910	1.695460	23.44312	0.711267
Probability	0.472624	0.428386	0.000008	0.700729
TAX	1.0000	0.056647	0.292296	-0.052878
REM	0.056647	1.000000	0.432054	-0.226909
INF	0.292296	0.432054	1.000000	-0.030861
IMPEN	-0.052878	-0.226909	-0.030861	1.0000

Source: Authors' calculations using EViews 12.

resulting in a standard deviation of 1.205289 between values of 4.886908 and 9.395658. In contrast, INF exhibits extreme volatility, with a standard deviation of 7.773154 and a total range of 31.66966, underscoring the need to treat short-term market changes with caution. Short-term price movements play a greater role than long-term price trends in influencing this relationship. Remittance values ranged from 0.279337 to 3.290774, with an average of 1.641698, enabling researchers to assess whether increases in remittances will affect indirect tax revenues through consumption channels.

The distributional properties of Jarque-Bera test results for INF indicate rejection of normality ($p = 0.000008$), confirming the expected distributional pattern of inflation data and underscoring the need to assess residuals from stationary models rather than relying on normality tests for individual variables. In this situation, the ARDL methodology is suitable because its models handle time series data that lack both the required normal distribution and complete integration-level homogeneity.

Finally, the correlation matrix indicates that the initial linear relationship between TAX and REM is weak (0.056647). In contrast, the relationship between REM and INF is higher (0.432054), suggesting that the effect of transfers, if any, may appear through aggregate/price channels or through lagged dynamics, which is methodologically consistent with the use of ARDL-ECM models that allow for the separation of short- and

long-term effects.

The Estimation Model

This study relies on the autoregressive distributed lag approach and the bounds test to test the existence of a long-term equilibrium relationship between the share of indirect taxes in GDP (), transfers (), import openness (), and the annual inflation rate () in Algeria from 1977 to 2023. The ARDL approach is characterised by its applicability when the variables are a mixture of $I(0)$ and $I(1)$ integrated variables (with the basic condition that no variables are of order $I(2)$). It also allows the estimation of long- and short-term relationships within a single framework.

This study relies on the ARDL distributed lag autoregression methodology and the ECM error correction model formula to test the impact of migrant remittances on indirect tax revenues in Algeria from 1977 to 2023. This methodology is suitable for small- to medium-sized samples and can handle integrated variables of orders $I(0)$ and $I(1)$, provided that there is no $I(2)$ (Pesaran et al., 2001). First, the stationarity properties were evaluated using the ADF and PP tests. The ARDL model is then estimated, and the optimal lags are automatically selected according to the Schwarz criterion (SIC/BIC).

Two specification strategies are adopted within the ARDL-ECM framework for estimation purposes and to verify the robustness of the results. Model A estimates the relationship between indirect tax revenues (TAX) and remittances (REM),

including two control variables: import share of GDP (IM PEN) and consumer price inflation (INF). Model B estimates only the relationship between TAX and REM. The lags are automatically selected using the Schwarz criterion (SIC), with the same estimation settings in both models. Then, a bounds test is performed to assess the existence of a relationship between levels, with the ECM formula extracted to measure short-term dynamics and the speed of adjustment once co-integration is confirmed. The use of two models reduces bias from variable omission and assesses the sensitivity of the study's conclusions to the nature of macroeconomic controls associated with the indirect tax base.

The basic ARDL equation is estimated in level form as follows:

$$TAX_t = \alpha_0 + \sum_{i=1}^p \alpha_i TAX_{t-i} + \sum_{j=0}^{q_1} \beta_j REM_{t-j} + \sum_{k=0}^{q_2} \gamma_k IMPEN_{t-k} + \sum_{m=0}^{q_3} \delta_m INF_{t-m} + u_t \quad (2)$$

Here, p , q indice 1, q indice 2, q indice 3 represent the lags to be selected according to an information criterion favouring a maximum appropriate for annual data.

Main Results.

Unit Root Tests

Unit root tests were performed for each series before the bounds test to ensure that the variables did not exceed , because the presence of variables invalidates the bounds test.

The results of the ADF and PP unit root

hypothesis of a unit root after differentiation. Therefore, the integration order for all variables, $I(t)$, at the 5% significance level supports the appropriateness of applying the ARDL/Bounds approach, provided that no variable is $I(2)$.

Bounds Test for Cointegration

The bounds test was applied to examine the null hypothesis that there is no long-term equilibrium relationship between the variables. The existence of co-integration is inferred by comparing the statistical F with the critical values for the cases of and as reported by Pesaran et al. (2001). Since the study variables are measured as percentages (percentage points) of GDP, they have been retained in this form to facilitate the interpretation of the coefficients without affecting the validity of the bounds test or its decision rules. When necessary, alternative critical values designed for small samples can be used, especially in small annual samples (Narayan, 2005).

The results of the bounds test (Table 4) show a significant difference between the two model specifications. In the basic model that includes INF and IMPEN controls (Model A), the F statistic is approximately 7.2749, which exceeds the upper critical values at the 5% and 10% levels, thus rejecting the null hypothesis that there is no relationship between the levels and confirming the existence of cointegration between TAX and its determinants. The econometric model using only REM data (model B) shows that its F -value of 1.5107 does not meet the required thresholds at the 5% and 10% levels, indicating that this basic model cannot provide evidence of a long-run equilibrium relationship. Indirect taxes are directly linked to macroeconomic conditions.

Table 3. Unit Root Test Results (ADF and PP)

Variable	ADF (Level)	PP (Level)	ADF (1st diff.)	PP (1st diff.)	Decision at 5%
TAX	-2.0118	-1.9965	-6.8123	-6.8172	I (1)
REM	-2.1364	-2.2205	-6.3768***	-6.3830	I (1)
INF	-2.5854	-2.6687	-5.4739***	-5.5306***	I (1)
IMPEN	-2.1578	-2.2228	-7.3288***	-7.384765	I (1)

Notes: ADF: intercept only; lag length in parentheses. PP: intercept only (Newey-West automatic bandwidth). Significance: *** 1%, ** 5%, and * 10%.

tests indicate that all REM, TAX, INF, and IMPEN series are nonstationary at the level below the "stationary only" specification, as the probability values at the level are greater than 0.05 for most variables. In contrast, the series becomes stationary in first differences, as the ADF and PP results on the first differences are highly significant (Prob = 0.0000) for all variables, indicating rejection of the null

Inflation and the import share of GDP were used as control variables to examine how remittances affected the collection of indirect tax revenue in a controlled environment.

Estimating the Long- and Short-Term Relationships

Table 4 presents the estimated long-run coefficients (level equations) obtained from the ARDL model to explain the impact of REM,

Table 4. Results of the bounds test

Dep Var Ind Var		ARDL		F-stat.	
Model (A) Dep: TAX Ind: REM, INF, and IMPEN		(3, 2, 2, 1)		7.274897	
Model (B) Dep: TAX Ind: REM		(1,0)		1.510732	
Critical bounds (Finite sample n = 30)		95% Lower bound	95% upper bound	90% Lower bound	90% Upper bound
Model (A)	F-statistics _(k=3)	3.	4.022	2.56	3.695
Model (B)	F-statistics _(k=1)	3.877	4.46	3.19	3.73

Note: ARDL lags were selected automatically using SIC. Bounds testing uses the finite-sample critical values reported by EViews for the actual sample size (Model A: n = 44; Model B: n = 46), Case 2 (restricted constant, no trend).

Source: Authors' calculations using EViews.

IMPEN, and INF on TAX over the adjusted period from 1980 to 2023.

Although the bounds test confirms the existence of cointegration and a global equilibrium relation for the system, the REM coefficient is not statistically significant ($p = 0.2641$) (Table 5). While the bounds test confirms the existence of a long-run equilibrium relationship among the system variables (H_{1a} accepted), the individual long-run coefficient on REM is not statistically significant ($p = 0.264$), leading to the rejection of H_{1b} . This implies that remittances do not exert a structurally independent and persistent effect on Algeria's indirect tax base over the long run. Economically, this indicates the absence of a structural, long-term effect of remittances on Algeria's indirect tax base. This result can be explained by the fact that a large share of the transfers can be directed to the informal sector or spent on basic goods and services exempt from value-added tax (VAT), thereby preventing these flows from becoming a permanent and stable source of public finance.

The analysis examines the full span of

the relationship, including its short-term movement patterns. Following the bounds test, which confirmed cointegration, the model was adjusted to the ARDL-ECM format to assess the speed of short-term dynamics relative to long-term ERs.

The results of the error correction model in Table 6 show short-term patterns, which differ from the study's long-term results. The one-period-lagged transfer coefficient (DREM(-1)) was positive and statistically significant at the 1% level (0.4433). The second hypothesis (H2) is confirmed through this result. This study demonstrates that remittance payments temporarily boost consumption while increasing indirect tax revenues.

In addition, the error correction coefficient (CointEq (-1)) was negative and highly significant (-0.1054, $p=0.0000$), confirming H3's validity of the dynamic model. The coefficient indicates that the speed of adjustment is relatively slow, as Indirect tax revenues correct only about 10.5% of the imbalance annually, implying that absorbing

Table 5. Long-Run Form (Level Equation)

Variable	Long-run coefficient	t-Statistic	p-value	Interpretation at 5%
REM	-4.591556	-1.136736	0.2641	Not significant
IMPEN	0.430719	0.816068	0.4205	Not significant
INF	0.528605	1.210263	0.2350	Not significant
C	1.107343	0.123934	0.9021	Not significant

Table 6. Error Correction Model (Short-Run Dynamics)

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D (TAX (-1))	-0.016198	0.093658	-0.172952	0.8638
D (TAX (-2))	-0.305325	0.098518	-3.099186	0.0040
D(REM)	0.010396	0.151357	0.068686	0.9457
D (REM (-1))	0.443318	0.147189	3.011894	0.0050
D(IMPEN)	0.123513	0.033551	3.681315	0.0008
D(INF)	0.006586	0.0157	0.419454	0.6777
D (INF (-1))	-0.052278	0.015341	-3.407837	0.0018
CointEq (-1) *	-0.105487	0.016486	-6.398724	0.0000

Table 7. Diagnostic and Stability Tests

Test	Null hypothesis (H0)	p-value(s)	Decision (5%)	Conclusion
Breusch-Godfrey Serial Correlation LM (up to 2 lags)	Number of serial correlations	Prob. F = 0.5227 Prob. Chi-Sq = 0.3941	Fail to reject H0	Number of serial correlations
Breusch- Pagan-Godfrey Heteroskedasticity Test	Homoskedasticity	Prob. F = 0.4601 (also: Prob. Chi-Sq = 0.4156 Scaled explained SS Prob. Chi-Sq = 0.9465)	Fail to reject H0	No heteroskedasticity
Ramsey RESET test	Correct functional form (no misspecification)	Prob. F = 0.5829 $\hat{A}$ (also: t-stat Prob. = 0.5829)	Fail to reject H0	No functional form problem (passed RESET)

shocks from transfers or imports and returning to equilibrium takes approximately 9–10 years.

Diagnostic and Stability Tests

The estimation process is complemented by diagnostic tests for residuals (autocorrelation, heteroskedasticity, and normality of residuals) in addition to CUSUM and CUSUMSQ stability tests to verify the model's stability over the period studied, as follows.

Table 7 shows that no significant statistical problems exist. The Breusch-Godfrey test for autocorrelation up to order 2 yielded p-values greater than 5%. $F = 0.5227$) and (Prob. Chi-square = 0.3941, indicating that the null hypothesis and autocorrelation were not rejected. The Breusch-Pagan-Godfrey test for homoscedasticity also showed probability values greater than 5% (Prob. $F = 0.4601$), supporting the homogeneity of variance hypothesis. Additionally, the Ramsey RESET test did not reveal any functional form specification errors (Prob. $F = 0.5829$), which reinforces the appropriateness of the model specification.

The CUSUM and CUSUMSQ stability tests also indicate that the model coefficients are stable at the 5% level, as the path is within the confidence limits throughout the study period, as shown in Figure 1, confirming the

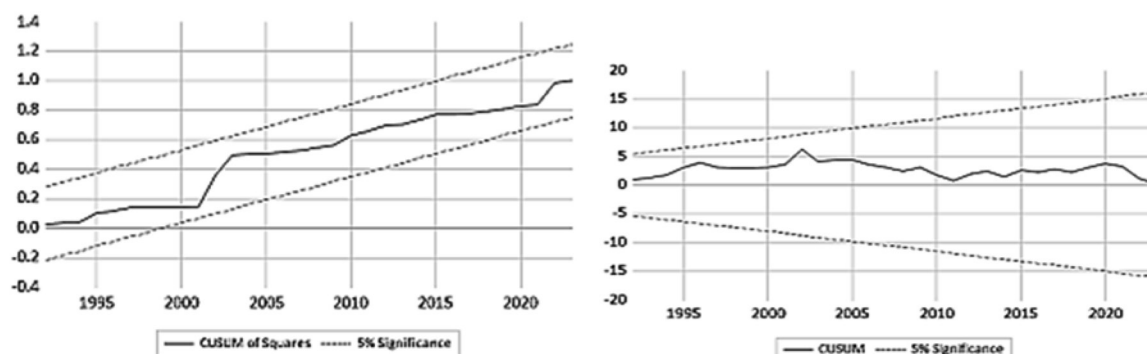
statistical stability of all error correction model coefficients and the absence of significant structural changes during the study period.

The results in Figure 2 also show that the Jarque-Bera test probability was 0.5265, which means that the null hypothesis that the residuals follow a normal distribution at the 5% significance level is not rejected, supporting the validity of the statistical inference associated with the model estimates.

Granger Causality Tests

To complement the bounds testing and error correction results, Pairwise Granger causality tests were conducted to analyse whether remittances (REM) predict indirect tax revenues (TAX) and vice versa. The results are shown in Table 8.

Table 8 presents the results of the Pairwise Granger causality tests in matrix form. Each row indicates an X (causing) variable, while each column indicates a Y (affected) variable. The matrix reveals no statistically significant causal relationship between remittances (REM) and indirect taxes (TAX) in either direction. This strengthens the ARDL-ECM model's finding that remittances do not have a long-run structural impact on Algeria's indirect tax base. The only significant causality there is at the 5% level is from indirect tax revenues to import openness

**Fig. 1. CUSUM and the CUSUM of the Square for the Equation**

(TAX $\rightarrow$ IMPEN; $F = 2.803$, $p = 0.041$). This may suggest that the collection of fiscal revenues impacts the trading situation. There appears to be another causal relationship from import openness to remittances (IMPEN $\rightarrow$ REM) that is only marginally significant at the 10% level ($F = 2.299$, $p = 0.079$), and may indicate

$= 7.275$, Model A), satisfying the prerequisite for ECM estimation. However, the individual long-run coefficient on remittances (REM) is not statistically significant ($\beta = -4.592$, $p = 0.264$), satisfying H_{1a} (cointegration confirmed), yet leading to the rejection of H_{1b} , as remittances do not individually and

significantly determine the long-run level of indirect tax revenues. This finding implies that while a system-level equilibrium exists, remittances do not exert a structurally independent and persistent effect on Algeria's indirect tax base over the long run. This result is consistent with the structural characteristics of the Algerian economy, where a substantial share of remittance inflows is absorbed by the informal sector or directed toward consumption of basic goods and services that are exempt from VAT, thereby limiting their fiscal translation into permanent and stable public revenue. This interpretation aligns with Bangaké et al. (2025), who demonstrated that the remittance-tax relationship is conditional on the degree of informality and institutional quality, and with Tyburski (2025), who emphasised that the state's fiscal capacity to capture economic activity significantly moderates this relationship. The insignificance of the long-run coefficients for IMPEN and INF further suggests that indirect tax collection in Algeria is primarily driven by structural and institutional inertia rather than macroeconomic fluctuations, reflecting a degree

of fiscal rigidity in the tax administration system.

Short-Run Dynamics: A Transitory Consumption Channel

In contrast to the long-run findings, the short-run ECM results reveal a positive and statistically significant relationship between lagged remittances and indirect tax revenues (D(REM (-1)): $\beta = 0.443$, $p = 0.005$), thereby confirming the second hypothesis (H_2). This result demonstrates that remittance inflows generate a temporary surge in household consumption, particularly in the first year following receipt, which translates into higher

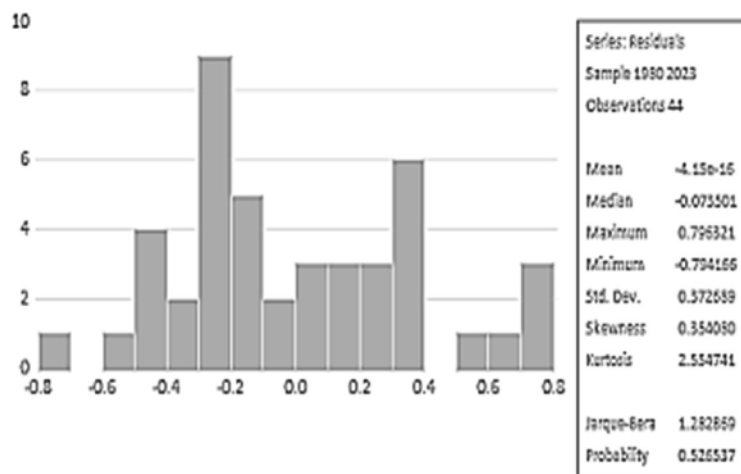


Fig. 2. Histogram and Jarque-Bera Normality Test of the ECM residuals

Table 8. Pairwise Granger Causality Tests (Lags = 4, 1977–2023)

X $\rightarrow$ Y	TAX	REM	IMPEN	INF
TAX	—	1.1913 (0.3323)	2.8034** (0.0410)	1.2149 (0.3226)
REM	0.9626 (0.4405)	—	0.2559 (0.9040)	0.5964 (0.6677)
IMPEN	0.5915 (0.6711)	2.2986* (0.0790)	—	1.4323 (0.2445)
INF	2.0488 (0.1095)	0.7865 (0.5420)	2.0431 (0.1103)	—

Notes: F-statistics reported; p-values in parentheses.

** $p < 0.05$, * $p < 0.10$. — denotes the own variable (diagonal).

Lag length selected based on SIC criterion. Sample: 1977–2023 ($n = 43$ after lag adjustment).

Source: Authors' calculations using EViews 12.

that remittances are trade-migration related.

Discussion of the Results. The empirical results obtained from the ARDL bounds testing framework, the error correction model, and the Granger causality tests collectively yield a nuanced and internally consistent picture of the relationship between migrant remittances and indirect tax revenues in Algeria over the period 1977–2023.

Long-Run Relationship: Cointegration Without Structural Effect

The bounds test confirms the existence of a long-run equilibrium relationship among the system variables at the 5% significance level (F

indirect tax collection — primarily through VAT and customs duties on imported consumer goods. This consumption-driven transmission channel is well-supported by the existing literature: Lee (2024) estimated that a one-percentage-point increase in the remittances-to-GDP ratio raises consumption tax revenue by 0.12 to 0.9 percentage points through higher household expenditure, and Vusal and Woldu (2025) found a positive association between remittances and indirect taxes in sub-Saharan Africa through demand channels. The positive short-run coefficient of import openness (D(IMPEN): $\beta = 0.124$, $p = 0.001$) further supports this interpretation, confirming that remittance-driven consumption is partly reflected in higher import demand, which in turn feeds customs duty revenues. The negative and significant lagged inflation coefficient (D(INF (-1)): $\beta = -0.052$, $p = 0.002$) indicates that inflationary pressures in the preceding period erode real purchasing power, dampening the indirect tax base in the short run — a finding consistent with the macroeconomic context of the high-inflation episodes observed in Algeria during the 1990s.

Error Correction Mechanism: Slow Structural Adjustment

The error correction term (CointEq (-1) = -0.105 , $p < 0.0001$) is negative and highly significant, confirming the third hypothesis (H_3) and validating the model's dynamic specification. The coefficient magnitude indicates that indirect tax revenues correct approximately 10.5% of their deviation from the long-run equilibrium annually, implying a full adjustment horizon of approximately 9 to 10 years following an economic shock. This notably slow speed of adjustment reflects deep-rooted structural rigidities in Algeria's indirect tax collection system, including its heavy dependence on hydrocarbon-linked economic activity, the pervasiveness of the informal economy, and the limited capacity of tax administration to respond dynamically to macroeconomic changes. This finding is consistent with Ebeke (2010), who argued that VAT systems in developing economies with significant informal sectors exhibit sluggish responses to remittance-induced consumption shocks, and with Abdih et al. (2012), who documented similar institutional inertia in MENA fiscal systems.

Granger Causality: Confirming the Absence of Predictive Feedback

The Pairwise Granger causality test results (Table 8) provide additional robustness confirmation for the core ARDL-ECM

findings. No statistically significant causal relationship is detected between remittances and indirect tax revenues in either direction (REM $\rightarrow$ TAX: $F = 0.963$, $p = 0.441$; TAX $\rightarrow$ REM: $F = 1.191$, $p = 0.332$), confirming that remittances do not function as a predictive leading indicator of indirect tax performance, nor do tax dynamics feed back into remittance flows. The only significant causal link at the 5% level runs from indirect tax revenues to import openness (TAX $\rightarrow$ IMPEN: $F = 2.803$, $p = 0.041$), suggesting a fiscal-to-trade feedback channel whereby changes in tax collection capacity influence the structure of trade activity — a finding that merits further investigation in future research. A marginal causal link from import openness to remittances at the 10% level (IMPEN $\rightarrow$ REM: $F = 2.299$, $p = 0.079$) may reflect trade-related migration incentives, though this relationship is not robust at conventional significance levels.

Synthesis and Policy Implications

Taken together, the empirical evidence supports a coherent narrative: remittances in Algeria produce a measurable but transitory boost to indirect tax revenues through the consumption channel in the short run, yet fail to generate a permanent structural improvement in the indirect tax base over the long run. The root causes of this disconnect lie in three interrelated structural constraints: (i) the dominance of informal economic activity that intercepts remittance flows before they reach taxable consumption channels; (ii) the absence of financial inclusion mechanisms that would channel remittances through formal banking and payment systems; and (iii) the slow institutional responsiveness of tax administration, as reflected in the ECT coefficient of -0.105 . These findings have direct implications for fiscal policy in Algeria. Policymakers seeking to leverage remittances as a domestic resource mobilisation tool must prioritise expanding formal financial access, promoting digital payment systems, and redesigning VAT thresholds to more effectively capture remittance-driven consumption — particularly in the durable goods and construction sectors, where remittance spending is most concentrated.

Conclusion. This study aimed to address a national research gap on the impact of migrant remittances on indirect tax revenues in Algeria from 1977 to 2023 by moving beyond cross-country panel studies. Using the ARDL-ECM methodology and including economic controls (import share of GDP and inflation rate), the central finding of the

research was that the impact of remittances on tax revenue is not structural or long-term but rather a short-term, transitory effect par excellence. The Bounds test established a total equilibrium relationship through its findings. Still, it showed that remittances had no impact on long-term estimates. In contrast, the error-correction model showed that indirect taxes responded positively to remittance shocks in the first period ($D\text{ REM}(-1) = 0.4433$). The model also revealed a very slow pace of structural adjustment in indirect tax collection, with only 10.5% of imbalances being corrected annually.

The results indicate that transfer payments in Algeria serve as a temporary measure to help people purchase goods, including imported items that generate customs revenue, but this benefit disappears quickly. The long-term impact is absent because structural elements, including the informal exchange channels that receive a large portion of remittances and the parallel economy, as well as the tendency of households to use these funds for purchases of basic goods that do not have value-added tax (VAT) or to save them as assets that do not incur taxes, prevent this situation.

The study provides specific financial guidelines for Algerian decision-makers by precisely identifying all short- and long-term operational systems. Financial inclusion should be expanded because the current system takes too long to correct errors (ECT approximately -10.5%). The government must offer financial incentives and reduce the parallel market exchange rate premium to accelerate formal remittance banking, as banks need these changes to convert remittances into accessible funds that boost taxable investment. The current value-added tax exemption system requires assessment, as remittances do not have lasting economic effects. Policymakers should focus on integrating the informal service sector into the formal economy to expand the indirect tax base effectively. A significant portion of migrant remittances is targeted at real

estate and individual construction projects. Therefore, governments can impose targeted indirect or consumption taxes on construction goods and real estate services associated with these foreign inflows. This should be followed to ensure that the expansion burden is met and targeted tax exemptions or subsidies for essential goods, thereby providing social support for people, families, and low-income populations.

Implementation of mandatory electronic invoicing for all businesses to issue electronic invoices for imported durable consumer products that transfer ownership rights to customers. This system enables businesses to achieve permanent revenue growth by converting temporary sales increases into ongoing income streams. The system also safeguards tax revenues by blocking unauthorised business operations outside the established system.

This study establishes various research directions to better understand how REM affects indirect tax collection in Algeria. First, we need to establish whether the relationship is nonlinear or asymmetric, which requires measuring the impacts of remittances at specific thresholds for remittances, inflation, and import openness. To identify the tax channels that most effectively demonstrate remittance effects, the indirect tax index should undergo component analysis, including VAT, customs duties, and registration/stamp fees. The study requires institutional and administrative elements as moderating factors to assess their impact on tax collection efficiency and tax process digitalisation through e-invoicing and e-payment systems, as well as on the size of the informal economy, because these elements explain delays in tax impact and long-term variability in impact. The existence of structural shifts over time warrants examination because they indicate whether different periods exhibit different tax-revenue relationships with remittances, helping identify the conditions that drive remittances to generate tax revenue.

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ГРОШОВІ ПЕРЕКАЗИ ТА НАДХОДЖЕННЯ ВІД НЕПРЯМИХ ПОДАТКІВ В АЛЖИРІ: ДАНІ, ОТРИМАНІ ЗА ДОПОМОГОЮ МОДЕЛЕЙ ARDL ТА ECM

У цьому дослідженні вивчається вплив грошових переказів від мігрантів на збір непрямих податків в Алжирі у період з 1977 по 2023 рік. У дослідженні використовуються методи авторегресійної моделі з розподіленим лагом (ARDL) та моделі корекції помилок (ECM) для аналізу довгострокових структурних впливів та короткострокових динамічних ефектів, при цьому частка імпорту у ВВП та рівень інфляції використовуються як контрольні змінні з метою усунення прогалини в дослідженнях, що стосуються лише однієї країни. Результати дослідження свідчать про складний взаємозв'язок і використовують тестування меж для встановлення довгострокової рівноваги між цими двома системами. Однак дослідження показує, що грошові перекази не впливають на надходження від непрямих податків через структурні зміни в економіці. Короткострокова динаміка позитивно реагувала на шоки грошових переказів, оскільки ці перекази призводили до тимчасового зростання споживання, що не перетворювалося на постійне зростання податкових надходжень. Аналіз корекції помилок показав, що інституційна адаптація відбувалася надзвичайно повільно: надходження від непрямих податків наближалися до свого довгострокового рівноважного рівня зі щорічним темпом 10,5 %. Тести на причинно-наслідковий зв'язок за Грейнджером не виявляють прогнозного зворотного зв'язку між грошовими переказами та надходженнями від непрямих податків на жодному рівні. Це дослідження показує, що збір непрямих податків страждає від двох проблем: структурної негнучкості та тіньової економіки. Для усунення цих обмежень необхідні два взаємодоповнюючі заходи державної політики: розширення доступу до офіційних банківських послуг та заохочення підприємств до використання цифрових платежів. Уряд повинен запровадити нову політику щодо ПДВ, щоб перетворити тимчасові витрати на грошові перекази на податкові надходження для країни. Крім того, це дослідження доповнює обмежені емпіричні дані щодо фінансових наслідків грошових переказів у країнах, що розвиваються, та надає рекомендації для політиків, які прагнуть посилити мобілізацію внутрішніх доходів.

Ключові слова: грошові перекази, непрямі податки, модель ARDL, модель ECM, Алжир.

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The authors confirm that artificial intelligence resources were used solely for language editing, proofreading, and improving the clarity and readability of the manuscript.

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Appendix 1. Annual Data Series (1977–2023)

n	TAX	REM	IMPEN	INF
1977	8.73	1.34	29.63	11.99
1978	9.40	1.19	27.75	17.52
1979	6.93	0.97	23.52	11.35
1980	7.06	0.71	22.70	9.52
1981	8.19	0.70	22.79	14.65
1982	7.89	0.73	21.93	6.54
1983	8.60	0.49	19.55	5.97
1984	9.22	0.28	17.21	8.12
1985	8.66	0.57	15.21	10.48
1986	8.80	2.15	13.39	12.37
1987	8.76	1.68	10.89	7.44
1988	8.07	2.64	13.01	5.91
1989	7.75	3.25	17.02	9.30
1990	7.07	2.47	15.75	16.65
1991	6.25	2.82	17.00	25.89
1992	6.86	2.90	17.29	31.67
1993	6.81	2.28	16.00	20.54
1994	7.82	3.29	21.51	29.05
1995	8.32	2.68	24.18	29.78
1996	8.51	1.87	19.36	18.68
1997	8.30	2.20	16.88	5.73
1998	8.49	2.20	17.91	4.95
1999	7.45	1.62	18.42	2.65
2000	6.45	1.44	17.07	0.34

n	TAX	REM	IMPEN	INF
2001	6.52	1.13	15.96	4.23
2002	7.55	1.74	19.52	1.42
2003	6.97	2.39	18.13	4.27
2004	6.52	2.68	19.53	3.96
2005	6.06	1.96	18.54	1.38
2006	5.30	1.31	16.80	2.31
2007	5.15	1.56	18.49	3.68
2008	5.37	1.54	21.06	4.86
2009	6.20	1.75	24.88	5.74
2010	5.41	1.49	21.87	3.91
2011	4.89	1.21	21.49	4.52
2012	5.95	1.39	22.70	8.89
2013	6.59	1.22	23.94	3.25
2014	6.27	1.35	24.97	2.92
2015	7.02	1.48	28.08	4.78
2016	6.91	1.56	27.35	6.40
2017	6.87	1.55	25.80	5.59
2018	6.64	1.75	24.97	4.27
2019	6.82	1.55	23.07	1.95
2020	6.87	1.37	21.56	2.42
2021	6.24	1.05	20.12	7.23
2022	4.97	0.93	17.23	9.27
2023	5.21	0.74	17.33	9.32