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# Remittances and Energy Consumption: A Panel Data Analysis for MENA Countries

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**ABSTRACT**

In this paper, we investigate the effect of remittances on energy consumption. To this aim, we analyzed MENA countries over the 1977-2014 period. We used Westerlund and Edgerton's (2007) cointegration test, the AMG estimator, and Dumitrescu and Hurlin's (2012) panel causality tests. The results of the cointegration test showed there is a long-term relationship between remittance inflow and energy consumption. According to the AMG estimator, remittance inflow has a positive impact on energy consumption, indicating that increases in remittances will be followed by increases in energy consumption. The panel causality test displayed a bidirectional causal linkage between remittance and energy consumption. On the basis of these findings, we can say that authorities should take account of remittance inflow in their energy consumption and environmental degradation policies.

**Keywords:** Remittances, Energy Consumption, MENA Countries, Panel Data, Cointegration
**JEL Classifications:** F24, Q4

## 1. INTRODUCTION

Remittances are an important factor for boosting economic growth in recipient countries. Remittance income also plays a crucial role in the reduction of poverty and income inequality because migrants transfer funds to their low-income families in many countries (Akçay and Demirtaş, 2015; Tung, 2018). Moreover, because it is one of the most important sources of foreign currency flows to developing countries, the growth of inward remittances promotes financial development and compensates for a national savings' deficit by enhancing banking deposits and lending to the private sector (Aggarwal et al., 2011; Ebeke and Goff, 2011; Masuduzzaman, 2014). Other benefits of remittances include increased productivity via an effect on promoting human capital, as documented by Jongwanich (2007). Furthermore, the flow of remittances are a more stable source of foreign currency flow compared with other external sources, including foreign direct investment, foreign aid, and export (Huay, 2017). Although these foreign capital flows are subject to cyclical fluctuations, which rise during booms and decrease during downturns, remittance income is generally observed to increase during economic recessions in recipient countries (Bououiyour and Miftah, 2015; Chowdhury, 2011; Koechlin and Leon, 2007).

In addition to these macroeconomic benefits, the receipt of remittances also has influence at the household level. The growth of inward remittances first leads to increases in the revenue of migrant families, and it is used to fulfill their needs because recipient families are usually less wealthy (Agarwal and Horowitz, 2002; Hussain and Yan, 2019). In this context, the remittances from migrant workers have a positive impact on consumption and savings, which then stimulates economic growth (Al-Mukit et al., 2013; Masuduzzaman, 2014). There has also been consensus in the existent literature that remittances promote education, health care access, and entrepreneurial opportunities, which in turn promote investment (Vacaflores, 2018). In sum, remittances

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play an important role in the economies of many developing and less developed economies (Hussain and Yan, 2019).

Conversely, remittances may influence the economy adversely. Remittances can exacerbate inflation through inducing increases in consumption (Narayan et al., 2011; Tung et al., 2015). Another risk associated with remittances is harming economic growth by taking out potential employees from the labor force due to the positive influence on household revenue. Remittance inflow can also have undesirable results on current account deficits, causing increases of the exchange rate, which is known as the Dutch disease phenomenon in the literature (Tung, 2018).

This study focuses on the impact of remittance inflow on energy consumption. Researchers have paid attention to examine the determinants of energy consumption. Related to this field, some studies have documented that the energy demand function is determined by economic growth, trade openness, financial development, industrialization, and urbanization (i.e., Haider and Adil, 2019; Paramati et al., 2018; Shahbaz et al., 2015, 2019). But it seems there is few studies regarding the influence of remittance inflow on energy consumption (Rahman et al., 2021; Sahoo and Sethi, 2020; Das and McFarlane, 2020; Akçay and Demirtaş, 2015). To this aim, we estimated the energy demand function for five MENA countries (i.e., Algeria, Egypt, Jordon, Tunisia, and Morocco) which are among the highest remittance inflowing countries. In the context of MENA countries (excluding high-income countries), the total amount of remittances realized was 11.3 billion in 2000 and hit 59 billion in 2019. Similarly, based on the data from the World Bank (2020), the share of official remittance in GDP also rose over the years. In this respect, for example, although it stood at around 2.79% in 2000, it accounted for 5.44% of GDP in 2019 (World Bank, 2020).

Energy consumption is one of the main inputs of economic growth. At the same time, energy consumption is essential for industrialization and economic activities (Sahoo and Sethi, 2020). Energy demand in developing countries has been increasing in relation to economic growth. In this regard, clarifying whether remittances have an effect on energy consumption will contribute to the literature by providing evidence about MENA countries. In addition, establishing a relationship between remittances and energy consumption has policy implications about energy demand and energy consumption for authorities in the examined countries. Moreover, this study applies advanced empirical approaches such as Westerlund and Edgerton's (2007) cointegration test, the Augmented Mean Group (AMG) estimator, and Dumitrescu and Hurlin's (2012) panel causality tests, which are among second-generational econometric techniques and thus take account of cross-sectional dependency.

The rest of the paper is organized as follows: The relationship between remittance flow and energy consumption is expressed in section 2; the literature review is presented in Section 3; Section 4 describes the data; Section 5 provides the result of the empirical study; and Section 6 explains the conclusion and policy recommendations.

## 2. REMITTANCE-ENERGY CONSUMPTION RELATIONSHIP

The relationship between energy consumption and remittances can be seen in several ways. For example, it is expected that remittance inflow positively affects energy consumption. In this case, remittances are considered permanent income by recipient households and are spent to meet their daily needs of energy (Das and McFarlane, 2020). Akçay and Demirtaş (2015) classified the channels through which remittance income may affect energy consumption positively in two main groups as (i) direct effect and (ii) indirect effect. Direct effect is denoted as consumption effect by Sahoo and Sethi (2020). According to direct effect, remittance inflows first increase the disposable income of recipient households, promoting the demand for durable and luxury goods such as refrigerators and automobiles, which require energy to work. The indirect effect can boost economic activities due to remittance inflows, which in turn stimulate energy consumption. The indirect effect can occur in several channels. One of them is the business effect (Sahoo and Sethi, 2020). The business effect captures the increase in energy used in the production process of intermediate and final durable goods due to increases in demand resulting from remittance inflow. Another energy-increasing impact can occur through the multiplier effect and the positive spillover effect. Because, when recipient households spend their remittances, this will increase the demand and hence economic activities in other sectors such as retail trade, real estate construction, and transport. Furthermore, remittances are a strong source of financial capital, which can be transferred to investments in other sectors. Therefore, production increases will create new income for households in the future, stimulating household consumption. Sahoo and Sethi (2020) highlighted the importance of a developed stock market to ensure confidence in the economy, which plays a vital role for investments and physical capital formations. Finally, Akçay and Demirtaş (2015) pointed out the human capital channel. Households can prefer to spend their remittance incomes to improve their education and health, which exacerbates economic productivity and growth.

In contrast, there can be no causality linkage between remittances and energy consumption. This situation results from detecting remittances as transitory income by the families of migrants due to the temporary employment of migrants abroad. Households do not change their consumption patterns if their income increases temporarily. Additionally, energy consumption can have an impact on remittances, showing that increases in energy demand to sustain increasing living standards will induce the rise of remittance demand to finance energy expenditures (Das and McFarlane, 2020).

## 3. LITERATURE REVIEW

Few studies have concentrated on the impact of remittance inflow on energy consumption. In regard to this, Akçay and Demirtaş (2015) empirically investigated the relationship between remittances and energy consumption in Morocco. Akçay and Demirtaş (2015) applied the Johansen-Juselius cointegration test

and the vector error-correction model (VECM) for their analyses over the 1975-2010 period. The authors also included also economic growth, financial development, and industrialization as determinants of energy demand. The empirical output denoted that related variables are cointegrated in the long run. The findings of impulse response functions confirmed that remittances explain variations in energy consumption. Furthermore, the findings of the VECM causality test support the impact of remittance on energy consumption reporting a unidirectional causal link, from remittances to energy consumption. Rahman et al. (2021) also examined the influence of remittances on energy consumption and focused on the four highest remittance recipient countries (India, Pakistan, Bangladesh, and Sri Lanka) in South Asia and analyzed the period from 1976 to 2019. The authors used the panel cointegration test from Pedroni (1999) and Kao (1999), the FMOLS and DOLS estimation techniques, and the Granger causality test. The empirical findings of the study showed there is a long-term relationship between energy consumption and remittances. According to the findings, remittance income has a positive impact on energy consumption. The outcome of the causality test showed a unidirectional causality, running from remittance to energy consumption. Rahman et al. also employed economic growth and urbanization as potential determinants of energy consumption and found a statistically significant and positive impact in the long run. Sahoo and Sethi (2020) searched whether there exists a linkage between remittance inflow and electricity consumption for India. For this purpose, Sahoo and Sethi (2020) included the variables of trade openness, foreign direct investment, and urbanization as explanatory variables in energy demand function during the 1975-2017 period. The authors employed the ARDL method and Engle and Granger's (1987) cointegration test, with a structural break for the robustness of the analysis. The results demonstrated that remittance inflow stimulates electricity consumption in India. Das and McFarlane (2020) studied the causality and cointegration association between remittances and energy consumption for Bangladesh. The authors used different types of energy sources: electricity, natural gas, coal, and petroleum. They analyzed the 1980-2016 period by employing the ARDL and Granger causality methods and reached different results, depending on the energy sources. For example, the results showed there is a bidirectional relationship between remittances and energy consumption when natural gas and electricity consumption are modeled as energy indicators.

## 4. DATA

To evaluate this association between remittance inflow and energy consumption, we concentrated on MENA countries. We analyzed five MENA countries (Algeria, Egypt, Jordon, Tunisia, and Morocco) using annual data spanning the 1977-2014 period, depending on the availability of data. Gulf Cooperation Council (GCC) countries are not included in the analysis because they are among the top remitters in the world (Miniaoui and Ouni, 2020). We collected the data used in this study from the World Development Indicators (WDI) database published by the World Bank (2020).

We examined the influence of remittances on energy consumption by considering economic growth as a control variable. Therefore the panel model used in this study is written below:

$$ENER_{it}=\beta_1 REM_{it}+\beta_2 GDP_{it}+\varepsilon_{it} \quad (1)$$

Where, $\beta_1$ and $\beta_2$ are the parameters. ENER, REM and GDP demonstrate energy consumption, remittances and economic growth, respectively. To represent energy consumption, we used the value of kilogram of oil equivalent per capita. REM refers to the amount of personal transfers and compensation of employees received in current US dollars. To display the variable GDP, we preferred the current US dollar value of GDP per capita. We employed the natural logarithm value of all variables in the model.

## 5. EMPIRICAL RESULTS

To analyze the possible impact of remittances on energy consumption in the first step, we applied the cross-section dependency test. To determine whether there exists a cross-section dependence, variables can help us select the proper unit root tests and cointegration methods. In this respect, if there is a cross-section dependency in the panel, we should employ second generation panel unit root tests because the results of the first-generation panel unit root tests will be spurious due to size distortions (Apergis and Payne, 2014).

To investigate the presence of cross-section dependency, we applied the CDLM test proposed by Pesaran (2004) and LMadj (adjusted cross-sectional dependence Lagrange multiplier) test introduced by Pesaran et al. (2008). Pesaran's (2004) CDLM test estimates the average of correlations of the OLS (ordinary least squares) residuals (Dobnik, 2011). This test is used when the time dimension is greater than the cross-section dimension (T > N). The LMadj test is the bias-adjusted version of Breusch and Pagan's (1980) LM test and has higher power than the CDLM and LM tests. Table 1 displays the results of the CDLM and LMadj tests. As shown in Table 1, the null hypothesis of cross-sectional independence across the panel members is rejected at the 1% significance level, implying that shocks to an individual can transmit to other individuals in the panel.

After reaching the evidence of cross-section dependency, we utilized Smith et al.'s (2004) panel unit root test. Smith et al.'s (2004) test is a second generation test that performs under cross-section dependency and estimates the results via the bootstrap technique. Table 2 displays the results of this test. According to Table 2, the null hypothesis of the unit root cannot be rejected at the level, but it is rejected in the first difference, revealing that each variable is integrated at order one.

In the third step, we searched the cointegration relationship to inspect the long-term connection between energy consumption

**Table 1: Results for cross-section dependency tests**

| Test | ENER | REM | GDP |
|---|---|---|---|
| CDLM test | 18.308 (0.000) | 10.064 (0.000) | 13.179 (0.000) |
| LMadj Test | 27.052 (0.000) | 13.873 (0.000) | 10.535 (0.000) |

Numbers in parentheses are P values

**Table 2: Results of the panel unit root test**

| Variables | $\bar{t}$ | $\overline{LM}$ | $\overline{Max}$ | $\overline{Min}$ | $\overline{Was}$ |
|---|---|---|---|---|---|
| ENER | –1.833 (0.197) | 1.160 (1.000) | 4.754 (0.082) | 1.756 (0.468) | 1.263 (1.000) |
| d (ENER) | –4.846 (0.000) | –4.266 (0.000) | 13.586 (0.000) | 12.146 (0.000) | –4.541 (0.000) |
| REM | –0.905 (0.926) | –0.772 (0.744) | 1.399 (0.935) | 1.265 (0.700) | 0.243 (1.000) |
| d (REM) | –4.266 (0.000) | –4.067 (0.000) | 13.401 (0.000) | 12.601 (0.000) | –4.256 (0.000) |
| GDP | –0.523 (0.963) | –0.324 (0.902) | 0.404 (0.998) | 0.196 (0.995) | 0.165 (0.996) |
| d (GDP) | –3.366 (0.000) | –2.959 (0.000) | 10.234 (0.000) | 8.639 (0.000) | –3.266 (0.000) |

d refers to the first differences. *P* values are given in parenthesis

**Table 3: Results of the panel bootstrap cointegration test**

| Test | Test statistic | P-value |
|---|---|---|
| LM bootstrap | 3.919 | 0.137 |

**Table 4: Results of the AMG estimator**

| Regressors | Coef. | Std. Err. | Z- stat. | Prob. |
|---|---|---|---|---|
| GDP | 0.1376959 | 0.0637651 | 2.16 | 0.031 |
| REM | 0.0302589 | 0.0090856 | 3.33 | 0.001 |
| C | 1.694327 | 0.8422296 | 2.01 | 0.044 |

**Table 5: Results of the causality test**

| Null hypothesis | W-statistic | P-value |
|---|---|---|
| REM does not cause ENER | 2.394911 | 0.022669 |
| ENER does not cause REM | 3.332570 | 0.001546 |
| GDP does not cause ENER | 2.341118 | 0.025749 |
| ENER does not cause GDP | 1.590213 | 0.112666 |
| GDP does not cause REM | 1.093758 | 0.219349 |
| REM does not cause GDP | 3.487739 | 0.000911 |

and remittances. To this aim, we employed Westerlund and Edgerton's (2007) panel bootstrap cointegration test, which has the assumption of cross-sectional correlation. This test corrects for the autocorrelation and endogeneity problems. Table 3 reports the outcomes obtained from Westerlund and Edgerton's (2007) test. As seen in Table 3, the lm statistic demonstrates that the cointegration null hypothesis cannot be rejected, confirming the presence of a long-term relationship among energy consumption, remittance inflow, and GDP in the model.

At the fourth step, we focused on the estimation of the long-term impacts of remittance income on energy consumption and infer the long-term coefficient parameters. We thus used a recently developed method, namely the AMG estimator. Eberhart and Bond (2009), and Eberhart and Teal (2010) proposed the AMG estimator, and it works in the case of cross-section dependency. Another advantage of the AMG estimator is it allows for heterogeneity. In addition, the AMG estimator produces efficient and unbiased results, regardless of the dimensions of time and cross-sections in the panel data (Le and Van, 2020).

According to the results in Table 4, there is a positive impact of remittance inflow on energy consumption, which implies that the higher the remittance inflow, the higher the energy consumption coincidence with the related theory. This evidence reveals that remittance inflow is one of the determinants of energy demand. According to the results, a 1% increase in remittance inflow will stimulate energy consumption by 0.03%. This effect is reflected in energy demand through the consumption or industrialization process. These findings are consistent with the results of previous studies by Akçay and Demirtaş (2015), Rahman et al. (2021), and Sahoo and Sethi (2020). The AMG results also reveal that economic growth positively affects energy consumption. The increase in economic growth will promote income and thus the needs of people, which in turn enlarges the production, requiring higher energy consumption. Simply, the concern with economic growth results from its impact on boosting production.

Last, to affirm the causality linkage between the variables, we utilized Dumitrescu and Hurlin's (2012) panel causality test. This test has the advantage of performing in case of cross-section dependency by using Monte Carlo experiments. Dumitrescu and Hurlin's (2012) test can work when either T > N or T < N for panels. In this test, the null hypothesis of no causation in the panel is tested against the alternative hypothesis, implying the existence of a causal relationship in at least one unit. The results of the causality test are displayed in Table 5. As seen in this table, there is a bidirectional causality linkage between remittance inflow and energy consumption at the 5% significance level. This finding reveals the influence of remittance on energy consumption, supporting the findings of the cointegration estimates. Further results from Dumitrescu and Hurlin's (2012) test highlight the presence of the casualty effect of energy consumption on remittance coincidence on the results from Das and McFarlane (2020). As noted by Das and McFarlane (2020), remittance inflows increase as a response to increases in energy demand to meet the rises in energy demand.

Table 5 also provides evidence about the association between energy consumption and economic growth. In related literature, four possible connections are explained. First, there can be a bidirectional causal relationship, from energy consumption to economic growth, namely the energy-led growth hypothesis. The evidence supporting the validity of the energy-led growth hypothesis implies that economic growth needs energy, and thus energy consumption boosts economic growth, resulting from being a production factor. Second, the conservation hypothesis can be valid, implying economic growth contributes to energy consumption. Third, there is the feedback hypothesis, which represents bidirectorial causality between energy consumption and economic growth. Fourth, the neutrality hypothesis can be an outcome, which postulates there is no causal connection between the related variables (Apergis and Tang, 2013; Bartleet and Gounder, 2010; Bercu et al., 2019; Hasanov et al., 2017; Mukhtarov et al., 2017). According to the results in Table 5, economic growth exhibits Granger causality to energy consumption, illustrating that

increases in economic growth will result in increases in energy consumption, supporting the long-term cointegration results. Finally, it can be seen that the null hypothesis of remittances does not cause GDP to be rejected at the 1% significance level. This one-way causality reflects the promoting impact of remittances on economic growth.

## 6. CONCLUSION

Migrants from poor countries immigrate with the aim of finding job opportunities in developed countries and send funds home to their families, which can influence local economic activity in the origin countries. The objective of this study was to examine whether remittances have an impact on energy consumption. To this aim, we focused on five MENA countries (i.e., Algeria, Egypt, Jordon, Tunisia, and Morocco), which are among the leading remittance recipient countries, for the years between 1977 and 2014. To analyze the long-term relationship between remittances and energy consumption, we applied Pesaran and Edgerton's (2007) cointegration test and obtained evidence of the co-movement of variables. Based on this finding, we estimated long-term coefficients via the AMG estimator. The results of the AMG estimator showed that remittances have a statistically significant impact on energy consumption, and this impact is positive, as expected in the theory. This positive influence reveals that, the higher the remittance inflow, the higher the energy consumption. The growth of inward remittance to developing countries will ensure reliable permanent revenue for households, which means a higher standard of living, inducing higher energy demand. In addition, we performed a causality analysis via Dumitrescu and Hurlin's (2012) panel causality test and noted a bidirectional causality linkage between remittance and energy consumption. This connection represents the promotion of energy consumption due to remittance increases, but thereafter it will increase the need of remittances to meet high energy demands.

Additionally, the findings of the causality test confirmed the economic growth-induced energy demand due to the one-way causal relationship, running from economic growth to energy consumption. It was also seen that remittances exhibit Granger causality in regard to economic growth, but economic growth does not exhibit Granger causality in regard to remittances, revealing that remittances boost economic growth and remitters transfer money, regardless of cyclical movements in economic activities in recipient countries. Consequently, remittances have an influence on energy consumption through the channels of both consumption and economic growth.

In sum, this study has policy implications relevant to remittances and energy demand in examined countries. In this context, governments can provide reductions in tax and transfer costs and subsidies for increasing remittances to accelerate economic growth. Moreover, policy makers should establish policies for the transmission of remittances mostly to investment and the production process. Governments should also implement policies to consider remittances to reach stable energy demand due to the direct and indirect influence of remittances on energy consumption. In contrast, as pointed out by Sahoo and Sethi (2020), policy makers should encourage the establishment of renewable energy sources because the enlargement of energy consumption will exacerbate environmental degradation in the examined countries.

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