SECTION: FINANCE

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THE IMPACT OF OIL PRICES ON MONETARY AGGREGATES IN AZERBAIJAN: ARDL AND COMBINED COINTEGRATION METHOD

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Abstract
Each state is known for its main economic resource. This resource is one of the factors affecting all its economic indicators. Oil is the main economic resource in Azerbaijan. Undoubtedly, the volume of oil production and especially oil prices on the world market play the role of the main driving force of the economy. Thus, many macroeconomic indicators, economic development, economic growth, sustainability indicators, social welfare of the population, balance of payments, foreign trade are highly dependent on the oil factor. At this time, the banking sector is not an exception. In this study, the impact of the world price of oil on monetary aggregates, which act as certain indicators of the banking sector, has been evaluated. The study covers the period 2005M01–2023M09. The overall result of the study was an emphasis on the importance of further deepening the measures taken to reduce the dependence of the monetary policy of the state and the banking sector on the oil factor in parallel with the further acceleration of work on the diversification of the economy and the development of the non–oil sector.

Keywords: WOP, monetary aggregates, Combined cointegration

Introduction

The working conditions of the Central Bank in 2022 are characterized by the multifaceted impact of global economic processes on the country's economy. The recovery of global demand at a faster pace than supply, the sharp volatility of world exchange prices for raw materials and inflation in the countries of trading partners, as well as the growth of supply and logistics costs, affected inflation within the country. In terms of balance of payments and support for domestic economic activity, the external environment has been largely favorable for Azerbaijan.

Given the balance of payments surplus, the supply on the foreign exchange market expanded and the country's strategic foreign exchange reserves continued to grow. A number of decisions were made to improve the operational basis of monetary policy, and the introduction of monetary policy instruments in a new configuration has begun. Work will continue in the direction of improving the strategic and operational foundations of monetary policy, guided by the "Strategy for the socio–economic development of the Republic of Azerbaijan for 2022–2026". The year 2022 is characterized by growing geopolitical tensions, rising commodity prices on world exchanges and inflation in trading partner countries, continued problems in the global value chain and the impact of these processes on the global economy at a time when the world is gradually recovering from the pandemic (CBAR,2023). Despite rising inflationary pressures in an increasingly complex global environment, Azerbaijan's external sector performance has improved and economic growth has picked up. Economic activity in the world is on a downward trend in 2022.

In 2022, monetary policy was aimed at alleviating inflationary pressures through adequate monetary conditions, and excess growth in aggregate demand was limited by monetary policy. The introduction of the new operational framework for monetary policy for the first time allowed the interest rate band to influence the interbank market. During the year, the largest increase in prices was recorded for energy products. The average Brent oil price per barrel in 2022 was approximately $99.2, up 40% from the 2021 average price of $70.9. The January IMF report predicts a decrease in the price of 1 barrel of oil to an average of $81.1 in 2023 (October forecast was $85.5), and in 2024 it will be at $75.4. The world oil price will be formed under the influence of global economic activity, geopolitical factors and decisions made within the framework of OPEC ++. According to the forecasts of major analytical centers, the consensus price in 2023 is $92 per barrel, including $85.5 according to the IMF. In general, global oil demand is forecast to stabilize in 2023 amid weakening economic growth. Given the high volatility of the Azerbaijani economic environment, the Central Bank will regularly update macroeconomic forecasts for 2023 under various scenarios (CBAR,2022a).

Our goal in the article is to study the impact of rising and falling oil prices on the world market on the monetary aggregates in Azerbaijan and the following hypothesis was put forth in the research:

$H1_0$: Rising WOP increase Broad Money Supply ($M3$).

$H2_0$: Rising WOP increase $M2$ money aggregate.

$H3_0$: Rising WOP increase $M1$ money aggregate.

$H4_0$: Rising WOP increase Cash Outside Banks ($M0$)

$H5_0$: Rising WOP increase Demand Deposits in manat

$H6_0$: Rising WOP increase Term Deposits in manat

$H7_0$: Rising WOP increase Deposits in in hard currency

$H8_0$: Rising WOP increase Ratio of $M3$ to Reserve Money

$H9_0$: Rising WOP increase Ratio of $M2$ to manat Reserve Money

Analysys of the economy and monetary aggregates

Since the study period covers the years 2005m01–2023m09, we have to give general figures for 2022. Thus, the macroeconomic data for 2022 can be said that the 133825.8 mln. manat, growth rate 104.6%, GDP deflator 137.3%, N–oil 61619.5 mln. manat (GR109.0%), capital investments 18272.3 mln. manat, (105.5%), Nominal income of population 68914.6 mln. manat (GR 120.5%), Nominal average monthly wage 839.4 Growth rate (114.7%) CPI monthly 1.0%. Annual average was 13,9%. During this year Budget revenue, 30660.5 mln. manat, as a share of , 22.9%, Budget expenditure 32063.3 mln. manat, as a share of , 24.0 %, Budget surplus –1402.8 mln. manat, as a share of was −1.0%. As of January 31, 2023, 25 banks are operating. The total assets of operating banks amount to 45,861.9 mln. manats, total liabilities 40,200.2 mln. manat, balance capital 5661.7 million manat was manat. Since the study period covers the years 2005m01–2023m09, we have to give general figures for 2022. Manat on average (december 2000=100) Nominal effective exchange rate () Total 93.2, N–oil sector 137.9, Real effective exchange rate () Total 118.6, N–oil sector 109.3, dollar was 123.7.

Monetary survey (end of period) Net Foreign Assets 22128,41 mln. manat, Net Domestic Assets 16003.32 mln. manat, Claims on economy 19464.99 mln. manat, Broad Money 38131.73 mln. manat, Broad money, in manat 26111.83 mln. manat,Velocity of money was 4.81. Analytical Balance of CBA (end of period) Official foreign reserves 7534.06 mln. US dollars, Net claims on central government –4655.08, Net claims on banks and non–bank credit organizations 7594,108, Monetary base 17449.88, Monetary base, in manat was 15563.33. Analytical Balance of Commercial banks (end of period) Net Foreign Assets of which 6424.6, Gross foreign assets 8512.425, Foreign liabilities –1559.03, Claims on economy 19464.99, Deposits in manat 14398.74, Deposits in foreign currency was 12019.26. Money aggregates (end of period) Broad Money Supply (M3) 42824.9, M2 money aggregate 29565.6, M1 money aggregate 25365.8, Cash outside banks (M0) 13297.5, Demand deposits in manat 12068.3, Time deposits in manat 4199.8, Deposits in hard currency 13259.3, Money multiplier Ratio of M3 to Reserve Money 2.05, Ratio of M2 to manat Reserve Money was 1.69. Monetary base (end of period) Monetary base 20900.3, Monetary base, in manat 17460,3, Cash in circulation 14714.4, Correspondent accounts 6169.7, Required reserves 1389.2, Ratio of cash in circulation to Monetary base was 70.4%. At the same time, it can be said that the average price of Brent oil was 100.9 USD in the 11th month of 2022, which is 42% more than the average price of the previous year (71 USD) (CBAR,2022b).

Literature review

Here it was determined that there is a positive relationship between the price of oil and foreign exchange earnings. In another study (Shetty and Ibrahim, 2017), between July 2014 and March 2016, a conceptual model was developed and examined that reflects the impact of the recent drop in oil prices on the main profitability indicators of the banking sector. The model predicted that falling oil prices would have a negative impact on Oman's banking sector.

In another article (Tabash and Khan, 2018). the effect of fluctuations in WOP on the growth of Islamic banking investments in the United Arab Emirates is discussed. In addition to the price of oil, the study used other variables such as and to determine the factors driving the growth of Islamic banking investment in the emerging UAE economy. The study is based on an econometric analysis using annual time series data between 1990 and 2015 for the variables under study. The main results of the study using and Granger causality tests showed that WOP have long–term and short–term relationships with Islamic banking investments in the UAE. Saif–Alyousfi et al., (2018) analyzed the evolution of the banking sector in the six GCC countries, including concentration, lending trends, balance sheet and financial security, and oil prices, over the period 2000–2014 and concluded that the level of capitalization of banks in these countries is a significant factor of financial comfort, despite the negative impact of the crisis. Despite apparent financial stability, there has been a sharp increase in lending in line with the steady rise in oil prices, low levels of bank liquidity compared to international standards, and certain weaknesses in the GCC country's banking sector that need to be examined. However, they noted that the capitalization level of banks here is quite high. Meanwhile, the authors note that despite the apparent financial strength, a sharp increase in credit has been recorded in these countries due to the continuous increase in oil prices, which has a negative impact on the liquidity of banks, they came to the conclusion that banks maintain a low level of liquidity compared to international standards.

In the works of researchers from the CIS countries (Dosmagambetv et al., 2019), the status of CGS in financing small and medium–sized businesses in Kazakhstan was discussed. In addition, an empirical analysis was presented using the VAR structural method, which showed that the creditworthiness of the entire financial system of Kazakhstan depends on oil prices. In addition, it was found that the volatility of oil prices affects the value of the currency, which in turn affects the financial position of small and medium–sized enterprises.

Lee and Lee (2019) examined the impact of oil prices on banking performance in China over the period 2000–2014, using a wide range of CAMEL indicators (capital adequacy, asset quality, management, profit and liquidity) and concluded that oil prices significantly affect the results of banking, as their increase leads to a decrease in the efficiency of banking in terms of capitalization, efficiency management, profitability and liquidity.

Viliani et al., (2019) using daily data, based on the results of a study dedicated to the asymmetric effect of the Iranian oil price on the bank stock index of the Tehran Stock Exchange, it was determined that the coefficient of the long–term transfer of the oil price to the bank stock index is positive. Based on the short–term models of , the relationship between the positive components of the bank stock index and oil prices was evaluated and it was determined that the asymmetric relationship between the bank stock index and the oil price was determined. In the research of Salimi et al., (2021), the effect of oil price on the monetary system was investigated, emphasizing the real sector of the Iranian economy, using the SVAR model for the years 1984–2016. Kocha et al., (2020) investigated the impact of Covid–19 and the WOP shock on the liquidity of the Nigerian banking system between June 1, 2019 and June 30, 2020 and concluded that there is a negative significant relationship between the oil price and banking system liquidity. In addition, the results of the Johansen co–integration test indicate that the series are co–integrated or that there is a long–term relationship. According to the result of the Granger test, there is no evidence of a causal relationship between an WOP shock and banking system liquidity and vice versa. Based on this, the study concludes that fluctuations in oil prices significantly affect the liquidity of the Nigerian banking system.

Naimy and Kattan, (2020) examined the structural changes in the work of banks for various aspects of bank performance (profitability, liquidity, credit quality and capitalization) in light of the recent drop in WOP in 2014 by using the Chou econometric test to determine the impact of recent WOP on the banking system of the Persian Gulf countries during the period 2011–2017. Although Qatari banks show stability, negative structural changes in the credit quality of Saudi banks, positive changes in the level of capitalization, negative changes in profitability, credit quality and capitalization of UAE banks were found.

Another study (Iwedi and Lenyie, 2021) examined the impact of WOP on the Nigerian banking sector from February 1, 2020 to June 30, 2020. It has been determined that there is a significant negative relationship between the shock of WOP and the financing of the banking sector of the Nigerian economy. That is, the fall in WOP had a negative impact on the financing of the economy by the banking sector. Overall, it is concluded that the effects of WOP an shock are the determining variables influencing the ability of the banking sector to finance the Nigerian economy. Mohammad and Aliyu (2022) use generalized moment default probability and Z estimate based on 2008–2016 data to empirically investigate the asymmetric relationship between WOP changes and traditional and Islamic banking stability in the MENA and the results obtained by measuring banking stability were that the banking stability of both types of banks respond to positive and negative WOP shocks. At the same time, it is emphasized that the stability of banks is somewhat better than that of Islamic banks in the region.

In their study, Al–Mohamad et al. (2022) examined the impact of WOP volatility on the efficiency of banks in the BRICS countries (Brazil, Russia, India, China and South Africa) as a tool to ensure the financial stability of the banking sector in the region. They applied a non–parametric methodology known as data coverage analysis (DEA) using data from 112 banks from 2003 to 2018. According to the results of the study, the banking system of China showed efficiency (90%), South Africa (87%), Brazil and India (77%), and Russia showed the least efficiency (50%). This highlighted the difference between oil importers and oil exporters.

Another study (Falahpor et al., 2022) investigating the impact of WOP shocks and economic sanctions on Iranian bank liquidity creation and the use of PSTR models in a non–linear structure considering country specific conditions. Negative WOP shocks have a negative impact on the generation of balance sheet liquidity, as well as on the overall liquidity generation of large banks, but have a positive impact on small banks. The results of positive jumps in WOP are significant only for the balance sheet liquidity of large banks. While examining average WOP shocks, the results show that WOP shocks hurt liquidity generation in large banks, but do not have a significant impact on small banks. Economic sanctions have a positive effect on the creation of liquidity of large banks and do not have a significant impact on small banks. Overall, the results again show that the impact of negative WOP shocks on bank liquidity is higher than positive WOP shocks and economic sanctions. In addition, it is necessary to create mechanisms to compensate for the negative impact on banks.

Information base is the CBA. Information about the variables was compiled and obtained from this source. The established models assessed the impact of WOP on the following variables. Money aggregates: Broad Money Supply (M3), M2 money aggregate, M1 money aggregate, Cash outside banks (M0), Demand deposits in manat (DDM), Time deposits in manat (TDM), Deposits in hard currency (DHC), Money multipliers: Ratio of M3 to Reserve Money (M3/MB), Ratio of M2 to manat Reserve Money (M2/MB) (A.Table 1, A.Picture 1). The study covered the period 2005m01−2022m08 using monthly data.

The functional dependence of monetary aggregates on world oil prices is presented below.

$$\begin{bmatrix} M3 \\ M2 \\ M1 \\ M0 \\ DDM \\ TDM \\ DHC \\ M2/MB \\ M3/MB \end{bmatrix} = f(WOP)$$

$$\begin{bmatrix} M3_t \\ M2_t \\ M1_t \\ M0_t \\ DDM_t \\ TDM_t \\ DHC_t \\ M2/MB_t \\ M3/MB_t \end{bmatrix} = \alpha + \begin{bmatrix} \beta \\ \gamma \\ \delta \\ \theta \\ \vartheta \\ \mu \\ \rho \\ \sigma \\ \tau \end{bmatrix} (WOP_t)$$

The principal focus was on the impact of WOP on the monetary aggregates listed above. The function expressing this effect is given by equations (1)–(9) and (10)–(18). These equations were used to estimate the coefficient of WOP as an explanatory variable. Here, is the point of intersection of the models, and are the coefficients explaining the variable, and time.

Data Description

Several preparatory steps are required before the ARDLBT co–integration procedure. In this regard, the first step is to analyze the variables (time series) using static and graphical methods.

Descriptive statistics of the time series are given in A.Table 2. Here variables— and is normally distributed according to the J–B criterion. Other variables — and not normally distributed. Kurtosis (excess) range variables – between WOP are not more than 0.1–0.9. between world oil prices more than 2.3. The standard deviation here have not been so many of them. and have a negative asymmetry.

Descriptive statistics of the time series in logarithms are given in A.Table 3. Here variables— and is normally distributed according to the J–B criterion. Other variables — and not normally distributed. Kurtosis (excess) range variables –between WOP are not more than 0.3–0.9. LM0, LM1, LM2, LTMD between WOP more than 1.2–3.05. The standard deviation here have not been so many of them. In all variables except have a negative asymmetry

Descriptive statistics of time series in first differences are given in A.Table 4. Here variable— is normally distributed according to the J–B criterion. Other variables — and not normally distributed. Kurtosis (excess) range variables – , , between WOP are not more than 0.1–1.1 between WOP more than 2.0–10.2. The standard deviation here have not been so many of them. In all variables except and have a negative asymmetry.

URT −Stationarity

In the study, we refer to the model. Therefore, after presenting descriptive statistics of time series, the first step in ARDL analysis should be unit root analysis. That is, before checking for the presence of a co–integrating relationship between the variables of the time series and the evaluation of the boundary test, it is required to check their unit root (stationarity). Three traditional tests were used in our study: (Dickey and Fuller, 1981), (Phillips and Perron, 1988) and KPSS (Kwiatkowski et al., 1992) tests. However, many researchers have to apply both traditional and structural URT to ensure that variables are not related I(2). In this study, we will not resort to tests for the root of the structural unit.

The ARDLBT co–integration procedure is one of the widely used econometric methods to study the possibility of cointegration between time series. This method has been used only recently. Established models are able to account for sufficient delays. This feature allows you better to reflect the mechanism of connection between time series. Compared to traditional co–integration methods that have been known for many years, this method does not require all time series to have the same I(0) or I(1). In models built by this method, different integral variables (I(0) and I(1)) can be used. In other words, for the cointegration procedure, each variable can be either I(0) or I(1). In this case, I(0) and I(1) can be evaluated simultaneously or separately. However, I(2) integration of any of the variables is unacceptable. In no case I(2) should be existed. And this may invalidate the methodology and its results (the ZF statistic and all critical indicators defined by Pesaran) (Pesaran and Shin, 1999, Pesaran et al., 2001). This method also confirms the tendency of the model time series to long–term equilibrium. Application of this method then to differentiate between long–term and short–term relationships. Long–term relationships between time series can also be examined using the cointegration procedure. Since both dependent and independent time series are defined using lags, autocorrelation and endogeneity of the model have also been assessed.

ARDLBT co–integration procedure produces unbiased estimates, ignoring the endogeneity of some regressors. Valid and reliable t statistics is also provided here. Proper selection of the appropriate lag for the model can significantly mitigate its endogeneity problem by reducing the residual correlation to zero. In addition, the integration of into long–term equilibrium is also allowed. This process is done through linear transformation and does not corrupt data over time. The approach is more reliable for short time series compared to the Johansen and Juselius co−integration methodology (Johansen and Juselius, 1990) and Engle−Granger method

$$\Delta L\begin{bmatrix} M3_t \\ M2_t \\ M1_t \\ M0_t \\ DDM_t \\ TDM_t \\ DHC_t \\ M2/MB_t \\ M3/MB_t \end{bmatrix} = \psi_0 + \sum_{i=1}^{p1} \psi_{1i}\Delta L\begin{bmatrix} M3_{t-i} \\ M2_{t-i} \\ M1_{t-i} \\ M0_{t-i} \\ DDM_{t-i} \\ TDM_{t-i} \\ DHC_{t-i} \\ M2/MB_{t-i} \\ M3/MB_{t-i} \end{bmatrix} + \sum_{i=0}^{p2} \psi_{2i}\Delta LWOP_{t-i} + \lambda_1 L\begin{bmatrix} M3_{t-1} \\ M2_{t-1} \\ M1_{t-1} \\ M0_{t-1} \\ DDM_{t-1} \\ TDM_{t-1} \\ DHC_{t-1} \\ M2/MB_{t-1} \\ M3/MB_{t-1} \end{bmatrix} + \lambda_2 LWOP_{t-1} + \varepsilon_t$$

Δ − first difference operator, L − is a logarithm function, ψ_0 − constant, ε_t − white noise error, ψ_{1i}, ψ_{2i} − ST coefficients, λ_1, λ_2 − LT coefficients.

Moreover, with this method, he also determines the rate and behavior of convergence to the long–term variable equilibrium. In other words, the equations constructed here include an unbounded ECM. p - is the delay length, that is, the delay period is determined using the information criteria AIC and SC. To begin the ARDLBT co–integration procedure, the null and alternative hypotheses are formulated and tested. The t–statistic (Banerjee et al., 1998) and F–statistic (Pesaran et al., 2001) tests are applied to the lagged regressors presented in the model. Below are the null and alternative hypotheses:

H_0: Cointegration —No
H_1: Cointegration — Yes
A joint significance F −statistic test for lag coefficients:
H_0: $\lambda_1 = \lambda_2 = 0$
H_1: $\lambda_1 \neq 0, \lambda_2 \neq 0$

Since exact critical values for integrating I(0) and I(1) do not exist, corresponding tables for this test were prepared using the previous method of Pesaran et al., (2001) to make the F-statistic test a standard test. The table they prepared shows the asymptotic distribution of the F- statistic for different cases. However, time series study periods are not very long, as many studies are over years. Regarding this issue, Narayan (2005) developed special F- statistic tables for those with little time series study periods and presented them to the scientific community (Alabdulwahab, Sami, 2021).

In many studies that have encountered similar cases, Narayan diagrams are used to test the validity of the hypotheses and models established by the researchers. The critical value comparison tests presented in the tables of Pesaran et al., (2001) and Narayan (2005) are currently performed using econometric software packages Eviews9–13. We also applied to both authors. Moreover, we also referred to Sam et al., (2019) another test of ARDL to determine cointegration. The continuation of the study depends on the result of comparing the F–statistic with the critical value in the table regarding whether the null hypothesis is rejected or not. The results of the statistic test that are greater than I(1) mean that there is co–integration between variables, while those that are less than I(0) mean that cointegration between variables is not possible. Thus, the F–statistic test takes into account all variables in the model. If the result of the statistic test is between the two critical boundary values I(1) and I(0), then this is considered a case of no result. So in this case it is impossible to say any specific opinion. The solution is not entirely clear. As a result, a different co–integration method can be used if the researcher considers defining co–integration to be his primary goal. In addition, an appropriate t–statistic test is applied to cross–check the following hypotheses

The procedure for accepting the null hypothesis for this test is similar to the F–statistic test. Thus if the fresults of the statistic test exceed the I(1) critical value, that is, the threshold (Pasaran et al., 2001), then the co–integration between the variables and the reliability of the model are considered to be accepted by the corresponding statistic test. is used to calculate the acceleration, deceleration and correction of the short–term estimation when the established model goes into a non–equilibrium state.

$$\Delta L\begin{bmatrix} M3_t \\ M2_t \\ M1_t \\ M0_t \\ DDM_t \\ TDM_t \\ DHC_t \\ M2/MB_t \\ M3/MB_t \end{bmatrix} = \psi_0 + \sum_{i=1}^{p1} \psi_{1i} \Delta L \begin{bmatrix} M3_{t-i} \\ M2_{t-i} \\ M1_{t-i} \\ M0_{t-i} \\ DDM_{t-i} \\ TDM_{t-i} \\ DHC_{t-i} \\ M2/MB_{t-i} \\ M3/MB_{t-i} \end{bmatrix} + \sum_{i=0}^{p2} \psi_{2i} \Delta LWOP_{t-i} + \varphi ECT_{t-1} + \varepsilon_t$$

Based on the above equations, long–term models are constructed to restore the to the previous equilibrium after the accumulation of short–term deviations from equilibrium. Taking long–term data into account, includes both short–term and long–term coefficients in the models. In these models, φ, the coefficient, reflects long–term causality. For the equilibrium model to be significant, this coefficient must be negative and statistically significant.

A diagnostic test for a model

Tests associated with the co–integration procedure show that in equations (10)–(18) is consistently free and normally distributed. The diagnostic tests for models are given here: the test for serial correlation (Durbin and Watson,1971), the test for serial freedom (Breusch,1978; Godfrey,1978), and the test for normal distribution (Bera,1980; Jarquet and Bera,1981;1987). Besides, the (Breusch and Pagan,1979) and (Bollerslev, 1986; Engle, 1982) tests were used to test for heteroskedasticity of the models.

Checking the stability of the model

The dynamic stability of models is very important for their correct autoregressive structure. The CUSUM and CUSUMQ tests were used in the study (Brown et al.,1975; Pesaran and Pesaran, 1997). These tests, as well as the Ramsey (statistical) test (Ramsey, 1969; Ramsey, 1974), were performed to test the stability of the model.

FMOLS, DOLS and CCR

Alternative co–integration methods — (Phillips and Hansen, 1990), (Stock and Watson, 1993), (Park, 1992) and Engle–Granger analysis (Musayev and Aliyev, 2017) — are very useful for confirming the significance of the co–integration procedure in research. For a more reliable analysis, the results of co–integration approach need to be reviewed several times. Furthermore, Engle–Granger and Phillips–Ouliaris co–integration tests (Phillips Ouliaris, 1990) were used to test the , and regression equations.

Granger causality test

The presence of co–integration between variables also means that there is a causal relationship between them. Granger (1969) noted that the causal relationship between variables can be unidirectional or bidirectional. Moreover, he argued that indicators of correlation between variables are not sufficient to assess the relationship between these variables. Granger explained this by saying that the variables in the models do not have an indirect relationship with the third variable. Moreover, in addition to determining the presence of long–term relationships, the direction of the relationship between variables can be determined, as well as short–term relationships can be assessed (Aliyev et al., 2016). The model was applied to test Granger causality:

$$L\begin{bmatrix} M3_t \\ M2_t \\ M1_t \\ M0_t \\ DDM_t \\ TDM_t \\ DHC_t \\ M2/MB_t \\ M3/MB_t \end{bmatrix} = \sigma_0 + \sum_{j=1}^{m} \sigma_{1j} L \begin{bmatrix} M3_{t-j} \\ M2_{t-j} \\ M1_{t-j} \\ M0_{t-j} \\ DDM_{t-j} \\ TDM_{t-j} \\ DHC_{t-j} \\ M2/MB_{t-j} \\ M3/MB_{t-j} \end{bmatrix} + \sum_{j=1}^{m} \sigma_{2j} LWOP_{t-j} + \omega_t$$

$$LWOP_t = \sigma_0 + \sum_{j=1}^{m} \sigma_{2j} LWOP_{t-j} + \sum_{j=1}^{m} \sigma_{1j} L \begin{bmatrix} M3_{t-j} \\ M2_{t-j} \\ M1_{t-j} \\ M0_{t-j} \\ DDM_{t-j} \\ TDM_{t-j} \\ DHC_{t-j} \\ M2/MB_{t-j} \\ M3/MB_{t-j} \end{bmatrix} + \omega_t$$

2 null hypotheses are put forward in this case:

1. $H_0 := \sigma_{21} = \sigma_{22} = \cdots = \sigma_{2n} = 0$
and $H_1 : LWOP$ is the cause of $LM3$, $LM2$, $LM1$, $LM0$, $LDDM$, $LTDM$, $LDHC$, $LM2/MB$ and $LM3/MB$
2. $H_0 := \sigma_{11} = \sigma_{12} = \cdots = \sigma_{1n} = 0$
and $H_1 : LM3$, $LM2$, $LM1$, $LM0$, $LDDM$, $LTDM$, $LDHC$, $LM2/MB$ and $LM3/MB$ is the cause of $LWOP$

In the first case, the failure of any of the null hypotheses, as a result of the mentioned tests, indicates Granger causality. In the second case, if both null hypotheses are rejected, then an inverse relationship arises between the variables. In the third case, accepting both null hypotheses means that there is absolutely no long–term co–integration relationship between the variables.

Granger cause–and–effect relationship for the short term

For the independent variable ($\Delta LWOP_{t-i}$) F - statistic test and χ^2 are estimated and the null hypothesis for the coefficients of the variables is tested ($H_0 : \psi_{21} = \psi_{22} = \ldots = \psi_{2i} = 0, H_1 : \psi_{21} \neq \psi_{22} \neq \ldots \neq \psi_{2i} \neq 0, i = 1, \ldots p$). Rejecting the null hypothesis means that $x-$ ($LWOP$) affects y ($LM3, LM2, LM1, LM0, LDDM, LTDM, LDHC, LM3/MB$ and $LM2/MB$) in the short term.

Granger cause–and–effect relationship for the long term

The verification of this relationship is mainly performed by determining the statistical significance of the coefficient of ECT_{t-1} with a t–statistic test. F–statistic test and χ^2 statistical quantities are also evaluated. This is done by testing the null hypothesis ($H_0 : \varphi = 0, H_1 : \varphi \neq 0$). Consequently, rejection of the null hypothesis means that deviations from the equilibrium state affect the dependent variable in the long term and will return to the equilibrium state after a certain period of time.

Strong cause–and–effect relationship

Essentially, these relationships imply both short–term and long–term causation. In other words, the F test and χ^2 statistics are estimated and the null hypothesis for the coefficients of the variables is tested ($H_0 : \psi_{21} = \psi_{22} = \ldots = \psi_{2i} = \varphi = 0, H_1 : \psi_{21} \neq \psi_{22} \neq \ldots \neq \psi_{2i} \neq \varphi \neq 0, i = 1, \ldots p$). All three causal relationships are tested using the Wald test.

Interpretation and discussion of model results

URT results

According to the above mentioned, applying the co–integration procedure requires that all variables be at most I(1). That is, their lack of I(2) is put forward as the main condition. Before starting the co–integration procedure, the second step is to check the unit root, that is, the stationarity of the variables. The results of the unit root of the variables and stationarity tests are shown in Table 5. Traditional tests of and were carried out as a test. Regarding the results of testing variables at their levels, According to the ADF test, the variables and have only been in the Constant version and while the variables and have been in the version with a Constant and Linear Trend – I (0). This was not the case in the None version of the test. According to the PP test, the variables and have only been in the Constant version and while the variables and have been in the version with a Constant and Linear Trend – I (0). This was not the case in the None version of the test. According to the test, the variables and (0.01%) have only been in the Constant version and while the variables (0.1%) and have been in the version with a Constant and Linear Trend – I (0). Since there is no "None" option in the test, it is not checked. Here, in the “Constant”, “Constant” and “Linear Trend” variants of the and tests, the null hypothesis – non–stationarity of the variables – was not accepted, and the stationarity of the variables in both variants (Constant, Constant and Linear Trend) of the test was confirmed. Testing the model variables at different levels allows us to apply the co–integration procedure. Standard unit root tests then confirmed that neither variable is I(2), which is one of the main conditions for the applicability of the co–integration procedure (Table 1 and A.Table 5).

As mentioned above, models built using the ARDLBT co–integration procedure were subjected to appropriate tests for the absence of serial correlation or heteroscedasticity. First of all. for these models is 0.99, 0.99, 0.99, 0.99, 0.99, 0.99, 0.99, 0.99, 0.99, 0.99, 0.92 and 0. 90 respectively. The adjusted was equal to .99, 0.99, 0.99, 0.99, 0.99, 0.99, 0.99, 0.99, 0.99, 0.99, 0.92 and 0. 90 respectively. This indicates that approximately 99%, 99%, 99%, 99%, 99%, 99%, 99%, 99%, 99%, 99%, 99% and 90% of the variance of the dependent variables (, , , , , , and) it means that this is explained by the model, and the remaining % is, due to error or other factors, not taken into account in the model.

F- statistic is: 16006.37, 45592.40, 12110.25, 12110.25, 16971.88, 8135.59, 24391.51, 6772.82, 9869.76, 11668.67, 602.13492.5106 229.95and 386.39 respectively, and the values are also 0.00. These results indicate that the models are not misfit. This means that the null hypothesis for the coefficients is not accepted.

Diagnostic test results

DW- statistic is 2.07, 2.09, 2.09, 1.72, 1.98, 2.06, 1.75, 2.13, 2.06, 2.06, 2., 1.92 and 2.06 respectively (A.Table 8). Based on the results of comparing the listed indicators with the corresponding critical values given in the table for and , it was established that the indicators of the models exceed the critical statistical values: . A.Table 11 present the results of tests for serial correlation, serial correlation ( ), heteroscedasticity ( ) and normality ( ). Based on the test results given in the table, we can say that the listed models are somewhat outdated, although not completed. These indicators make the application of the procedure acceptable.

Stability of models

The reliability of the results of models built using the co–integration procedure is ensured by testing the long–term structural stability of the model parameters. Brown et al., (1975) proposed the use of (cumulative sum of recursive residuals) and (cumulative sum of recursive residuals) for long–term structural stability of parameters in models. The results of and at the 5% significance level are presented in the tables, respectively. The test requires that the and plots remain within a critical threshold of 5% for the model to be significant in terms of long–term structural parameter stability. Plots for in all models in this study are at the 5% significance level. However, the graphs for are not within the 5% significance level. This means that the models are not completely stable. Thus, systematic changes in the coefficients occurred during the study period.

ARDL co−integration test

Since the models have fully passed the diagnostic test, we can proceed with the ARDLBT co–integration procedure. The results of estimating the lagged ARDL co–integration models were as follows: Model 1: statistics were 16.05 and 8.11 ((—3.92) and (—4.95)), Model 1A: 17.53 and 9.20 ((—4.68) and (—5.25)), Model 2: 8.20 and 5.70 ((—3.98) and (—4.10)), Model 2A: 16.02 and 9.71 ((—5.15) and (—5.42)), Model 3: 14.63 and 7.92 ((—4.76) and (—4.89)), Model 4: 6.53 and 4.75 ((—3.55) and (—3.79)), Model 4A: 13.03 and 9.18 ((—4.96) and (—5.29)), Model 5: 3.43 and 3.49 ((—2.16) and (—3.25)), Model 6: 9.40 and 8.40 ((—4.30) and (—5.05)), Model 7: 8.10 and3.55 49 ((—3.23) and (—3.09)), Model 8: 3.60 and 4.05 (—3.55) and (—3.99)), Model 9: 3.89 and 4.75 ((—4.75) and (—3.80)). Whether there is co–integration between the variables in the models, F–statistics in the tables presented by Pesaran et al., (2001) and in the tables prepared by Narayan (2005) for models covering a shorter period and can be verified by comparison with the critical values in the tables prepared by Sam et al., (2019). In addition, statistics and t–statistics can be obtained using econometric software packages Eviews9–13 and automatically compared with the critical values developed by Pesaran and Narayan. In all models, an F–statistic that exceeds the upper limit of Pesaran, Narayan and Sam's critical values by 1% indicates the presence of long–run interaction or in other words, co–integration relationships between the variables in the model (Table 2 and A.Table 9).

Conditional Error Correction Regression and short−term interactions CECR

Long–term relationships between the variables presented in the models were tested using the co–integration methodology. Moreover, the statistical properties of the models were tested using serial correlation, heteroscedasticity and normal distribution. The results of the long–term assessment of the model variables are shown in Table 10. and took on a positive sign at a one–unit delay in these models (1,1A, 2,2A, 3,3A, 4,4, 5, 6, 7 and 8) and a negative sign in these model 9 (positive). This ensures co–integration of the models. Thus, and has a positive impact on and in the long term.

Short−term dynamics

Table 9 shows the results of short−term relationships. In all constructed models, the coefficients of ECT are negative and have a statistical significance of 0.01%. This case means that the condition for confirming short–term dynamics is executed. This also means that there are long–run relationships between the dependent variables and the regressor in the models. Additionally, the ECT coefficients also confirm that the models are again approaching equilibrium after moving away from equilibrium, with the following annual adjustment rate.

FMOLS, DOLS, CCR and Long−term interactions

The reliability of the established co–integration relationships between the model variables is also related to the statistical significance of the coefficients of the variables. A.Table 10 shows the results of the coefficients of the variables in each of the long–term relationship equations estimated using , and . Furthermore, short–term and long–term causality as well as strong causality were also analyzed using Engle–Granger co–integration method/

Granger causality test

This test is based on the fact that only one of the variables is an absolute cause ( ) and and the others (and) are effects. A.Table 13, Panel A below, presents the results of the Granger causality test. Based on the results, it can be noted that the level of significance of acting as a cause is not at all high.

Thus, it should be noted that the short–term cause–and–effect relationship between the variables in the models is not determined. Despite the absence of such a relationship, mutual causation between the variables and strong causality in the long term were found. Additionally, this table shows that white noise errors ( ) are constant across all models. For this purpose, the root test of the module was used. The results of the stationarity tests are shown in Table 14. It should be noted that short–run and long–term causality can be analyzed more fundamentally by applying the Engle–Granger co–integration method. Long–term causality and strong causality among model variables were confirmed in models.

Results of Bayer–Hanck Cointegration Test

The calculations carried out determined that the Results of the Bayer–Hanck Cointegration Test are significantly different (A.Table 15).

CONCLUSION AND POLICY IMPLICATIONS

The hypotheses proposed in the article turned out to be almost correct. So, depending on the historical and geographical conditions, a part of economic resources prevails in each state. These resources, either in the form of raw materials or in the form of finished products produced thanks to them, enter the domestic and world markets and become the driving force of their own economy, and not infrequently, the world economy. Azerbaijan also enters the world market with oil, which is one of the natural resources and is considered the main source of energy. This oil is the basis for the formation, development and stability of the Azerbaijani economy, including the financial and banking sector. It has an indirect and mainly direct impact on the activity of the financial and banking sector and the system of indicators. In addition to the main macroeconomic and microeconomic indicators, the indicators of the financial and banking sector move in sync with the oil factor, that is, with WOP. Monetary aggregates are also highly dependent on this factor. The rapid rise and fall of oil prices and oil revenues in 2008–2009 and 2014–2017, in other words, their fluctuations, did not affect these monetary aggregates. However, in February and December 2015, the devaluation of the Azerbaijani manat and other monetary policy measures were able to stabilize the situation. The main idea we put forward is as follows, to highlight the role of Azerbaijan's oil revenues in the economic development and economic growth depending on the WOP, to highlight their important place in the financial and banking sector, and to reduce the impact on the monetary aggregates, diversifying the economy and the non–oil sector to recommend further acceleration of development works. Thus, the oil factor has been affecting the financial–banking sector and monetary aggregates in Azerbaijan for a long time in the short, medium and long–term perspective. In addition, in the course of a scientific and empirical study of changes in the financial and banking sector and monetary aggregates in Azerbaijan against the backdrop of a rapid increase in WOP and oil revenues, as well as their sharp decline, the following results were obtained:

- WOP have a great impact on the financial and banking sector and monetary aggregates, not only in the short term, but also in the medium and long term. This result requires a deeper assessment of the overall dynamics of the financial–banking sector in terms of its structure and quality.
- Excessive dependence on oil can increase uncertainty in the financial–banking sector along with macroeconomic uncertainty. The economic and financial crises observed over the last 10 years are proof of this. Monetary policy and exchange rate management can provide a solid basis for diversifying the economy and removing the impact of changes in WOP on the financial and banking sector.

Moreover, the results of this study suggest that the dependence of the economies of oil exporting countries on the WOP and its sensitivity to its fluctuations may also apply to Azerbaijan and its economy. Thus, in order to eliminate the dependence of the economy, and especially the financial and banking sector, on fluctuations and shocks in WOP, or at least reduce this dependence and ensure more sustainable development of the country, it is necessary to emphasize the usefulness and importance of constant government policy in this area. The results obtained as a result of the study can become one of the scientific foundations of the state's economic policy aimed at diversifying the economy of Azerbaijan or other similar oil–exporting countries and reducing the impact of WOP shocks on their economies and especially on the financial and banking sector.

Ethical consideration

The study was conducted in accordance with the Declaration of Helsinki and approved by the Research Ethics Review Committee at the Asian Institute of Technology, Thailand, with the reference code RERC 2019.

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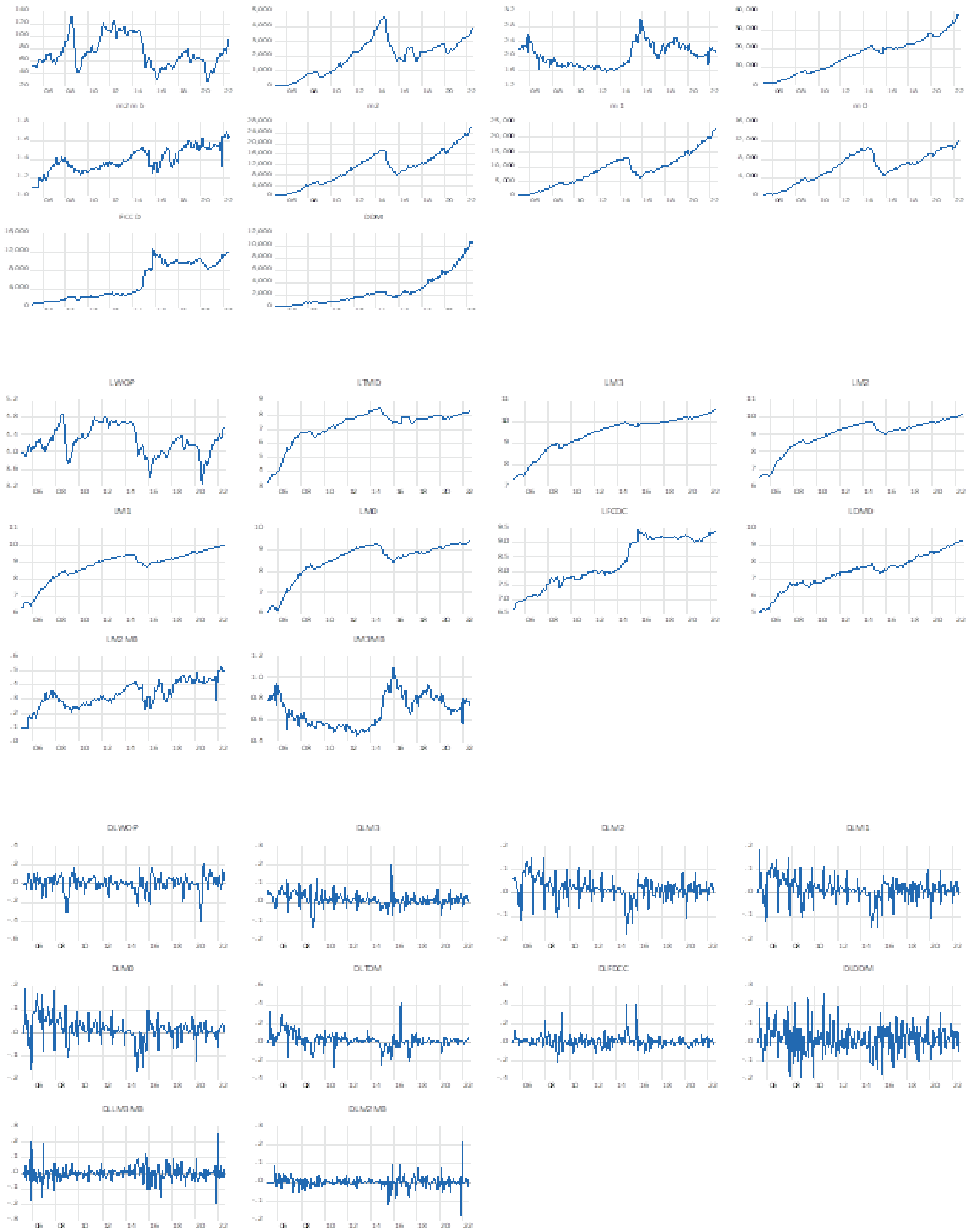
Variables		Source
$M3$	Broad Money Supply (M3)	www.cbar.az
$M2$	M2 money aggregate	www.cbar.az
$M1$	M1 money aggregate	www.cbar.az
$M0$	Cash Outside Banks (M0)	www.cbar.az
DDM	Demand Deposits in manat	www.cbar.az
TDM	Term Deposits in manat	www.cbar.az
DHC	Deposits in freely convertible currency	www.cbar.az
$M3/MB$	Ratio of M3 to Reserve Money	www.cbar.az
$M2/MB$	Ratio of M2 to manat Reserve Money	www.cbar.az
WOP	World oil prices – barrel/ (dollars)	www.cbar.az

A. Table 1: Data and internet resource



A.Figure 1: Variables in its level for the and in its first difference

	WOP	TDM	M3	M2	M1	M0	M2/MB	M3/MB	DDM	
Mean	74.24024	1967.108	16495.24	10969.21	9001.504	6294.559	1.398720	2.020616	2706.945	5525.446
Median	67.69000	2225.300	17684.00	11004.00	8410.800	6529.400	1.380000	2.000000	1913.600	3138.200
Maximum	133.9000	4749.400	39064.90	26973.80	23066.40	12169.30	1.700000	2.990000	10897.20	12705.50
Minimum	26.19000	27.20000	1441.300	634.9000	607.7000	442.4000	1.100000	1.570000	165.3000	806.4000
Std. Dev.	24.67200	1169.877	9503.582	6422.116	5401.682	3228.266	0.130781	0.298460	2515.041	3850.808
Skewness	0.465263	0.062160	0.127940	0.226888	0.417212	−0.257356	−0.051373	0.526561	1.494790	0.293919
Kurtosis	2.194234	2.342493	2.156634	2.376449	2.636473	2.017079	2.594069	2.506486	4.570089	1.347462
Jarque–Bera	13.32058	3.936656	6.828852	5.228659	7.283160	10.82309	1.541503	11.89180	100.2493	27.04700
Probability	0.001281	0.139690	0.032895	0.073217	0.026211	0.004465	0.462665	0.002617	0.000000	0.000001
Sum	15664.69	415059.7	3480496.	2314504.	1899317.	1328152.	295.1300	426.3500	571165.5	1165869.
Sum Sq. Dev.	127828.6	2.87E+08	1.90E+10	8.66E+09	6.13E+09	2.19E+09	3.591755	18.70642	1.33E+09	3.11E+09
Observations	211	211	211	211	211	211	211	211	211	211

A.Table 2: Descriptive statistics for the variables

	LWOP	LM3	LM2	LM1	LM0	LFCDC	LDMD	LM3/MB	LM2/MB	LTMD
Mean	4.251574	9.452344	9.017240	8.827732	8.505063	8.312472	7.468507	0.692852	0.331142	7.193840
Median	4.214939	9.780416	9.306014	9.037271	8.784070	8.051405	7.556742	0.693147	0.322084	7.707647
Maximum	4.897093	10.57298	10.20262	10.04613	9.406672	9.449790	9.296261	1.095273	0.530628	8.465774
Minimum	3.265378	7.273301	6.453467	6.409681	6.092215	6.692580	5.107762	0.451076	0.095310	3.303217
Std. Dev.	0.338321	0.834744	0.912670	0.883091	0.850546	0.828834	1.001576	0.144701	0.094639	1.190769
Skewness	−0.149127	−1.033759	−1.314873	−1.217842	−1.493028	−0.161523	−0.357066	0.296314	−0.289372	−1.798211
Kurtosis	2.530530	3.114246	4.005269	3.836874	4.348032	1.604396	2.739129	2.058312	2.840177	5.580029
Jarque–Bera	2.719765	37.69585	69.68388	58.31435	94.36729	18.04110	5.081908	10.88395	3.169299	172.2358
Probability	0.256691	0.000000	0.000000	0.000000	0.000000	0.000121	0.078791	0.004331	0.205020	0.000000
Sum	897.0822	1994.445	1902.638	1862.651	1794.568	1753.932	1575.855	146.1917	69.87093	1517.900
Sum Sq. Dev.	24.03688	146.3277	174.9228	163.7685	151.9200	144.2627	210.6623	4.397040	1.880889	297.7654
Observations	211	211	211	211	211	211	211	211	211	211

A.Table 3: Descriptive statistics for the logarithmic of the variables

	DLWOP	DLM3	DLM2	DLM1	DLM0	DLDDM	DLTDM	DLDHC	DLM3MB	DLM2MB
Mean	0.002900	0.015713	0.017853	0.017316	0.015783	0.019945	0.023654	0.012894	−2.17E−05	0.001960
Median	0.006805	0.013971	0.019578	0.018306	0.014791	0.020486	0.018596	0.009299	0.000000	0.000000
Maximum	0.215385	0.200556	0.154814	0.186645	0.189491	0.264338	0.442163	0.414470	0.251314	0.215596
Minimum	−0.406052	−0.135866	−0.176677	−0.150804	−0.161012	−0.185991	−0.256459	−0.219745	−0.196506	−0.178555
Std. Dev.	0.091617	0.037453	0.048530	0.050635	0.052213	0.077402	0.082216	0.068614	0.052332	0.032855
Skewness	−1.143175	0.402748	−0.539444	−0.337362	−0.179353	0.107340	0.578144	2.062537	0.412327	0.442257
Kurtosis	5.670142	6.761386	5.018031	4.741675	5.492700	3.641283	8.106795	14.64227	8.057379	15.84334
Jarque–Bera	108.1242	129.4724	45.81891	30.52597	55.49445	4.001648	239.8931	1334.888	229.7499	1450.169
Probability	0.000000	0.000000	0.000000	0.000000	0.000000	0.135224	0.000000	0.000000	0.000000	0.000000
Sum	0.609061	3.299679	3.749154	3.636451	3.314457	4.188499	4.967385	2.707645	−0.004556	0.411507
Sum Sq. Dev.	1.754287	0.293165	0.492223	0.535853	0.569784	1.252142	1.412746	0.983957	0.572370	0.225606
Observations	210	210	210	210	210	210	210	210	210	210

A.Table 4: Descriptive statistics for the first difference of the variables

		At Level			First Difference		
		ADF	PP	KPSS	ADF	PP	KPSS
		H0: Variable Has a Unit Root		H0: Variable is Stationary	H0: Variable Has a Unit Root		H0: Variable is Stationary
Variables		**Test Statistics and Prob.**					
$LWOP$	t_m	−3.131516**	−2.478396	0.339086	− 9.148344***	−8.681503***	0.099401
	t_T	−3.218926*	−2.535182	0.184235**	−9.126400***	−8.656542***	0.100814
	t_0	0.066639	0.305544	N/A	−9.163154***	−8.701854***	N/A
$LM3$	t_m	−4.395243***	−4.439137***	1.645110***	−13.76105***	−13.96437***	0.918831***
	t_T	−2.984605	−2.999108	0.393935***	−14.44684***	−14.46993***	0.190289**
	t_0	5.625059	4.390541	N/A	−5.297411***	−13.04276***	N/A
$LM2$	t_m	−4.661632***	−3.504183***	1.422613***	−2.132672	−12.56828***	0.578706**
	t_T	−3.102985	−2.685569	0.337770***	−7.569598***	−12.72515***	0.184190**
	t_0	0.913628	2.777351	N/A	−1.790789*	−11.82507***	N/A
$LM1$	t_m	1.498381	1.366317	1.556833***	−14.23754***	−14.31039***	0.370679*
	t_T	−0.101202	−0.292280	0.159444**	−14.39216***	−14.44093***	0.204834**
	t_0	4.059562	3.829779	N/A	−13.36662***	−13.89476***	N/A
$LM0$	t_m	−4.567201***	−3.711697***	1.283487***	−1.989120	−12.57577***	0.670990**
	t_T	−2.756586	−2.484521	0.353448***	−2.421273	−12.85253***	0.179095**
	t_0	0.748558	2.439137	N/A	−1.694669*	−12.02085***	N/A
$LDDM$	t_m	−1.774090	−1.690402	1.736736***	−17.64953***	−17.74790***	0.240043
	t_T	−2.887704	−2.836827	0.184852**	−17.68700***	−17.81689***	0.148203*
	t_0	4.119266	4.152849	N/A	−16.37332***	−16.27780***	N/A
$LTDM$	t_m	−5.880283***	−4.811468***	1.218199***	−7.001425***	−12.18290***	0.768125***
	t_T	−3.860866**	−3.366859*	0.361466***	−7.679654***	−12.60262***	0.186852***
	t_0	1.725815	1.736426	N/A	−6.485674***	−11.66955***	N/A
$LDHC$	t_m	−1.485692	−1.495507	1.756459***	−14.31171***	−14.31408***	0.147391
	t_T	−1.931155	−1.931155	0.168433**	−14.34021***	−14.34474***	0.061605
	t_0	2.558142	2.601062	N/A	−13.86292***	−13.85779***	N/A
$LM3/MB$	t_m	−1.854148	−2.232600	0.531296**	−20.78851***	−20.99441***	0.112912
	t_T	−2.221419	−2.599708	0.212803***	−20.76417***	−20.97311***	0.070700
	t_0	−0.396012	−0.376024	N/A	−20.83867***	−21.04595***	N/A
$LM2/MB$	t_m	−2.285831	−2.463128	1.494538***	−20.31934***	−22.30894***	0.118393
	t_T	−3.781030**	−4.526905***	0.058688	−20.27862***	−22.37586***	0.107361
	t_0	0.552791	0.962721	N/A	−20.26197***	−21.53485***	N/A

Note: ***, ** and * indicate rejection of the null hypotheses at the 1%, 5% and 10% significance levels, respectively.

A. Table 5: Unit root test result of the data in its level and in its first difference.

Lag	LogL	LR	FPE	AIC	SC	HQ
Endogenous variables: LM3 / LWOP,V						
0	–305.5909	NA	0.003450	2.844156	2.890883	2.863032
1	1042.154	2645.803	1.51e–08	–9.494505	–9.307598	–9.419003
2	1071.960	57.68858	1.25e–08	–9.686263	–9.359177*	–9.554134
3	1090.973	36.27513	1.14e–08*	–9.778556*	–9.311289	–9.589800*
Endogenous variables: LM2/LWOP,V						
0	–344.1645	NA	0.004922	3.199673	3.246399	3.218548
1	986.8055	2612.872	2.52e–08	–8.984382	–8.797475	–8.908879
2	1021.985	68.09005	1.98e–08	–9.225671	–8.898584*	–9.093542*
3	1032.303	19.68455	1.95e–08*	–9.237816*	–8.770549	–9.049060
Endogenous variables: LM1/LWOP,V						
0	–334.2849	NA	0.004494	3.108617	3.155343	3.127492
1	978.7123	2577.589	2.71e–08	–8.909791	–8.722884	–8.834288
2	1011.287	63.04748	2.18e–08*	–9.127068*	–8.799981*	–8.994938*
Endogenous variables: LM0/LWOP,V						
0	–341.7425	NA	0.004814	3.177351	3.224077	3.196226
1	973.9802	2582.940	2.83e–08	–8.866177	–8.679270	–8.790674
2	1006.769	63.46308	2.27e–08	–9.085433	–8.758346*	–8.953303*
3	1018.827	23.00385	2.21e–08*	–9.113613*	–8.646346	–8.924857
Endogenous variables: LDHC/LWOP,V						
0	–236.0718	NA	0.001818	2.203427	2.250154	2.222303
1	898.7194	2227.747	5.67e–08	–8.172529	–7.985622	–8.097026
2	929.6372	59.84082	4.63e–08	–8.374536	–8.047449	–8.242406
3	954.3789	47.20307	4.01e–08*	–8.519621*	–8.052354*	–8.330864*
Endogenous variables: LTDM/LWOP,V						
0	–405.9054	NA	0.008696	3.768714	3.815440	3.787589
1	885.7501	2535.692	6.39e–08	–8.052997	–7.866090	–7.977494
2	920.5038	67.26512	5.04e–08*	–8.290357*	–7.963270*	–8.158228*
Endogenous variables: LDDM/LWOP,V						
0	–290.4969	NA	0.061175	2.881742	2.914385	2.894948
1	453.1890	1465.391	4.18e–05	–4.405803	–4.307875	–4.366185
2	477.3170	47.06747*	3.43e–05*	–4.604108*	–4.440896*	–4.538079*
Endogenous variables: (M3/MB)/LWOP,V						
0	80.18795	NA	9.85e–05	–0.711410	–0.664683	–0.692534
1	983.7578	1773.828	2.59e–08	–8.956293	–8.769386	–8.880790
2	1027.209	84.09930	1.88e–08*	–9.273817*	–8.946730*	–9.141687*
Endogenous variables: (M2/MB)/LWOP,V						
0	–115.2583	NA	0.000597	1.089938	1.136665	1.108814
1	794.5616	1786.098	1.48e–07	–7.212549	–7.025642	–7.137046
2	837.5109	83.12767	1.08e–07	–7.525446	–7.198359*	–7.393316
3	851.0533	25.83667	1.04e–07	–7.567311	–7.100044	–7.378555
4	868.1116	32.07281	9.64e–08*	–7.641582*	–7.034135	–7.396198*
5	871.0313	5.408928	1.02e–07	–7.585542	–6.837915	–7.283532
*indicates lag order selected by the criterion						

A.Table 6: VAR Lag Order Selection Criteria

LM3 / LWOP, V	Model 1	ARDL (1,3,3)(3 lags,automatic)(AIC)C2,C3
LM3 / LWOP, V	Model 1A	ARDL (1,1,0)(2 lags,automatic)(SC)C2,C3
LM2/LWOP,V	Model 2	ARDL (3,0,3)(3 lags,automatic)(AIC)C2 C3
LM2/LWOP,V	Model 2A	ARDL (1,0,0)(2 lags,automatic)(SC)C2,C3
LM1/LWOP,V	Model 3	ARDL (1.0.2)(2 lags,automatic)(AIC)C2,C3
LM0/LWOP,V	Model 4	ARDL (3.1.3)(3 lags,automatic)(AIC)C2,C3
LM0/LWOP,V	Model 4A	ARDL (1.0.0)(3 lags,automatic)(SC)C2,C3
LDDM /LWOP,V	Model 5	ARDL (1.0.3)(3 lags,automatic)(AIC)C2,C3
LTDM /LWOP,V	Model 6	ARDL (1.0.2)(2 lags,automatic)(AIC)C2,C3
LDHC /LWOP,V	Model 7	ARDL (1.0.2)(2 lags,automatic)(AIC)C2,C3
LM3/MB /LWOP,V	Model 8	ARDL (2.0.2)(2 lags,automatic)(AIC)C2,C3
LM2/MB /LWOP,V	Model 9	ARDL (3.0.5)(2 lags,automatic)(AIC)C2,C3
C4—Case 4: Unrestricted Constant and Restricted Trend; C2—Case 2: Restricted Constant and No Trend); C3—Case 3: Unrestricted Constant and No Trend; C—5: Unrestricted Constant and Unrestricted Trend		

A:Table 7. Models

Variable	Coefficient												
	Model 1	Model 1A	Model 2	Model 2A	Model 3	Model 4	Model 4	Model 5	Model 6	Model 6	Model 7	Model 8	Model 9
$LM3_{(-1)}$	0.98***	0.98***											
$LM2_{(-1)}$			1.05***	0.98***									
$LM2_{(-2)}$			0.06										
$LM2_{(-3)}$			−0.13*										
$LM1_{(-1)}$					0.98***								
$LM0_{(-1)}$						1.03***	0.97***						
$LM0_{(-2)}$						0.10							
$LM0_{(-3)}$						−0.16*							
$LDHC_{(-1)}$								0.98***					
$LTDM_{(-1)}$									1.19***				
$LTDM_{(-2)}$									−0.13*				
$LDDM_{(-1)}$										0.75***			
$LDDM_{(-2)}$										0.22***			
$M2/MB_{(-1)}$											0.60***		
$M2/MB_{(-2)}$											0.30***		
$M3/MB_{(-1)}$												0.45***	0.62***
$M3/MB_{(-2)}$												0.25***	0.30 ***
$M3/MB_{(-3)}$												0.18**	
$LWOP$	0.05*	0.02**	0.02	0.03**	0.03*	0.07	0.03**	0.02	0.05	0.03	0.03**	−0.00	−0.02
$LWOP_{(-1)}$	−0.02					−0.5			0.09				
$LWOP_{(-2)}$	0.03								−0.11				
$LWOP_{(-3)}$	−0.05*												
V	−0.06	0.02**	−0.02	−0.03**	−0.05	−0.02	0.02*	0.01	0.01	0.07**	0.06***	−0.06	0.03
$V_{(-1)}$	0.06		−0.16		−0.10	−0.13		0.39*				0.41	
$V_{(-2)}$	0.30***		0.05		0.19*	−0.01		0.36*				0.55*	
$V_{(-3)}$	−0.29***		0.16			0.19*		−0.75***				0.07	
$V_{(-4)}$												−0.95***	
C	0.10**	0.07*	0.06	0.05	0.60	0.08	0. 05	0.09	0.06	0. 01	−0.03	0.17	0.25
R^2	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.92	0.90	0.88
$Adj-R^2$	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.92	0.90	0.87
$F-st$	16×10^3	45×10^3	12×10^3	32×10^3	16×10^3	81×10	24×10^31	67×10	98×10	11×10^3	60×10	22×10	38×10
$Prob(F-st)$	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
$D-W$	2.07	2.09	2.05	1.72	1.98	2.06	1.75	2.13	2.06	2.06	2.05	1.92	2.06
Note: ***, ** and * indicate rejection of the null hypotheses at the 1%, 5% and 10% significance levels, respectively.													

A.Table 8: Estimated primary ARDL model

Estimated model			
	Bound Test		
	F −St.	t −St.	$Co - integration$
Model 1	$16.05^{***A,C}$ $8.11^{***B,C}$	-3.92^{**B} -4.95^{***C}	Accepted
Model 1 A	$17.53^{***A,C}$ $9.20^{***B,C}$	-4.68^{***B} -5.25^{***C}	Accepted
Model 2	$8.20^{***A,C}$ $5.70^{***B,C}$	-3.98^{**B} -4.10^{***C}	Accepted
Model 2A	$16.02^{***A,C}$ $9.71^{***B,C}$	-5.15^{***B} -5.42^{***C}	Accepted
Model3	$14.63^{***A,C}$ $7.92^{***B,C}$	-4.76^{***B} -4.89^{***C}	Accepted
Model 4	$6.53^{***A,C}$ $4.75^{***B,C}$	-3.55^{**B} -3.79^{**C}	Accepted
Model 4A	$13.03^{***A,C}$ $9.18^{***B,C}$	-4.96^{***B} -5.29^{***C}	Accepted
Model 5	$3.43^{*A,C}$ $3.49^{B,C}$	-2.16^{B} -3.25^{*C}	Accepted
Model 6	$9.40^{***A,C}$ $8.40^{***B,C}$	-4.30^{***B} -5.05^{***C}	Accepted
Model 7	$8.10^{***A,C}$ $3.55^{B,C}$	-3.23^{*B} -3.09^{*C}	Accepted
Model 8	$3.60^{*A,C}$ $4.05^{B,C}$	-3.55^{**B} -3.99^{**C}	Accepted
Model 9	$3.89^{**A,C}$ $4.75^{*B,C}$	-3.65^{**B} -3.80^{**C}	Accepted

Critical Values			10%		5%		2.5%		1%	
Bounds F −St.	Lower I(0)	n=1000[1]	2.63^{A}	3.17^{B}	3.1^{A}	3.79^{B}	3.55^{A}	4.41^{B}	4.13^{A}	5.15^{B}
		n=80[2]	2.713^{A}	3.26^{B}	3.235^{A}	3.94^{B}			4.358^{A}	5.407^{B}
		n=∞[3]	2.30		3.01		3.74		4.71	
	Upper I(1)	n=1000[1]	3.35^{A}	4.78^{B}	3.87^{A}	5.73^{B}	4.38^{A}	6.68^{B}	5^{A}	7.84^{B}
		n=80[2]	3.453^{A}	4.247^{B}	4.053^{A}	5.043^{B}			5.393^{A}	6.783^{B}
		n=∞[3]	4.39		5.42		6.42		7.68	
Actual Sample Size = 223,222 k=2										
Bounds t −St.	Lower I(0)		$-2.57^{B,C}$		$-2.86^{B,C}$		$-3.13^{B,C}$		$-3.43^{B,C}$	
	Upper I(1)		$-2.91^{B,C}$		$-3.22^{B,C}$		$-3.5^{B,C}$		$-3.82^{B,C}$	

Notes: ***, ** and * indicate rejection of the null hypotheses at the 1%, 5% and 10% significance levels, respectively. [1]Pesaran et al., (2001), [2]Narayan (2005), [3]Sam et al., (2019).

A.Table 9: Results of from Bound Tests

Variable	Coefficient											
	Model 1	Model 1A	Model 2	Model 2A	Model 3	Model 4	Model 4	Model 5	Model 6	Model 7	Model 8	Model 9
Conditional Error Correction Regression												
$LM3_{(-1)}$	–0.02***	–0.03***										
$LM2_{(-1)}$			–0.02***	–0.02***								
$\Delta LM2_{(-1)}$			0.07									
$\Delta LM2_{(-2)}$			0.13*									
$LM1_{(-1)}$					–0.02***							
$LM0_{(-1)}$						–0.02***	–0.02***					
$\Delta LM0_{(-1)}$						0.05						
$\Delta LM0_{(-2)}$						0.16*	0.13*					
$LDHC_{(-1)}$								–0.02*				
$LTDM_{(-1)}$									–0.02***			
$\Delta LTDM_{(-1)}$									–0.22***			
$LDDM_{(-1)}$										–0.11***		
$\Delta LDDM_{(-1)}$										–0.26***		
$M2/MB_{(-1)}$											–0.10***	
$\Delta(M2/MB_{(-1)})$											–0.45***	
$M3/MB_{(-1)}$												–0.09**
$\Delta(M3/MB)_{(-1)}$												–0.30***
$\Delta(M3/MB)_{(-2)}$												–0.17**
$LWOP$		0.02**	0.02	0.03**		0.03**	0.02		0.03	0.03**	0.00	–0.02*
$LWOP_{(-1)}$	0.01				0.03			0.03				
V	0.01	0.02*	0.02*	0.03**		0.02*			0.07**	0.05***	0.03	0.03
$V_{(-1)}$					0.02	0.02	0.03					
$\Delta LWOP$	0.05*					0.07		0.05				
$\Delta LWOP_{(-1)}$	0.02							0.11				
$\Delta LWOP_{(-2)}$	0.05											
ΔV	–0.06		–0.02		–0.05	–0.02	0.01	0.01			–0.05	
$\Delta V_{(-1)}$	–0.02		–0.20**		–0.19*	–0.18*	0.39***				0.38*	
$\Delta V_{(-2)}$	0.29***		–0.16*			–0.19*	0.75***				0.87***	
$\Delta V_{(-3)}$											0.95***	
C	0.10**	0.07*	0.07	0.05	0.06*	0.05	0.09	0.06	0.01	–0.03	0.17	0.25
R^2	0.23	0.11	0.20	0.11	0.12	0.20	0.22	0.19	0.08	0.15	0.39	0.15
$Adj-R^2$	0.20	0.10	0.18	0.10	0.12	0.18	0.20	0.17	0.07	0.15	0.37	0.12
$F-st$	7.25***	9.19***	6.59***	9.71***	6.39***	5.95***	10.29***	8.63***	4.98***	9.05***	12.95***	8.98***
$Prob(F-st)$	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
$D-W$	2.07	2.09	2.05	1.72	1.98	2.06	2.13	2.06	2.06	2.05	1.92	2.06
Note: ***, ** and * indicate rejection of the null hypotheses at the 1%, 5% and 10% significance levels, respectively.												

A.Table 10: Conditional Error Correction Regression

	OLS	ARDL	FMOLS	DOLS	CCR	VECM
Model1, 1A						
LWOP	1.55***	1.27**	1.82***	1.72***	1.81***	1.49***
V	1.85***	1.45***	1.95***	1.89***	1.95***	1.42***
C	0.03	2.47	−1.23	−0.72	−1.17	−0.92
R^2	0.56		0.55	0.59	0.55	0.55
Adj. R^2	0.56		0.55	0.58	0.55	0.39
Model 2, 2A						
LWOP	1.62***	1.13*	1.90***	1.80***	1.89***	1.77***
V	1.86***	1.30**	1.96***	1.92***	1.96***	1.45**
C	−0.06	3.47	−1.42	−0.88	−1.37	−0.12
R^2	0.55		0.52	0.58	0.52	0.52
Adj. R^2	0.52		0.52	0.56	0.52	0.43
Model 3, 3A						
LWOP	1.25***	0.81	1.48***	1.39***	1.47***	1.57
V	1.86***	0.83	1.95***	1.90***	1.95***	1.36
C	1.97***	5.85*	0.82	1.28	0.89	1.25
R^2	0.62		0.61	0.65	0.61	0.42
Adj. R^2	0.62		0.61	0.65	0.61	0.30
Model 4, 4A						
LWOP	1.52***	0.90	1.77***	1.75***	1.65***	1.38**
V	1.55***	0.92*	1.65***	1.65***	1.58***	0.98***
C	0.26	4.37	−0.99	−0.92	−0.48	−1.58
R^2	0.47		0.45	0.46	0.48	0.55
Adj. R^2	0.47		0.45	0.45	0.48	0.47
Model 5						
LWOP	0.55***	0.75	0.70***	0.63***	0.68***	0.98**
V	1.98***	1.07	2.03***	2.01***	2.03***	1.76***
C	3.65***	4.05	2.95***	3.26***	2.99***	2.09***
R^2	0.80		0.80	0.82	0.81	0.38
Adj. R^2	0.80		0.80	0.82	0.81	0.25
Model 6						
LWOP	2.09***	1.13	2.48***	2.36***	2.45***	2.39***
V	2.05***	0.52	2.18***	2.08***	2.16***	1.41***
C	−4.22***	2.63	−5.95***	−5.17***	−5.85***	4.48***
R^2	0.43		0.42	0.49	0.42	0.48
Adj. R^2	0.43		0.42	0.47	0.42	0.37
Model 7						
LWOP	1.55***	1.23*	1.80***	1.70	1.80***	2.05***
V	2.55***	2.42***	2.65***	2.60	2.65***	2.65***
C	−2.05***	0.20	−3.85*	−2.52	−3.75*	−4.55**
R^2	0.75		0.75	0.76	0.75	0.20
Adj. R^2	0.75		0.75	0.76	0.75	0.09
Model 8						
LWOP	0.23***	0.30***	0.25***	0.25***	0.25***	0.30***
V	0.38***	0.38***	0.35***	0.37***	0.36***	0.38***
C	0.02	−0.26	−0.15	−0.06	−0.16	−0.20
R^2	0.65		0.65	0.70	0.65	0.43
Adj. R^2	0.65		0.65	0.70	0.65	0.25

	Model 9					
$LWOP$	−0.36***	0.00	−0.37***	−0.37***	−0.37***	−0.12
V	0.36***	0.30	0.37***	0.37***	0.37***	0.38**
C	3.08***	1.55	3.08***	3.08***	3.08***	2.09*
R^2	0.55		0.52	0.52	0.52	0.55
Adj. R^2	0.55		0.52	0.52	0.52	0.43

Note: ***, ** and * −indicate rejection of the null hypotheses at the 1%, 5% and 10% significance levels, respectively.

A.Table 12: Coefficients of long−range models

	Models	$LM1$	$LM2$	$LM3$	$LM0$	$LDHC$	$LTDM$	$LDDM$	$LM2/MB$	
$ARDL$	$ARDL$	−0.02***	−0.02***	−0.02***	−0.02***	−0.01***	−0.03***	−0.03***	−0.12***	−0.09**
$COINTEG$	$FMOLS$	−0.02***	−0.02***	−0.01***	−0.02***	−0.02***	−0.02***	−0.02***	−0.03***	−0.02
	CCR	−0.02**	−0.02***	−0.01**	−0.01*	−0.02***	−0.02***	−0.03***	−0.03***	−0.02
	$DOLS$	−0.02***	−0.02***	−0.02***	−0.02**	−0.02	−0.02***	−0.02***	−0.10***	−0.05*
$ARDLBT$	$CointEq(-1)$	−0.02***	−0.02***	−0.02***	−0.02***	−0.02***	−0.02***	−0.03***	−0.12***	−0.12***
$VECM$	$VECM$	−0.03**	−0.02***	−0.02***	−0.03**	−0.03*	−0.03*	−0.03*	−0.06	−0.20**

Note: ***, ** and * indicate rejection of the null hypotheses at the 1%, 5% and 10% significance levels, respectively.

A/Table 13: Results of ECM