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"Revealing the future": an ARIMA model analysis for predicting remittance inflows

Imran Khan and Darshita Fulara Gunwant
Department of Management Studies,
Birla Institute of Technology and Science Pilani – Dubai Campus,
Dubai, United Arab Emirates

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Abstract

Purpose – The purpose of this research is to develop a predictive model that can estimate the volume of remittances channeled toward Yemen's economic reconstruction efforts.

Design/methodology/approach – This study utilized a time-series dataset encompassing remittance inflows into Yemen's economy from 1990 to 2022. The Box-Jenkins autoregressive integrated moving average (ARIMA) methodology was employed to forecast remittance inflows for the period 2023 to 2030.

Findings – The study's findings indicate a downward trajectory in remittance inflows over the next eight years, with projections suggesting a potential decline to 4.122% of Yemen's gross domestic product by the end of 2030. This significant decrease in remittance inflows highlights the immediate need for concrete steps from economic policymakers to curb the potential decline in remittance inflows and its impact on Yemen's economic recovery efforts.

Originality/value – The impact of global remittance inflows on various macroeconomic and microeconomic factors has long been of interest to researchers, policymakers, and academics. Yemen has been embroiled in violent clashes over a decade, leading to a fragmentation of central authority and the formation of distinct local alliances. In such prolonged turmoil, foreign aid often falls short, providing only temporary relief for basic needs. Consequently, the importance of migrant remittances in sustaining communities affected by conflict and disasters has increased. Remittances have played a crucial role in fostering economic progress and improving social services for families transitioning from conflict to peace. Therefore, this study aims to estimate and forecast the volume of remittances flowing into Yemen, to assist in the nation's economic reconstruction.

Keywords Yemen, Economic reconstruction, Remittance inflows, Forecasting, Time-series analysis

Paper type Research paper

1. Introduction

Yemen has endured a protracted cycle of armed conflicts for over a decade, fueled by domestic militant organizations and foreign powers. These conflicts have eroded the central authority of the Yemeni government, fragmenting the nation into disparate factions. The gradual disintegration of Yemen's national unity has been met with growing concern among the international community, including the United States. Beyond geopolitical implications, the war's impact on Yemeni institutions has exacerbated the country's dire socioeconomic conditions, transforming it into the world's worst humanitarian crisis (Moyer *et al.*, 2019).

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Yemen, with a population of 30 million, ranks dismally on the Human Development Index (HDI) due to poverty, low life expectancy, and poor education (Moyer *et al.*, 2019). The ongoing war has exacerbated this crisis. A 2015 study showed that over half the population lost their main income source due to the conflict (Fakhreddine, 2016). World Bank reports (2018) documented the war's devastation on Yemen's economy and society. Production has plummeted by 50%, incomes have spiraled downward, and 81% of the population lives on $3.20 a day (World Bank, 2018). The UN estimated that 22 million people need urgent humanitarian aid. This six-year conflict has become the world's worst humanitarian crisis, claiming nearly 18,400 lives. Since 2020, 20 million Yemenis have faced unprecedented food insecurity, with 66% needing food aid to survive (HRW.ORG, 2021). The UN predicted that indirect war deaths from hunger and lack of healthcare could reach five times the number of direct war deaths by 2030, with a potential 1.5 million infant deaths. Table 1 compares the impact of war-related fatalities in 2019, 2022, and 2030 to indirect war fatalities.

Yemen, a low-income nation, grapples with severe economic challenges. Many Yemenis migrate for work, with a significant portion (73.16%) residing in Saudi Arabia and the UAE (World Bank, 2017). This remittance flow is crucial as Yemen's food import capacity weakens due to rising prices and a depreciating currency. The situation is dire, with millions reliant on food aid and the COVID-19 pandemic worsening malnutrition, according to the World Food Programme. Yemen's trade deficit widens year after year, straining the economy further. National debt spirals upwards, exceeding $30 billion by 2017. GDP growth is volatile, fluctuating between 10% in 2016 and -28% in 2015. While Egypt is the top export partner, the UAE is the main source of imports (O'Neill, 2021). Effective use of remittances and addressing the trade deficit are critical for Yemen's economic recovery.

Yemen's six-year conflict and the pandemic have caused a devastating humanitarian and economic crisis (Xu, 2020). Lack of aid, dwindling reserves, and rising costs have weakened the currency and inflated food prices. Over 80% of the population (24 million) needs urgent assistance (UN, 2023). Yemen relies heavily on foreign inflows – aid, development funds, or remittances – to meet basic needs and rebuild the economy. Furthermore, Yemen's economic progress relies on both globalization and structural reform, and remittances play a crucial role in linking these two features. Globalization offers prospects for economic diversity and specialization, while remittances serve as a crucial source of support for household incomes and contribute to other facets of growth (Behera and Pozhamkandath Karthiayani, 2022).

Yemen's pre-war economy was heavily reliant on oil and gas exports, which accounted for 25% of its GDP and 65% of government revenue (Gaynor, 2021). However, the conflict fragmented institutions and severely impacted the Central Bank's ability to manage foreign exchange, hindering imports and paying public sector salaries. This, coupled with the humanitarian crisis, led to hyperinflation and a struggling economy. Given this situation, remittances have gained significant importance as a growing source of income for developing countries, including Yemen. Over two decades, remittances have increased by an astonishing 103.67%, rising from 0.37% to 0.76% of GDP in 2019, surpassing traditional aid and investment (World Bank, 2021). In 2022 alone, Yemen received $3.9 billion in remittances,

Year	War-related fatalities	Indirect war fatalities
2014	0	0
2019	102,000	131,000
2022	166,000	296,000
2030	316,000	1,484,000

Source(s): United Nations

Table 1.
Effects of war

serving as a lifeline for 10% of its population (Oxfam intl, 2020). However, the civil war, combined with the effects of the pandemic, has caused a 45% decline in real GDP by 2019, further exacerbated by the pandemic.

Remittances play a crucial role in the development of economies like Yemen (Ekanayake and Moslares, 2020). Therefore, accurate predictions of future remittance inflows would be invaluable for policymakers to maximize their benefits through proactive policy implementation. However, the existing literature lacks specific forecasts for Yemen. Past studies on remittances in developing economies have presented conflicting trends, with some predicting declines and others anticipating increases (Khan and Gunwant, 2023a). This study aims to fill this gap by providing forecasts for future remittance inflows in Yemen. Such forecasts are crucial because Yemen, being a war-torn country with high poverty rates, low employment, and declining economic growth, heavily relies on remittances for basic survival. Understanding the future flow of remittances can significantly contribute to the Yemeni economy's well-being. This study is structured into five sections: an introduction, a comprehensive literature review, a model selection process, the presentation and discussion of the results, and a conclusion that includes recommendations.

2. Literature review

Remittance studies encompass two main perspectives: micro and macro. Microeconomics studies focus on understanding why migrants remit and how much, with a particular focus on their social and demographic characteristics. Three main motivations for remittances emerge: altruism, self-benefit, and economic factors (Khan and Gunwant, 2023a). Macro studies examine the overall flow of remittances and the economic well-being of both sending and receiving countries. Key factors considered for sending countries include GDP, migrant stock, and exchange rates (Xu and Zhang, 2021). Host countries, on the other hand, consider variables such as unemployment, wages, and economic growth, as a thriving host economy tends to fuel remittance growth (McCracken *et al.*, 2017).

Remittances, which refer to the money sent home by migrants, play a critical role in the development of recipient nations (Padhan *et al.*, 2023). Even during the economic downturn caused by the COVID-19 pandemic in 2020, remittances displayed surprising resilience, experiencing a smaller decline than initially anticipated (Khan and Akhtar, 2022). According to the World Bank, remittances to developing countries decreased by a marginal 1.6% in 2020 compared to 2019, which was significantly less severe than the impact of the 2009 financial crisis. Notably, remittance flows were more stable than foreign direct investment, which experienced a decline of over 30% in 2020. The World Bank projected, that in 2020, remittances would surpass both foreign investment and aid (World bank press release, 2021). The relationship between remittances and economic activity is complex. One perspective suggests that economic growth in sending countries leads to a reduction in remittances as incomes rise (Khan and Gunwant, 2023b). This countercyclical trend is supported by some studies (Hor and Pheang, 2017). However, another perspective argues that economic growth in recipient countries creates better investment opportunities, attracting higher levels of remittances (McCracken *et al.*, 2017). This highlights the positive correlation between GDP and remittance inflows.

The literature identifies several factors that influence remittance flows, including the number of expatriate migrants. Additionally, socio-demographic factors such as financial constraints have been identified as variables that affect remittance inflows (Padhan *et al.*, 2022). These studies consider variables such as the proportion of females in the host country's population, the duration of the migrant worker's stay, the household's income level, the employment status of other family members, the migrant's relationship status, educational attainment, work experience, the number of children and their educational status, and the

economic conditions before migration (Ilahi and Jafarey, 1999). Djajić (1989) attempts to model the savings strategies of migrant workers to understand their decisions regarding remittances.

A significant body of research explores the link between remittances and economic development in recipient countries. Studies by Tabit and Moussir (2016) establish a positive correlation between the size of a migrant population and the value of remittances sent back home. However, the impact of domestic inflation on remittances remains inconclusive. Inflation can erode the purchasing power of recipient countries, potentially increasing their reliance on remittances, as shown by Elsabbagh *et al.* (2021). Conversely, high inflation may indicate economic instability, discouraging remittances (Ezeoha, 2013). The overall impact of remittances on development is mixed. On one hand, they can alleviate poverty by boosting family income (Daway and Ducanes, 2015). On the other hand, their effect on economic growth depends on how they are used. When directed towards investments in education and training (Edwards and Ureta, 2003), physical capital accumulation (Lucas, 2005), or overcoming credit constraints for households and entrepreneurs (Mesnard, 2001), remittances can promote economic growth. Further research is needed to fully understand the complex dynamics at play (Gapen *et al.*, 2009), but it is crucial for recipient countries to effectively utilize remittances to achieve meaningful development.

There is ongoing debate about the impact of remittances on economic growth (Gapen *et al.*, 2009). While some argue that remittances bring benefits such as expanded financial services (Hakura *et al.*, 2009), others contend that their impact depends on how they are used. Critics (Glytsos, 1993) believed that remittances are primarily spent on necessities or luxuries, hindering long-term growth. Ethical concerns also exist, suggesting that remittances may disincentivize work, thus slowing development (Chami *et al.*, 2003). The Dutch Disease theory (Rabbi *et al.*, 2013) suggests that an influx of remittances could strengthen the recipient country's currency, which could harm export competitiveness and overall economic growth. Thus, concerns are raised regarding the potential disincentive effects on labor and the implications of the Dutch Disease.

3. Data and methodology

3.1 Data

Remittances, defined as the proportion of a country's gross domestic product (GDP) that is sent back home, serve as the primary variable in this study. Data was obtained from the World Bank's Development Indicators database (World Bank, 2021). The researchers utilized EViews10 software to examine remittance inflow data from 1990 to 2022. To predict remittance inflows for the period of 2023–2030, the Box-Jenkins methodology was implemented.

3.2 ARIMA methodology

Autoregressive Integrated Moving Average (ARIMA) models represent a powerful tool for time series analysis (Crawford and Fratantoni, 2003). These models capture the influence of past data points and error terms on current values, enabling forecasts for various applications (Xu, 2017). ARIMA extends the capabilities of Autoregressive Moving Average (ARMA) models by accommodating non-stationary data through differencing (Makridakis and Hibon, 1997). ARMA models, introduced by Wold (1939), combine autoregressive (AR) and moving average (MA) models for stationary data. ARIMA offers advantages over simpler methods like benchmark analysis by considering underlying trends and patterns in time series data.

While machine learning provides flexibility, ARIMA excels in interpretability, allowing users to understand the "why" behind forecasts (Xu and Zhang, 2022a). However, ARIMA's effectiveness depends on the characteristics of the data. For complex patterns or situations involving many variables, machine learning may outperform ARIMA (Xu and Zhang, 2022b, c). The choice between the two approaches comes down to the specifics of the data, the goals of the analysis, and the need for interpretability versus complexity.

3.3 Box-Jenkins method of forecasting

The ARIMA model emerged in the seminal book "Time Series Analysis: Forecasting and Control" by Box and Jenkins (1970). Commonly referred to as the Box-Jenkins model, it forecasts future values based on past data and error terms. This builds upon the components of ARIMA: (AR) models (past values), moving average (MA) models (errors), and the combination of both (ARMA) (Box and Jenkins, 1976). The "I" in ARIMA tackles non-stationary data through differencing (Hyndman and Athanasopoulos, 2018). The AR component (AR(p)) uses past values (d(t−1), d(t−2), etc.) and an error term to predict the current value (d) of a variable (Box *et al.*, 2015). The order (p) determines the number of past values that influence the prediction. The formula for an autoregressive process of order p (AR(p)) is represented as:

$$d_t = \lambda_t + \psi_1 d_{t-1} + \psi_2 d_{t-2} + \psi_3 d_{t-3} + \ldots + \psi_p d_{t-p} + u_t = \lambda_t + \sum \psi_i d_{t-i} + u_t \quad (1)$$

An MA(q) process models m_t using a linear combination of q past white noise terms u_t to m_{t-i} and the current u_t, all assumed to have zero-mean, constant variance, be uncorrelated, and independent. This combination and the properties of white noise ensure stationarity. Consequently, the MA(q) process can be expressed as follows:

$$d_t = \Omega_t + \rho_1 m_{t-1} + \rho_2 m_{t-2} + \rho_3 m_{t-3} + \ldots + \rho_q m_{t-q} = u_t + \sum \rho_i m_{t-i} \quad (2)$$

ARIMA models (p, d, q) combine AR (autoregressive) and MA (moving average) processes with differencing (d) to achieve stationarity. Stability in AR requires coefficients to be less than 1, ensuring that the characteristic root lies within the unit circle (Chatfield and Xing, 2019). The ARMA (p, d, q) model is defined as follows:

$$d_t = \lambda_t + \psi_1 d_{t-1} + \psi_2 d_{t-2} + \psi_3 d_{t-3} + \ldots + \psi_p d_{t-p} + u_t + \Omega_t + \rho_1 m_{t-1} + \rho_2 m_{t-2} + \rho_3 m_{t-3} + \ldots + \rho_q m_{t-q} \quad (3)$$

Within the context of time series analysis, Equation (3) elucidates the invertibility of AR and MA processes, indicating the possibility of converting these processes into invertible representations.

3.4 Forecasting in the ARIMA model: Box-Jenkins method

The Box-Jenkins approach offers a structured framework for constructing ARIMA models for time series forecasting (Box *et al.*, 2015). It involves a four-step process. First, the identification stage involves analyzing correlograms and partial correlograms to determine the optimal values for p (autoregressive terms), d (differencing needed), and q (moving average terms) in the ARIMA model. Second, the estimation phase utilizes the identified parameters to build the ARIMA model and estimate its coefficients. Third, diagnostic checking ensures the model's validity. This involves evaluating whether the model's residuals behave like white noise, meaning they are uncorrelated, have a mean of zero, and exhibit constant variance. Statistical tests and information criteria such as AIC and BIC aid in

assessing the model's fit (Brockwell and Davis, 2016). Finally, in the forecasting stage, the selected ARIMA model is leveraged to predict future values of the time series, both within the existing data and beyond. The accuracy of these forecasts is subsequently assessed using metrics like root mean squared error (RMSE). By following these steps, the Box-Jenkins approach offers a robust framework for building and validating ARIMA models for time series analysis.

4. Result and discussion

To accurately forecast remittance inflows as a proportion of gross domestic product from 2023 to 2030, a comprehensive analysis of historical remittance inflow patterns from 1990 to 2022 is imperative. Available data reveals that remittance inflows accounted for 26.53% of GDP in 1990 but experienced a significant decline to 16.53% of GDP in 2022. This represents a substantial decrease of 38% in remittance inflows as a percentage of GDP over 32 years. Despite mounting evidence suggesting the critical role of remittance inflows in driving a nation's economic growth and development, Yemen, in contrast to other emerging economies, has not witnessed a surge in remittances. Consequently, the subsequent section will meticulously employ all four procedures of the Box-Jenkins (B-J) approach to achieve the desired outcomes.

4.1 Step 1–3 of forecasting

To begin the forecasting process, we first assess stationarity. ARMA models are suitable for stationary data, while ARIMA models handle non-stationary data through differencing (Box *et al.*, 2015). In this study, we used the Dickey-Fuller test (Dickey and Fuller, 1979) to test for a unit root, indicating non-stationarity. The null hypothesis (H_0) assumes a unit root, while the alternative (H_1) assumes stationarity (no unit root). Table 2 presents the test results for the level data and the first difference. The level data was found to be non-stationary, but the first difference showed significant stationarity at a 5% level of significance. Thus, the ARIMA model is suitable for further analysis.

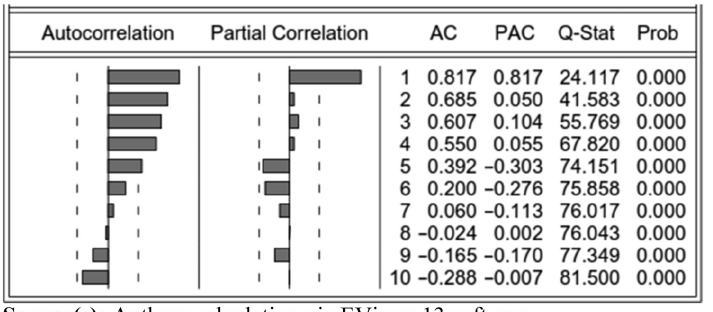
In the second stage of forecasting, correlograms were constructed using the initial differences to discern potential ARIMA configurations based on patterns observed in the Autocorrelation Function (ACF) and Partial Autocorrelation Function (PACF) components. The ACF and PACF components were employed to identify potential Autoregressive (AR) and Moving Average (MA) components, respectively. The researchers found several plausible combinations, such as AR (1) and MA (1), AR (1) and MA (2), AR (1) and MA (3), and AR (1) and MA (4), as illustrated in Figure 1. The selection of the ARIMA configuration depends on achieving a balance between the model fit quality and parsimony. Additionally, alternative approaches, such as information criteria, could be considered for selecting the optimal ARIMA model.

The third step of the forecasting process involved a comprehensive evaluation of all potential models generated in the second stage. Table 3 outlines the assessment procedure. The current remittance inflows were regressed against all available lagged AR and MA terms to determine the optimal AR and MA terms. The ARIMA structure was selected

Table 2.
Unit root test

	At level and intercept			At 1st diff. and intercept		
Variable	*t*-statistic	*p*-value	Result	*t*-statistic	*p*-value	Result
REM	−2.139142	0.5022	nonstationary	−5.35987	0.0001	stationary

Source(s): Authors calculation via EViews 13 software



	AC	PAC	Q-Stat	Prob
1	0.817	0.817	24.117	0.000
2	0.685	0.050	41.583	0.000
3	0.607	0.104	55.769	0.000
4	0.550	0.055	67.820	0.000
5	0.392	−0.303	74.151	0.000
6	0.200	−0.276	75.858	0.000
7	0.060	−0.113	76.017	0.000
8	−0.024	0.002	76.043	0.000
9	−0.165	−0.170	77.349	0.000
10	−0.288	−0.007	81.500	0.000

Source(s): Authors calculation via EViews 13 software

Figure 1.
Correlogram results

based on the lowest Akaike Information Criterion (AIC) and Schwarz Information Criterion (SIC) values, along with the highest adjusted *R*-squared values. The results revealed that the ARIMA (1, 1, 4) structure exhibited the best stability and suitability for forecasting remittance inflows.

4.2 Models comparison

In the forecasting stage, four models (Model 1 to Model 4: AR (1) MA (1–4)) were evaluated to predict remittance inflows. To ensure an unbiased selection, an ex-post prediction technique was employed, using a portion of the data for parameter estimation and the remaining data for model comparison (Gujarati and Porter, 2009). Performance metrics such as Root Mean Square Error (RMSE), Theil's Inequality Coefficient (TIC), Bias Proportion (BP), Variance Proportion (VP), and Coefficient of Persistence (CP) were used to assess model performance. Model 4 (AR (1) MA (4)) emerged as the optimal choice due to its closest resemblance to the actual data (Brooks, 2014). The authors emphasized minimizing forecasting errors (low RMSE), achieving a near-zero TIC, minimizing BP and VP, and striving for a CP close to 1 (Brooks, 2014). This approach ensures reliable prediction and highlights Model 4 (AR (1) MA (4)) as the most suitable model for remittance inflow forecasting. This is visually depicted in Figure 2.

4.3 Step 4 diagnostic and forecasting

To ensure the validity of the selected ARIMA model, diagnostic tests are essential. The first diagnostic test involves evaluating whether the model's residuals adhere to a white noise process. The null hypothesis for this test asserts that the residuals possess characteristics of white noise. The Ljung-Box Q statistics were employed to conduct this test. Figure 3 illustrates that none of the values intersect the dotted lines for autocorrelation or partial correlation, and the *p*-values surpass 5%. Therefore, we are unable to reject the null hypothesis, implying that the residuals conform to a white noise process.

Diagnostic Test 2: ARMA process for (covariance) stationarity and invertibility.

The second diagnostic test endeavors to validate the stationarity of the predicted ARMA process, as evidenced by the AR roots being located within the unit circle. The final diagnostic test scrutinizes the invertibility of the estimated ARMA process, ensuring that all MA roots are within the unit circle. Figure 4 depicts the covariance, stationarity, and invertibility of the estimated ARMA process, with all the blue and red dots falling within the circle. This suggests that all the necessary criteria have been satisfied, confirming the suitability of the selected model for generating predictions.

Variable	Coefficient	Std. error	*t*-statistic	Prob
C	−0.58793	0.754985	−0.778731	0.4441
AR(1)	0.861853	0.329559	2.615169	0.0155
MA(1)	−0.677824	0.516389	−1.312624	0.2023
SIGMASQ	4.780284	1.138706	4.197996	0.0003
R-squared	0.098126	Mean dependent var		−0.32737
Adjusted *R*-squared	−0.019509	S.D. dependent var		2.34612
S.E. of regression	2.36889	Akaike info criterion		4.70675
Sum squared resid	129.0677	Schwarz criterion		4.89872
Log likelihood	−59.54109	Hannan-Quinn criterion		4.76383
F-statistic	0.834154	Durbin-Watson stat		1.89702
Prob(*F*-statistic)	0.488861			
C	−0.432504	0.561868	−0.769761	0.4493
AR(1)	0.216624	0.254482	0.851234	0.4034
MA(2)	0.059218	0.213943	0.276794	0.7844
SIGMASQ	5.045582	1.243431	4.05779	0.0005
R-squared	0.048074	Mean dependent var		−0.32737
Adjusted *R*-squared	−0.076091	S.D. dependent var		2.34612
S.E. of regression	2.433737	Akaike info criterion		4.75493
Sum squared resid	136.2307	Schwarz criterion		4.94691
Log likelihood	−60.19159	Hannan-Quinn criterion		4.81202
F-statistic	0.387178	Durbin-Watson stat		1.87339
Prob(*F*-statistic)	0.763274			
C	−0.400998	0.591967	−0.677399	0.5049
AR(1)	0.144087	0.23986	0.600712	0.5539
MA(3)	0.135537	0.29874	0.453695	0.6543
SIGMASQ	5.001099	1.18911	4.205749	0.0003
R-squared	0.056466	Mean dependent var		−0.32737
Adjusted *R*-squared	−0.066603	S.D. dependent var		2.34612
S.E. of regression	2.422985	Akaike info criterion		4.7467
Sum squared resid	135.0297	Schwarz criterion		4.93867
Log likelihood	−60.08043	Hannan-Quinn criterion		4.80378
F-statistic	0.458815	Durbin-Watson stat		1.82619
Prob(*F*-statistic)	0.713703			
C	−0.517398	0.601336	−0.860413	0.3984
AR(1)	0.214886	0.232745	0.923271	0.3655
MA(4)	0.286418	0.220949	1.296307	0.2077
SIGMASQ	4.611844	1.12449	4.101277	0.0004
R-squared	0.129905	Mean dependent var		−0.32737
Adjusted *R*-squared	0.016415	S.D. dependent var		2.34612
S.E. of regression	2.32678	Akaike info criterion		4.67728
Sum squared resid	124.5198	Schwarz criterion		4.86925
Log likelihood	−59.14326	Hannan-Quinn criterion		4.73436
F-statistic	1.144633	Durbin-Watson stat		1.86541
Prob(*F*-statistic)	0.352113			

Source(s): Authors calculation via EViews 13 software

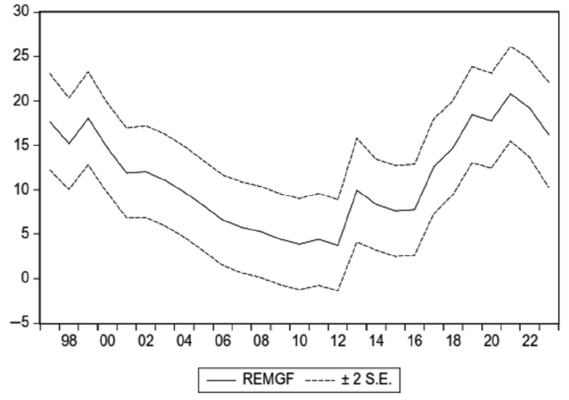
Table 3.
ARIMA models result analysis

4.4 Forecasting

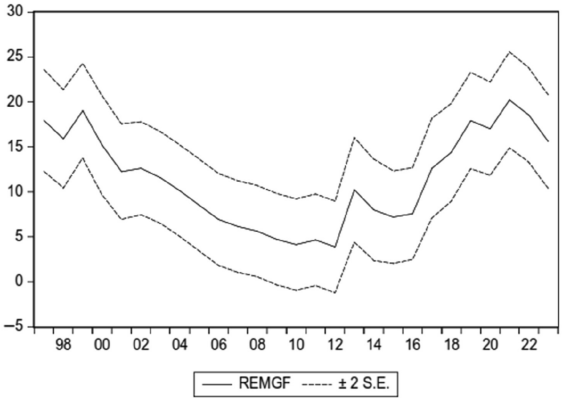
The final step of the process involved forecasting remittance inflows after selecting, comparing, and validating the chosen model, which in this case is ARIMA (1, 1, 4). The projected remittance inflows are depicted in Figure 5. The model suggests that remittance inflows are expected to remain relatively stable in the near future, followed by a gradual decline. Remittance inflows accounted for 16.53% of the GDP in 2022, but they are projected to decrease to 4.122% by 2030 (Table 4). This projected decline in remittance inflows

represents a significant concern for the conflict-stricken economy as it indicates a potential reduction in the country's reliance on this crucial source of income.

ARIMA models are specifically designed for time series data, making them highly suitable for predicting and interpreting consecutive observations. Unlike benchmark analysis, ARIMA incorporates temporal relationships and trends in the data rather than relying on basic averages or historical means. Furthermore, ARIMA outperforms robust analysis by directly integrating the intrinsic dynamics of the time series. While robust analytic approaches may struggle to adapt to the changing features of time-dependent data, ARIMA incorporates both autoregressive and moving average components, making it more adaptable in capturing dynamic patterns. ARIMA's capacity to autonomously detect and adapt to seasonality, trends, and cyclic patterns in the data significantly improves its performance compared to benchmarks and rigorous analysis. Thus, considering the advantages that the ARIMA methodology offers over benchmark and robust analysis, the forecasted results of this study can be effectively implemented for devising economic policies.



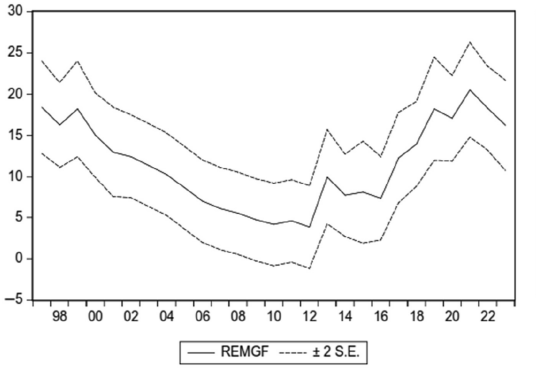
Forecast: REMGF	
Actual: REMG	
Forecast sample: 1995 2030	
Adjusted sample: 1997 2023	
Included observations: 27	
Root Mean Squared Error	2.017342
Mean Absolute Error	1.428175
Mean Abs. Percent Error	11.80547
Theil Inequality Coefficient	0.081089
Bias Proportion	0.037492
Variance Proportion	0.023608
Covariance Proportion	0.938901
Theil U2 Coefficient	1.063394
Symmetric MAPE	13.21290



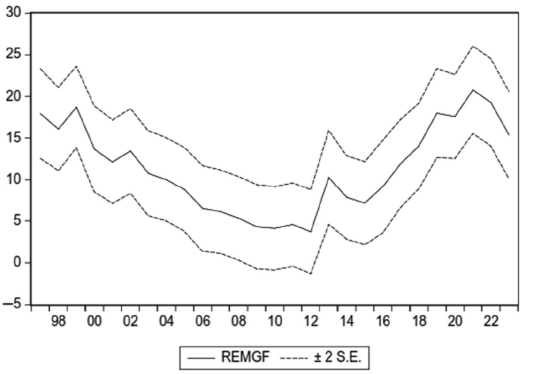
Forecast: REMGF	
Actual: REMG	
Forecast sample: 1995 2030	
Adjusted sample: 1997 2023	
Included observations: 27	
Root Mean Squared Error	2.051308
Mean Absolute Error	1.506123
Mean Abs. Percent Error	12.67050
Theil Inequality Coefficient	0.082242
Bias Proportion	0.016662
Variance Proportion	0.008720
Covariance Proportion	0.974618
Theil U2 Coefficient	1.053768
Symmetric MAPE	13.90404

(*continued*)

Figure 2.
Forecasted result



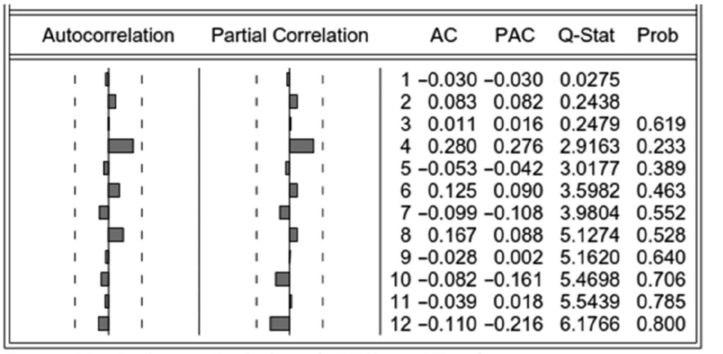
Forecast: REMGF	
Actual: REMG	
Forecast sample: 1995 2030	
Adjusted sample: 1997 2023	
Included observations: 27	
Root Mean Squared Error	2.034137
Mean Absolute Error	1.448520
Mean Abs. Percent Error	11.97878
Theil Inequality Coefficient	0.081528
Bias Proportion	0.015745
Variance Proportion	0.008701
Covariance Proportion	0.975554
Theil U2 Coefficient	1.058239
Symmetric MAPE	13.29285



Forecast: REMGF	
Actual: REMG	
Forecast sample: 1995 2030	
Adjusted sample: 1997 2023	
Included observations: 27	
Root Mean Squared Error	1.976439
Mean Absolute Error	1.444181
Mean Abs. Percent Error	12.05634
Theil Inequality Coefficient	0.079202
Bias Proportion	0.021355
Variance Proportion	0.019041
Covariance Proportion	0.959604
Theil U2 Coefficient	1.035514
Symmetric MAPE	13.19079

Source(s): Authors calculation via EViews 13 software

Figure 2.



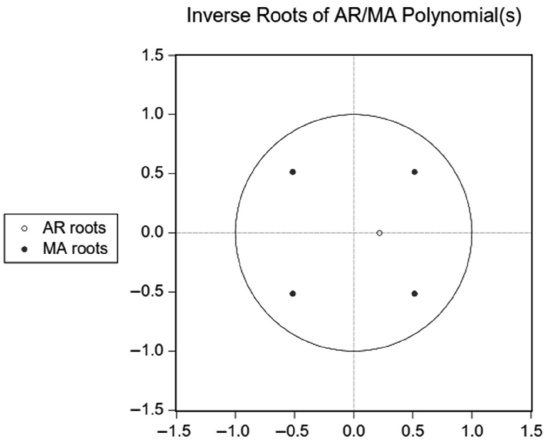
	AC	PAC	Q-Stat	Prob
1	−0.030	−0.030	0.0275	
2	0.083	0.082	0.2438	
3	0.011	0.016	0.2479	0.619
4	0.280	0.276	2.9163	0.233
5	−0.053	−0.042	3.0177	0.389
6	0.125	0.090	3.5982	0.463
7	−0.099	−0.108	3.9804	0.552
8	0.167	0.088	5.1274	0.528
9	−0.028	0.002	5.1620	0.640
10	−0.082	−0.161	5.4698	0.706
11	−0.039	0.018	5.5439	0.785
12	−0.110	−0.216	6.1766	0.800

Source(s): Authors calculation via EViews 13 software

Figure 3.
Correlogram q-statistic results

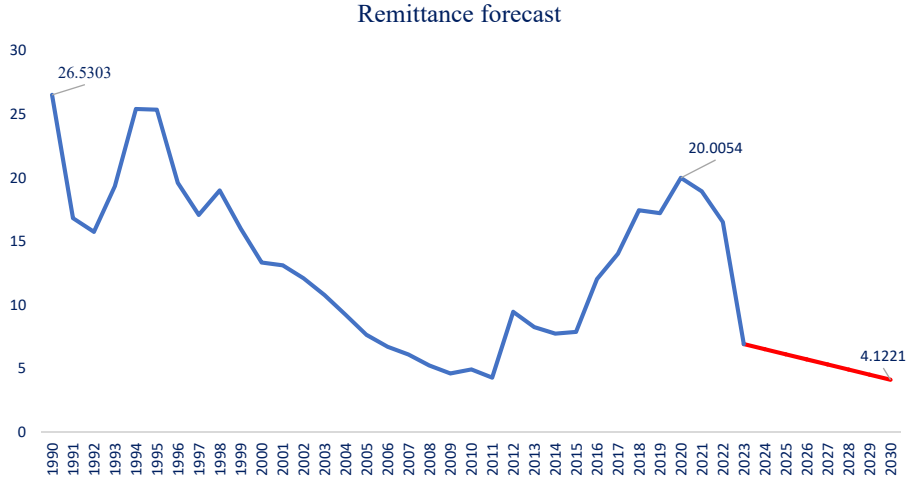
5. Conclusion and recommendations

Remittances play a pivotal role in achieving sustainable development goals, with eight out of the seventeen United Nations Sustainable Development Goals directly linked to remittance



Source(s): Authors calculation via EViews 13 software

Figure 4.
ARMA model stationarity and invertibility results



Source(s): Authors calculation via EViews 13 software

Figure 5.
Forecast result graph

flows. Notably, the United Nations Development Program has acknowledged that Yemen would face insurmountable hurdles in attaining any of the UN's 2030 Sustainable Development Objectives, even if the ongoing conflict subsides. Remittance inflows are widely recognized as crucial enablers of sustainability goals for any economy. However, this analysis projects a decline in remittance inflows over the next eight years, with a projected contribution of 4.122% to GDP by 2030. This heavy reliance on remittance inflows has raised concerns among policymakers, prompting proactive measures to mitigate the anticipated drop.

The role of remittances in economic growth and their impact on various aspects of social, economic, and financial development has been extensively studied by academics. Over the past two decades, remittance flows have expanded fivefold, involving a staggering one billion

Year	Remittance forecast
1990	26.5303
1991	16.8336
1992	15.7527
1993	19.347
1994	25.4189
1995	25.371
1996	19.6087
1997	17.0883
1998	19.0098
1999	16.0081
2000	13.3437
2001	13.1278
2002	12.0995
2003	10.7819
2004	9.2454
2005	7.6589
2006	6.7285
2007	6.1038
2008	5.2414
2009	4.6159
2010	4.9374
2011	4.2898
2012	9.4657
2013	8.2703
2014	7.7506
2015	7.8938
2016	12.0397
2017	14.0487
2018	17.4533
2019	17.2289
2020	20.0054
2021	18.939
2022	16.532
2023	6.929
2024	6.528
2025	6.127
2026	5.7261
2027	5.3251
2028	4.9241
2029	4.5231
2030	4.1221

Source(s): Authors calculation via EViews 13 software

Table 4.
Remittance forecast result

individuals, representing one-seventh of the world's population. This global phenomenon encompasses both remittance senders and recipients, with approximately 800 million individuals benefiting from these financial transfers. For over 70 countries, remittances constitute a vital source of income, accounting for an estimated 4% of their national GDP.

Primarily, remittances serve as a lifeline for families, enabling them to cover essential needs such as food, medical care, education expenses, and daily living costs (IFAD, 2021).

Yemen can reap significant benefits from emulating the successful strategies of nations that have effectively utilized remittances as a catalyst for economic growth, particularly during periods of adversity. Yemeni policymakers should formulate comprehensive guidelines and procedures to foster remittance-driven local investment initiatives. These guidelines should be characterized by practicality and provide clearly defined objectives, strategies, and timelines to assist Yemeni households in navigating the challenges associated with remittance-based investments. To maximize the positive impact of remittances, relevant policies should be implemented, encompassing the following measures:

(1) Mobile payment applications: The adoption of mobile payment platforms should take precedence over traditional remittance channels, such as banks, to facilitate expeditious financial transactions.

(2) Exchange rate pre-booking: Banks and other entities engaged in fund transfers should introduce a system for pre-booking exchange rates. This would enable remitters to secure favorable exchange rates when transferring funds.

(3) Tax incentives for Yemeni expatriates: Establishing tax reduction or exemption thresholds for Yemeni nationals residing abroad who remit funds back to Yemen could be an impetus for increased remittance flows.

(4) Door-to-door remittance distribution: Implementing a door-to-door remittance fund cash distribution system would ensure the timely receipt of funds for individuals without access to bank accounts or mobile phones.

6. Limitation and future work

The study's scope is limited to the examination of remittance inflows as the sole variable, with predictions based solely on this factor. However, it is essential to recognize that foreign direct investments and official development assistance (ODA) are equally valuable sources of foreign capital and should be considered in future investigations. Despite these restrictions, the study has successfully addressed the research question posed.

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Corresponding author
Darshita Fulara Gunwant can be contacted at: df.gunwant@gmail.com