

## The Quantitative Theory Of Money: An Approach To The Colombia Case

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| Keywords:                                                                | SUMMARY                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
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| E41 Demand for money; E52 Monetary policy; E370 Models and applications. | The quantitative theory of money is an essential part of the study of monetary dynamics in the economy, this field of study is important to understand the supply and demand movements of money, inflation management and the search for sustainable growth. This paper makes an approximation to the demand for money in the Colombian economy, for this purpose an econometric model was built using the variables exposed by the monetarist school. The model analyzes the period from the first quarter of 2005 to the first quarter of 2020. Additionally, the model complied with the assumptions of the ordinary least squares methodology to construct the demand for money in Colombia in the pre-pandemic period of Covid 19. |

### Introduction

The Great Depression of the 1930s and the Second World War generated a wave of hyperinflation, increases in the unemployment rate, in fact stagflation took over the world economy. In this context, Keynes' general theory gained more acceptance among the States in order to increase the employment rate. Keynes' idea of the multiplier, and, that public spending would increase income and demand and therefore, unemployment would have to decrease, were the economic policies preferred by the governments.

In the best moment of the Keynesian ideas, the economists, Federich Hayek and Milton Friedman, began an academic crusade to refute the postulates of the Keynesian school, affirming that the unregulated market would improve the welfare conditions of the population, as well as calling attention to the fact that the excessive increases in the amount of money that governments were injecting into the economies would result in excessive increases in the price level of the economy.

In his article interest rate and demand for money, Milton Friedman, begins as follows:

ONE major strand of Keynesian analysis traces the implications of a particular empirical assumption about the demand for money-that its elasticity with respect to interest rates is very high, approaching infinity (in Keynes' own terms, liquidity preference is, if not absolute, approximately so). Such a situation would have very far-reaching implications: it would greatly limit the effectiveness of price flexibility in correcting unemployment; it would render changes in the quantity of money produced by open market operations impotent to affect economic conditions; it would make the effect of government deficits on income and employment independent of the way in which the deficits are financed. (Friedman, 1966, p. 71).

Friedman begins his article by attacking Keynesian ideas, analyzing the elasticity of the interest rate with respect to the demand for money, which usually tends to infinity. Furthermore, the measures proposed by Keynes to correct unemployment, would have little effectiveness in affecting

economic conditions, insofar as they cause significant changes in the quantity of money causing increases in the government deficit. Finally, Friedman considers that the empirical studies of the demand for money are of greater theoretical importance than Keynes' considerations on the elasticity of the interest rate with respect to the demand for money.

Like Keynes' analysis, these assertions raise two separable issues. One issue is empirical: What is the elasticity of the demand for one or another monetary total with respect to various interest rates? How stable is the relation between the (real) quantity of money demanded and interest rates, for both different monetary totals and different interest rates? How consistent are the elasticities for different periods and countries? How important are interest rates compared with other variables in explaining changes in the quantity of money demanded? The other issue is theoretical: Would a highly inelastic demand for money with respect to interest rates have the far-reaching implications alleged. (Friedman, 1966).

Friedman questioned Keynesian monetary theories stating that it was impossible to have a completely inelastic demand for money, as well as the elasticity of the demand for money, understanding that monetary aggregates have various interest rates. The quantity theory of money is useful for several reasons. A fundamental one is that it is difficult to think about inflationary problems without also thinking about money, i.e., to paraphrase Friedman, inflation is always and everywhere a monetary phenomenon. In addition, "The quantitative theory of money allows us to establish the relationship between money and inflation" (Jones, 2012). For this reason, understanding this theory helps us to understand the dynamics of inflation in an economy.

Economic theory has a substantial importance for monetary problems, since the times of David Hume, with his work, *Moral, Political and Literary Essays*, which is the predecessor of the quantitative theory of money. Hume's first contributions to the relationship between money and inflation, were the seed for Fischer, Marshall and Friedman's postulates at a time when inflation in the world was a big problem (hyperinflation).

The demand for money is a subject of study for any macroeconomic model, in Colombian literature some authors have researched the demand of money function during the periods 2000-2010 finding that statistical significance of the theory of money demand in the economic reality of the country in the period of analysis. Similarly, Luis Lozada and Jorge Lucena conducted the same study for the periods 2006-2010 in the Venezuelan economy.

For the Colombian case, the price level (inflation) is a representative variable for the macroeconomic sustainability of the country. Therefore, the 1991 Constitution, approved that the Bank of the Republic (Central Bank) would be an autonomous and independent institution of the central government as follows:

The central bank will exercise the functions of central banking. It shall be organized as a legal entity of public law, with administrative, patrimonial and technical autonomy, subject to its own legal regime. The basic functions of the Banco de la República shall be to regulate the currency, international exchange and credit; to issue legal currency; to manage international reserves; to be the lender of last resort and banker of credit institutions; and to serve as fiscal agent of the government. All of these shall be exercised in coordination with general economic policy. The Bank shall report to Congress on the execution of the policies under its charge and on such other matters as may be requested (Political Constitution of Colombia, 1991).

In this line, Article 373 states that "The State, through the Banco de la República, shall ensure the maintenance of the purchasing power of the currency". For these reasons, this paper analyzes the demand for money in Colombia from the monetary theory proposed by Milton Friedman, the leading exponent of the Chicago School. To do so, we followed the Central Bank of Colombia powers to sustain the price level in the economy. Finally, it is important to remember, that in the decade of the 90's inflation in Colombia reached levels of 38%.

### Monetary Theory: Theoretical Foundations

In a general way it can be stated, that to the extent that individuals need more money to carry out their transactions in goods and services, the more money they have, i.e., "the quantity of money in the economy is closely related to the number of euros exchanged in transactions" (Mankiw, 2014).

The quantity theory of money states that: "Equation (1)"  $M_t V_t = P_t Y_t$

Where,  $M_t$  is the amount of money in an economy,  $V_t$  is the velocity of money,  $P_t$  is the price level of the economy, and finally,  $Y_t$  is the real GDP. This expression is called the quantity equation. The first part of the quantitative equation ( $M_t V_t$ ) refers to the money used in the transactions of individuals, while the second part of the quantitative equation ( $P_t Y_t$ ) is nominal GDP, i.e. the total quantity of goods and services purchased in an economy at a given time, estimated in current prices.

According to the quantitative theory of money: These goods and services are purchased with money and the first member is the amount of money in circulation,  $M_t$ , multiplied by the number of times each currency changes hands,  $V_t$ . The theory thus says that nominal GDP is equal to the effective amount of money used in purchases,  $M_t V_t$ . (Jones, 2012, P. 15).

The assumption of the classical dichotomy states that in the long run the real variable (real GDP) is independent of the nominal variable (nominal GDP), i.e., economic growth in the long run does not depend neither on the price level (inflation) nor on money but on real variables such as: investment rate, technological development and productivity. For this reason, according to the classical dichotomy, we assume that  $Y_t = \bar{Y}_t$ , i.e., from the quantitative theory of money, real GDP is an exogenous variable. In addition, we add the assumption that the velocity of money is a constant, however, it is important to recognize that the velocity of money varies if the demand for money varies.

Including the previously explained assumptions we obtained that the quantitative equation determines the price level of the economy, "Quantitative theory of money, according to which the growth of prices is determined by the excess growth of the money supply over the growth of real production" (Fernandez, 2006).

#### The demand for money

The quantity theory of money is based on a simple money demand function, "The demand for money assumes that the demand for real money balances is proportional to income." (Mankiw, 2014). It is important to remember that money like any commodity has a price and an opportunity cost.

In other words, the money we keep in cash does not generate any profit, for this reason, keeping cash generates a sacrifice or opportunity cost. If we would want to have cash we renounce to obtain some profit; such as a savings account or treasury bonds (TES), that is to say, the opportunity cost of money is the renunciation of the yield in different financial or real assets.

Therefore, the opportunity cost of money will be equal to the nominal interest minus inflation ( $i - \pi$ ), where  $i$  is the nominal interest and  $\pi$  is the price level (inflation), this is known as the Fischer equation. In this order of ideas, the demand for money is expressed by the following function:

"Equation (2)"  $\left(\frac{M}{P}\right)^d = L(i, Y)$ .

Where  $L$  stands for liquidity, i.e., the demand for cash, knowing the Fischer equation:

"Equation (3)"  $i = r + E\pi$

Where  $i$  is the nominal interest rate,  $r$  the real interest rate and  $E\pi$  the expected inflation. Hence, we replace the Fischer equation in the demand for money, equaling the supply of money balances, obtaining the following expression:

"Equation (4)"  $M/P = L(r + E\pi, Y)$ .

Equation (4) establishes that the level of real money balances depends on the expected inflation rate, as well as the level of the present money supply determines the price level of the economy.

### Proposed model

Considering that the demand for money is a function of income and interest rates, and the fundamentals of the quantitative theory of money developed by Milton Friedman, and considering the econometric model proposed by (Avila Aguirre, 2013) the following model is proposed:

$$\text{"Equation (5)" } M2 = \beta_0 + \beta_1 Y + \beta_2 P + \beta_3 IPVN + \beta_4 DTF + \mu$$

Where:

$M2$  = the monetary aggregate  $M2$  will be the demand for money, consisting of  $M1$  + quasi-money,  $M1$  being cash and quasi-money being the most liquid financial assets.

$Y$  = gross domestic product measured in quarters, because permanent income is not easily observable, quarterly GDP is taken as a proxy variable.

$P$  = the price level of the economy, measured in CPI variations published by DANE (National Administrative Department of Statistics).

$IPVN$  = new housing price index, this indicator is assumed to understand the profitability of real assets in the economy.

$DTF$  = this variable is considered in the demand function as the interest rate of financial assets, for our model we assumed the  $DTF$  at 90 days.

$\mu$  = The error of the regression.

The time series analysis usually presents unit root problems, to avoid this problem we propose to work with a difference model, for this reason:

The proposed model is as follows:

$$\text{"Equation (6)" } \Delta \frac{M}{P} = \beta_0 + \beta_1 \Delta Y + \beta_2 \Delta P + \beta_3 \Delta IPVN + \beta_4 \Delta DTF + \mu$$

Where:  $\Delta$  = variation,  $M/P$  = actual balances,  $Y$  = real income measured by real GDP,  $P$  = price level of the economy,  $IPVN$  = price index for new homes,  $DTF$ : fixed-term deposits, 90 days and  $\mu$  = The error of the regression.

### Analysis of results

Time series analysis implies that the series needs to be stationary, "In a sense a time series model is just a method of extrapolation" (Pindyck, 2001). Hence, stationarity is the preservation of its statistical properties, "A time series is called stationary if it preserves its statistical characteristics (such as mean value, standard deviation, etc., evaluated over a sufficiently long window) over time." (Nava, 2013), that is, a series is stationary if its distribution does not vary over time (Mahadeva & Robinson, 2009). Usually GDP, monetary aggregates and the interest rate are normally non-stationary variables. In order to validate whether the variables selected in the proposed model are stationary or non-stationary, it is necessary to perform different tests to validate the stationarity, the graphic analysis, the correlogram test and the popular unit root test are highlighted, then, the unit root test is applied to validate the stationarity of the variables proposed in the model.

$H_0$ : has unit root (the series is Nonstationary)  $H_a$ : No unit root (the series is stationary) Table 1. Unit root tests

Dickey-Fuller test for unit root

Number of obs = 59

|       |                   | Interpolated Dickey-Fuller |                      |                       |
|-------|-------------------|----------------------------|----------------------|-----------------------|
|       | Test<br>Statistic | 1% Critical<br>Value       | 5% Critical<br>Value | 10% Critical<br>Value |
| Z (t) | -7.071            | -3.567                     | -2.923               | -2.596                |

MacKinnon approximate p-value for Z(t) = 0.0000

Source: Author's calculations, Stata software.

Using the Dickey-Fuller test, the null hypothesis was rejected, since the probability was greater than 0.05 for these variables, therefore, the model does not have a unit root and the series are stationary.

The following is the estimation of the parameters, using the ordinary least squares OLS method, using quarterly figures for the following period (first quarter of 2005 to first quarter of 2020). Using the Stata statistical package, the following results were generated.

Table 2. OLS regression demand for money

```
. req dM dPIB dIPC dIPVN dDTF
```

| Source   | SS         | df | MS         | Number of obs | = | 60     |
|----------|------------|----|------------|---------------|---|--------|
|          |            |    |            | F(4, 55)      | = | 3.68   |
| Model    | 715549265  | 4  | 178887316  | Prob > F      | = | 0.0101 |
| Residual | 2.6763e+09 | 55 | 48659593.6 | R-squared     | = | 0.2110 |
|          |            |    |            | Adj R-squared | = | 0.1536 |
| Total    | 3.3918e+09 | 59 | 57488591.8 | Root MSE      | = | 6975.6 |

| dM    | Coef.     | Std. Err. | t     | P> t  | [95% Conf. Interval] |           |
|-------|-----------|-----------|-------|-------|----------------------|-----------|
| dPIB  | -2.10638  | .6475155  | -3.25 | 0.002 | -3.40403             | -.80873   |
| dIPC  | -2964.09  | 1463.193  | -2.03 | 0.048 | -5896.395            | -31.78515 |
| dIPVN | -103.4402 | 1282.343  | -0.08 | 0.936 | -2673.313            | 2466.432  |
| dDTF  | 333061.4  | 164996.7  | 2.02  | 0.048 | 2400.626             | 663722.2  |
| _cons | 13276.57  | 2719.606  | 4.88  | 0.000 | 7826.362             | 18726.78  |

Source: Author's calculations, Stata software

Analyzing the data generated, it is evident, that the variables of the model (GDP, CPI, DTF) are statistically significant, p-value is less than the significance level (0.05), the IVPN variable is not significant ( $P > 0.05$ ). The normality test allows us to analyze whether the regression errors are normally distributed, considering the Jarque-Bera test and the following hypothesis test:

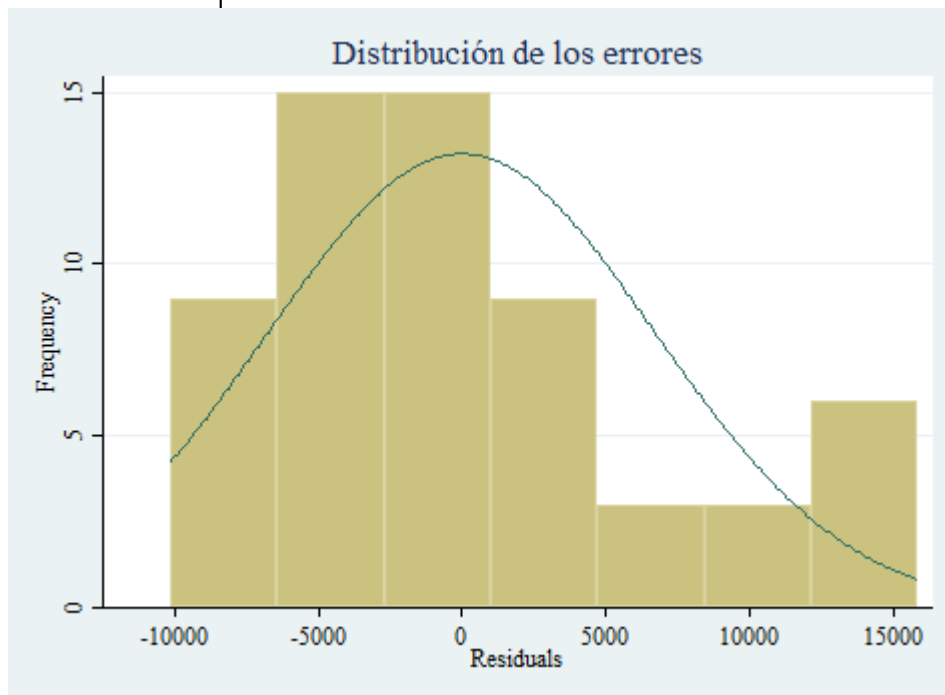
Ho: Errors follow a normal distribution

Ha: errors do not follow a normal distribution

Graph 1. Normality test

Skewness/Kurtosis tests for Normality

| Variable | Obs | Pr (Skewness) | Pr (Kurtosis) | adj chi2 (2) | joint Prob>chi2 |
|----------|-----|---------------|---------------|--------------|-----------------|
| error    | 60  | 0.0269        | 0.7653        | 4.93         | 0.0851          |



Source: author's calculations, Stata program.

The previous graph shows that the error terms follow a normal distribution, likewise, the probability is greater than 0.05 for this reason  $H_a$  ( $0.0851 > 0.05$ ) is not rejected, and it is affirmed that the normality assumption is fulfilled.

Continuing with the validity of the model, the basic hypotheses of the regression model are presented, first, the inflated variance factor (IVF) test is performed, to determine if any multicollinearity problem is present, "Often, in practice, we are faced with the more difficult problem of having independent variables with a high degree of multicollinearity. Multicollinearity arises when two or more variables are highly correlated with each other." (Pindyck, 2001). In other words, multicollinearity makes it difficult to interpret the coefficients.

Table 3. Multicollinearity test

| Variable  | VIF  | 1/VIF    |
|-----------|------|----------|
| intercept | 9.12 | 0.109649 |
| dIPVN     | 7.24 | 0.138208 |
| dIPC      | 2.88 | 0.347206 |
| dPIB      | 2.26 | 0.441751 |
| dDTF      | 1.13 | 0.887700 |
| Mean VIF  | 4.53 |          |

Source: Author's calculations, Stata software

The evaluation of the VIF shows that there is no multicollinearity insofar as the VIF values were found to be between 1 and 10. Additionally, the non-heteroscedasticity assumption "assumption of constant error variances or homoscedasticity" is evaluated (Pindyck, 2001). It is important to emphasize that heteroscedasticity occurs in cross-sectional studies. However, in general, time series studies such as the one being developed do not have this problem.

The hypothesis test will be as follows:

Ho: Homoscedasticity

Ha: Heteroscedasticity

Applying White's test, we obtain:

Table 4. Homoscedasticity Test

White's test for Ho: homoskedasticity  
 against Ha: unrestricted heteroskedasticity

chi2(14) = 17.15  
 Prob > chi2 = 0.2484

Cameron & Trivedi's decomposition of IM-test

| Source             | chi2  | df | p      |
|--------------------|-------|----|--------|
| Heteroskedasticity | 17.15 | 14 | 0.2484 |
| Skewness           | 15.71 | 4  | 0.0034 |
| Kurtosis           | 0.78  | 1  | 0.3766 |
| Total              | 33.64 | 19 | 0.0202 |

Source: Author's calculations, Stata software

The p-value of the Chi-Square statistic is greater than 0.05, reflecting that there is no statistical evidence to reject the Ho, therefore, it can be affirmed that the assumption of non-heteroscedasticity(homoscedasticity) is fulfilled.

The autocorrelation indicates that the model errors are related, for the proposed model it is evident in the Durbin-Watson (2.13), that the model has no first order autocorrelation:

Ho: No autocorrelation

Ha: There is autocorrelation

Table 5. Autocorrelation Test



```
. estat durbinalt, lags (1 2 3)
```

Durbin's alternative test for autocorrelation

| lags (p) | chi2  | df | Prob > chi2 |
|----------|-------|----|-------------|
| 1        | 1.006 | 1  | 0.3159      |
| 2        | 1.351 | 2  | 0.5090      |
| 3        | 2.127 | 3  | 0.5465      |

H0: no serial correlation

```
. dwstat
```

Durbin-Watson d-statistic( 5, 60) = 2.13598

Source: Author's calculations, Stata software

Finally, once the assumptions of the ordinary least squares methodology were validated, the elasticities for each variable under study were calculated using the formula for linear models  $\beta(X/Y)$ , for this purpose the elasticities for the second quarter of 2020 are presented in the following table:

Table 6. Calculation of elasticities

| Table 1. Elasticities |             |
|-----------------------|-------------|
| GDP                   | -0,86194409 |
| IPC                   | -0,5883593  |
| IPVN                  | -0,02769438 |
| DTF                   | 0,00112376  |

Source: Own elaboration.

## Results

Avila Aguirre in his study of the demand for money determined that "the income elasticity of the demand for money turned out to be 0.20, which leads to the conclusion that money did not behave as a "luxury good", with elasticity greater than unity." (Avila Aguirre, 2013). On the contrary, Milton Friedman in his work on the demand for money evidenced that "The simple correlation between the logarithm of the real stock of money per capita and the logarithm of real income per capita is 0.99, and the computed elasticity is 1.8" (Friedman, 1959), that is, a 1% increase in real income generates a positive change of 1.8% in real balances, in other words, for Friedman the elasticity of real income with respect to money balances is elastic ( $>1$ ).

In the proposed model, the elasticity was 0.86%, that is, inelastic, proving that Milton Friedman's hypothesis regarding the elasticity of real income on real balances is not validated for our model. When analyzing the behavior of the price level, it is evident that a 1% increase in the price level generates a decrease in real monetary balances of 0.58%, i.e., there was an inelastic



elasticity ( $<1$ ) in the study period. It is important to highlight that for the study period the price level showed a sign different from the monetary theory, a hypothesis to explain this situation is the target inflation methodology used by Banco de la República, that is, increases in real balances do not generate inflation problems. In the first place because of the consistent management of the intervention rate of Banco de la República, which causes rational agents in the economy not to demand more money, however, the changes are very low, for this reason, it is necessary to analyze the effects of the price level on the demand for money in situations of economic decline in the country.

When analyzing the interest rate of financial assets, an elasticity of 0.001% was observed, i.e., a 1% increase in the interest rate causes a 0.001% increase in the demand for money, this variable is inconsistent with the theory, insofar as increases in the interest rate of financial assets encourage greater demand for money for investment purposes and less demand for money for speculation purposes, in other words, economic agents demand less money as the interest rates of financial assets increase.

Finally, it was evidenced that the real assets variable (IVPN) is not significant, for this reason, it is recommended to find empirical evidence to establish a proxy variable to show the interest rate of real assets in the Colombian economy.

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