The Determinants and Stability of Demand for Money: The Case of Azerbaijan

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Abstract The main purpose of this study is to ascertain the determinants of demand for money and its stability in Azerbaijan using monthly time series data spanning from January 2006 to November 2020. Johansen cointegration, vector error correction model (VECM) and Impulse Response Function were employed to investigate the relationship between real money demand (M1), and macroeconomic variables, namely income, inflation, interest rate and exchange rate. CUSUM and CUSUMSQ stability tests were applied to check whether the money demand function was stable during the observed period. The results of Johansen cointegration reveal a long-run relationship between mentioned variables. Consistent with money demand theory, the VECM results show that the demand for real money balances is positively related to income but it responds inversely to inflation, interest rate and exchange rate. Impulse Response Function confirms the result of VECM. Moreover, after incorporating the stability tests, the empirical results show that real money demand function is stable over the observed period, suggesting possible use of the narrow money aggregate as a target of monetary policy in Azerbaijan.

Keywords Money Demand, Johansen Cointegration, Error-Correction Model, Stability

1. Introduction

Since the demand for money plays a major role in the formulation of appropriate monetary policy, determinants of demand for money and its stability remain in the sphere of thorough investigation. The relationship between changes in money demand and other macroeconomic variables contributes to the determination of optimal quantity of money supplied in the economy. Moreover, a stable money demand has been perceived as a prerequisite for the use of monetary aggregates in conducting proper monetary policy [9]. Stability of money demand means that there is a predictable and reliable relationship between monetary aggregates and macroeconomic variables included in the money demand function. When talking about a stable money demand, controlling the money supply by the central bank will be an effective monetary policy since the effects of a change in monetary values on macroeconomic variables such as output, interest rates and the overall level of prices can be predicted.

Different interpretations are made on the subject when looking at the determinants of demand for money or money demand function. For example, in the Fisher [7] version of "Quantity Theory of Money", income circulation rate is considered constant and real money balances are associated with income. Keynes [12], on the other hand, emphasizes that money can also be demanded on speculative motive that the function of money demand

should include the market interest rate along with income. In Friedman's [8] approach, various situations that may affect the demand for money, such as the ratio of human capital to physical capital, the benefit of holding money are mentioned.

The first discussion in the literature about the place of the exchange rate in the money demand equation belongs to Mundell [17]. Mundell stated that the demand for money probably depends on the exchange rate, in addition to the interest rate and income level, and stated that this would only slightly reduce the effectiveness of monetary policy in flexible exchange rate regimes.

As the main objective of the Central Bank of the Republic of Azerbaijan is to achieve price stability by keeping inflation within the target range, identifying the determinants and stability of money demand can be an effective tool to shape policy decisions. Therefore, the purpose of this study is to disclose the determinants and stability of the demand for money in Azerbaijan using monthly time series data from January 2006 to November 2020. For this purpose, Johansen cointegration and Recursive residuals (CUSUM and CUSUMSQ) tests for stability were employed to estimate the variables that influence the demand for money and to check whether money demand is stable in Azerbaijan or not.

The structure of the paper is arranged as follows. In the following section, available literature on the subject is examined. In the third section, the model, data and methodology are introduced. In the fourth section, the findings obtained and discussion are presented. In the last section, concluding remarks are provided.

2. Literature Review

The determinants of demand for money and its stability have been a subject of many studies in the literature. With the emergence of developments that may cause instability in money demand, the first studies have been carried out to examine the stability of money demand and the money demand function in developed countries since the 1970s. By the 2000s, with financial innovation and deregulation of markets, similar studies have emerged in developing countries. It seems that the most widely used analysis method in empirical literature is cointegration analysis.

Berentsen, Huber, and Marchesiani [3] in their study "Financial innovations, money demand, and the welfare cost of inflation" analyzed the relationship between financial innovations and the behavior of money demand and inflation in the U.S after the 1990s. For this purpose, a microfounded monetary model was constructed using liquidity shocks and interest on money market deposits. The results prove that improved access to money markets can explain the behavior of money demand very well and it can decrease the welfare cost of inflation substantially. In a related paper, "Limited commitment and the demand for money", Berentsen, Huber, and Marchesiani [4] provide a

complementary view to the instability of the U.S. money demand by showing that limited commitment can significantly improve the fit between the model and the data.

"On the stability of money demand", Lucas and Nicolini [14] analyze the stability of money demand in U.S during the period 1915-2012 as a result of the introduction of Regulation Q. A new monetary aggregate was constructed using M1 money aggregate and currency and different deposit variables. The result shows that the new money aggregate is stable in the U.S.

Maravic and Palic [16] in their study "Econometric Analysis of Money Demand in Serbia" assess the stability of the money demand function in Serbia and estimate the macroeconomic variables that influence the demand for money. Income, inflation, interest rate and exchange rate were selected as independent variables and Johansen cointegration procedure, error-correction model and recursive coefficient test were used. The results show that there is a long run relationship among variables, but money demand showed the signs of instability in Serbia.

The article, "The Determinants and Stability of Money Demand in Turkey" written by Algan and Gencer [1], investigated the determinants and stability of money demand in Turkey covering the period 1987M1-2007M2. The money demand function was created using M1, a narrow definition of money supply, income, interest rate, inflation, and exchange rate. The result of the study shows that money demand function with M1 has a stable relationship with income, interest rate, inflation, and exchange rates.

Bahmani-Oskooee & Bohl [2] tested the stability of the M3 demand for money for the economy of Germany in their study called "German monetary unification and the stability of the German M3 money demand function". The study employs quarterly data for the period 1969-1995 and Johansen co-integration test and CUSUM-CUSUMSQ tests are performed. The results reveal instability in the selected money demand function.

In his paper, "Demand for Money in Hungary: An ARDL Approach", Dritsakakis [5] examined the demand for money in Hungary using the autoregressive distributed lag (ARDL) cointegration method and quarterly data for the period 1995-2010. The empirical results indicate that there exists a stable and cointegrated long-run relationship between money demand and its determinants. While M1 is positively associated with the income, the coefficients of interest rate and nominal exchange rate are negative.

The research, "An Econometric Analysis of Demand for Money and Its Stability in Tanzania" conducted by Manamba [15], examines the determinants of demand for money and its stability in Tanzania using annual time series data from 1966 to 2015. Johansen cointegration, vector autoregressive-vector error correction model (VAR-VECM) and variance decomposition method were employed to realize the result. The results of the cointegration analysis reveal a long-run relationship

between real money balances and the explanatory variables namely, real GDP, deposit interest rate, real exchange rate and inflation rate. VECM results show that the demand for real money balances is positively related to scale variable (real GDP) while it responds inversely to deposit interest rate and inflation rate.

The main aim of the paper written by Kjosevski is to determine the short and long-run determinants and stability of money demand (M1) in Macedonia. The author applied cointegration technique and VECM model covering the period from January 2005 to October 2012. Inflation, exchange rate and interest rate were used as explanatory variables and the results show that while interest rate significantly explains money demand in the short run, exchange rate and inflation can explain variations of money demand in the long-run. Moreover, money demand is found to be stable in Macedonia during the mentioned period [13].

The paper “The determinants of money demand in China” by Dou, examines the determinants of China’s money demand using both a linear econometric model and SVAR model. Income, interest rate, expected inflation rate, financial innovations, government debt, capital mobility and currency substitution were included in the model and the empirical results show that China’s money demand is mainly determined by income, interest rate and expected inflation rate. On the other hand, China’s money demand function is found to be unstable, indicating certain risks of its economy [6].

The purpose of the paper “Stability of Money Demand Function in Turkey” conducted by Tumturk is to investigate demand for money and its stability in Turkey using annual data spanning from the period of 1970 and 2013. Cointegration and dynamic regression estimation were applied linking the log of real money balances, $\ln M/P$, to the log of real GDP, $\ln Y/P$, and the log of the nominal interest rate, $\ln i$. The results revealed that chosen variables have a significant effect on the money demand and the narrow monetary aggregate (M1) was found to be stable [19].

The study conducted by Halicioglu and Ugur examines the stability of the narrow money demand function (M1) in Turkey covering the period 1950-2002. Cointegration procedure along with the CUSUM and CUSUMSQ stability tests were employed in order to test the stability of Turkish M1. The result we demonstrate that there is a stable money demand function and it could be used as an intermediate target of monetary policy in Turkey [10].

The determinants and stability of money demand functions has been analyzed by Padhan [18] using quarterly data from 1996Q2 to 2009Q2. Relationships between monetary aggregates and interest rates, exchange rates, stock prices and GDP were estimated using cointegration tests, error correction mechanism, Granger causality and CUSUM tests. The empirical results reveal the existence of long-run and short-run relationships

among the variables. The CUSUM and CUSUMQ tests support the existence of stability of money demand function.

3. Materials and Methods

The model to be used to identify the determinants of money demand for Azerbaijan is as follows

$$(m-p)_t = \beta_0 + \beta_1 y_t + \beta_2 \pi_t + \beta_3 i_t + \beta_4 e_t + \varepsilon_t \quad (1)$$

Where, $(m-p)$, y , π , i and e represent real money balances, real economic activity, inflation, interest rate and exchange rate of manat to USD, respectively. This equation, in which real money balances are associated with income and interest rates, was created by adding inflation and exchange rate variable to the classical money demand function. The M1 monetary aggregate is used as a dependent variable in the model and is expressed in real terms dividing it by the Consumer Price Index (CPI). M1 monetary aggregate is preferred as it better reflects the financial situation and changes in developing countries like Azerbaijan. It is a good measure of liquidity in the economy and central banks can control this aggregate more accurately. Real GDP is chosen as a proxy for real economic activity because it is the most widely used measure of economic activity. The theoretical expectation about income elasticity is that it should be positive. Inflation, the alternative cost variables of money demand, is included in the model and can have increasing and decreasing effects on money demand. The interest rate on short term government bonds is chosen as the interest rate variable in the model and is expressed as a percentage and the coefficient β_3 reveals the percentage effect of a one-unit change in interest rates on money demand. The reason for choosing interest rates on short-term government bonds is that monetary policy may directly affect this kind of interest rates. The theoretical expectation regarding the interest rate is that it is negatively associated with the demand for money due to the alternative cost of holding money.

There is no consensus in the literature about the effect of the exchange rate on money demand and empirical results indicate that the coefficient β_4 can take both a negative and positive value. A positive coefficient related to the elasticity of the exchange rate is interpreted as the wealth effect in the economic literature so that with the appreciation of foreign currency against national currency, the individuals holding foreign currency in their portfolios increase their demand for the national currency in order to benefit from this increase in value. A negative coefficient for exchange rate elasticity is that the relatively appreciated foreign currency is preferred more by risk-averse individuals and a decrease in the demand for the national currency. The exchange rate variable reflects the nominal US dollar rate in manat and is expected to have a negative sign.

To interpret the coefficients as elasticity in the study, all

variables except interest rate were transformed into logarithmic form.

The data in the money demand equation for Azerbaijan, which is tried to be estimated in Model 1, was obtained using monthly time series data from January 2006 to November 2020 and all data is taken from the statistical database of the Central Bank of the Republic of Azerbaijan. EViews was used for the estimation.

Descriptive statistics of the variables are presented in Table 1. The sample consists of 179 observations.

To analyze the determinant and stability of demand for money in Azerbaijan firstly, unit root test will be applied to determine whether the series are equally integrated or not. Then, the long-run relationship between the variables will be investigated using Johansen cointegration methodology. If there is at least one cointegrating equation, Vector Error Correction (VEC) model will be used. Subsequently, Impulse Response Function (IRF) will be applied to see response of independent variables to the shock. Finally, Recursive residuals (CUSUM and CUSUMSQ) tests will

be adopted to check the stability of the money demand function.

4. Result and Discussion

Unit Root Test

Cointegration analysis can be performed if the series that are not stationary at level become stationary when their first difference is taken [11]. In this context, the stationarities of the series should be examined first. The stationarities of the series used in the study were examined using the Augmented Dicky Fuller (ADF) test. The results of the ADF test show that all series are stationary having integrated order I (1) (see Table 2). The fact that all variables are integrated at their first difference makes it necessary to test a possible cointegration relationship between them.

Table 1. Descriptive statistics of chosen variables

	LM1	LGDP	LINFLATION	INTEREST	LEXCHANGE
Mean	7.261892	9.888290	1.562817	7.486145	0.047805
Median	7.450216	10.04995	1.388651	6.750000	-0.160337
Maximum	10.98134	11.31058	3.072693	15.00000	0.601419
Minimum	4.596135	6.920474	-1.609438	2.000000	-0.242964
Std.Dev.	1.381248	0.903553	0.883111	4.174919	0.340338
Observations	179	179	179	179	179

Table 2. ADF Unit Root Test Results

Variables	Level		First Difference	
	t Statistics	Prob.*	t Statistics	Prob.*
LM1	-1.794529	0.3824	-14.99591***	0.0000
LGDP	-2.282825	0.1788	-3.047571**	0.0327
LINFLATION	-2.121220	0.2367	-15.25785***	0.0000
INTEREST	-1.719373	0.4198	-9.307883***	0.0000
LEXCHANGE	-1.505351	0.5286	-1.782890*	0.0880

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

Table 3. Var Lag Order Selection Criteria

Lag	LogL	LR	FPE	AIC	SC	HQ
0	-961.5758	NA	0.055888	11.30498	11.39684	11.34225
1	320.6795	2474.528	2.30e-08	-3.399760	-2.848591	-3.176119
2	391.7920	133.0760	1.34e-08	-3.939087*	-2.928611*	-3.529079*
3	417.9114	47.35102	1.33e-08	-3.952180	-2.482396	-3.355804
4	441.2279	40.90606	1.36e-08	-3.932490	-2.003398	-3.149746
5	462.3956	35.89856	1.43e-08	-3.887668	-1.499269	-2.918557
6	494.2985	52.23859	1.33e-08	-3.968403	-1.120697	-2.812925
7	523.5041	46.11420*	1.28e-08*	-4.017592	-0.710578	-2.675747
8	548.1886	37.53196	1.30e-08	-4.013902	-0.247580	-2.485689

* indicates lag order selected by the criterion

Table 4. Johansen Cointegration Test Results

Hypothesized No.of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.**
None *	0.253978	103.1348	69.81889	0.0000
At most 1 *	0.173367	51.56670	47.85613	0.0215
At most 2	0.056400	18.05728	29.79707	0.5618
At most 3	0.043509	7.839973	15.49471	0.4826
At most 4	6.17E-05	0.010864	3.841465	0.9167

Residual Diagnostics

As the presence of serial correlation and heteroskedasticity invalidates statistical validity of parameter estimates, residual diagnostics analysis is crucial to check statistical adequacy of the model. The results of VAR Residual Serial Correlation LM test and Heteroskedasticity test show no existence of serial correlation and heteroskedasticity respectively. However, residuals are not normally distributed according to the Jarque Bera test.

Lag Length Criteria and Cointegration test

The appropriate lag length for the cointegration test was determined using the Vector Autoregressive (VAR) model estimate criterion. According to Akaike Information Criteria (AIC) and Schwarz Criteria (SC), appropriate lag length was defined as 2 (see Table 3). As seen in Table 4, Unrestricted Cointegration Rank Test (Trace) results indicate 2 cointegrating equations. Explicitly, there exists a cointegration (long-run) relationship between variables at the 5% significant level.

Vector Error Correction Model and Stability of Parameters

After determining cointegration relationship between variables, VEC estimates were applied. Model 1 shows the results of the cointegration equation.

$$\text{Model 1. } LM1_{t-1} = 9.24 + 1.82LGDP_{t-1} - 0.95LINFLATION_{t-1} - 0.003INTEREST_{t-1} -$$

$$- 0.65LEXCHANGE_{t-1} \quad (2)$$

The findings of the estimates are consistent with the economic theory that there exists a positive relationship between demand for money and income. 1 % increase in GDP will result in demand for money increasing by 1.82%. Conversely, inflation, interest rate and exchange rate are negatively associated with money demand. 1% increase in inflation and appreciation of foreign currency will lead money demand to decrease by 0.95% and 0.65% respectively. 1 unit increase in interest rate will decrease money demand by 0.3%.

Despite the fact that Azerbaijan is experiencing a fixed exchange rate regime, a hard peg of the Azerbaijani Manat to the US Dollar for almost four years, money demand is changing over time. This can be explained with shocks to the variables that determine the demand for money (i.e. shocks to the domestic price level, the domestic output and the interest rate) that force a change in the level of the money demand.

The error correction term of the model was found to be negative and statistically significant (see Table 5). This finding indicates the validity of the predicted long-term relationship and states that if there is a deviation from the long-term equilibrium relationship determined between the variables, 3% of this imbalance is resolved within a month. If money demand is deviated from the equilibrium due to shocks, GDP should decrease while inflation, interest rate and exchange rate should increase to make it back to equilibrium point. However, as GDP and exchange rate variables are weakly exogenous, the result doesn't reflect the reality.

Table 5. Vector Error Correction Estimates

Error Correction:	D(LM1)	D(LGDP)	D(LINFLATION)	D(INTEREST)	D(LEXCHANGE)
CointEq1	-0.030889 (0.02252) [-1.37172]	0.307044 (0.04908) [6.25633]	0.034797 (0.02202) [1.58058]	0.022729 (0.05523) [0.41154]	-0.004831 (0.00198) [-2.43643]
D(LM1(-1))	0.072497 (0.55381) [0.13091]	-6.670038 (1.20698) [-5.52621]	-0.048032 (0.54143) [-0.08871]	0.347207 (1.35828) [0.25562]	-0.101780 (0.04877) [-2.08710]
D(LGDP(-1))	0.019284 (0.04522) [0.42647]	0.320451 (0.09855) [3.25170]	-0.012175 (0.04421) [-0.27541]	0.217308 (0.11090) [1.95946]	-0.000464 (0.00398) [-0.11643]
D(LINFLATION(-1))	0.343863 (0.57383) [0.59924]	-6.651156 (1.25062) [-5.31829]	-0.284235 (0.56101) [-0.50665]	0.465506 (1.40739) [0.33076]	-0.106220 (0.05053) [-2.10216]
D(INTEREST(-1))	-0.025126 (0.03119) [-0.80559]	0.098393 (0.06797) [1.44751]	0.029153 (0.03049) [0.95607]	0.246548 (0.07649) [3.22306]	0.001721 (0.00275) [0.62668]
D(LEXCHANGE(-1))	-2.923813 (0.95839) [-3.05075]	-4.830346 (2.08874) [-2.31256]	2.498670 (0.93697) [2.66674]	4.263942 (2.35057) [1.81400]	0.463914 (0.08439) [5.49714]
C	0.017920 (0.02596) [0.69041]	0.129803 (0.05657) [2.29458]	-0.003575 (0.02538) [-0.14088]	-0.098500 (0.06366) [-1.54727]	0.004371 (0.00229) [1.91256]

Impulse Response Function

The result of the Impulse Response Function is presented in Figure 1. A shock to money demand causes GDP to go down in the short run. The impact of this shock has disappeared after achieving a proportionality relationship in the long term.

On the other hand, in the short run, interest rate increases due to a shock in the money demand and after a second month, it goes down. Inflation and exchange rates, which fell to a very low level with the first effect of the shock, stopped decreasing at the end of the third month, but remained stable at a negative level.

Structural and Parameter Stability Tests

In the study, whether the predicted coefficients are stable or not was examined with the help of sum of recursive residuals (CUSUM) and sum of squares of recursive residuals (CUSUMSQ) tests. In this test, the fact that the cumulative sum of error terms and squares of error terms of the model are among the 5% critical values indicates that the coefficients are stable. The CUSUM and CUSUMSQ test results expressed in Figure 2 and Figure 3 show that the specified values are within the critical values. This result supports the stability of the estimated money demand function.

Figure 1. Impulse Response Funtion

Figure 2. Result of CUSUM Test

Figure 3. Result of CUSUMSQ Test

5. Conclusions and Recommendation

In this study, determinants and stability of demand for money in Azerbaijan using monthly time series data from January 2006 to November 2020 were investigated. Narrow money demand, known as M1 monetary aggregate, was estimated using Johansen cointegration methodology and a long-term cointegrated relationship between real money demand and GDP, inflation, interest rate and exchange rate variables was determined. Empirical findings reveal a positive relationship between income and

money demand while inflation, interest rate and exchange rate have negative effects on demand for money in Azerbaijan. Explicitly, 1% increase in GDP increases money demand by 1.82%. On the other hand, 1% increase in inflation, interest rate and exchange rate leads money demand to decrease by 0.95%, 0.3% and 0.65% respectively. As expected, the signs of the coefficients are consistent with the economic theory. The negative sign of interest rate elasticity indicates that the interest rate can be used to influence the M1 demand for money. Contrary to the results of other studies examined, the fact that the

interest rate elasticity is very close to 0 indicates that a desired effect on money balances requires a relatively large change and the power of interest rates to affect money demand is quite limited. The exchange rate coefficient with a negative sign supports the currency substitution effect in the literature. When the short-term coefficients are estimated with the error correction model, the adjustment speed of the model was found to be -0.03. This result indicates that an imbalance that will occur in the short term, 3% of them will be corrected in a month. The findings obtained from the Impulse Response Function show that the shocks affecting the real money demand have a positive effect on income and a negative effect on inflation, interest rate and exchange rate variables.

CUSUM and CUSUMSQ structural stability tests applied to the model concluded that the model is stable in the period chosen for the study. A stable demand for money indicates that the central bank can influence macroeconomic policies by controlling the amount of money.

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