ESTIMATION OF DOLLAR CURRENCY
IN VENEZUELA USING A TIME-SERIES MODEL

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SUMMARY

The Venezuelan economy has been experiencing a de facto or informal dollarization that is deepening more and more as time goes by. The causes of this phenomenon lie in the progressive loss of all the properties of the local currency: first as a store of value, then as a unit of account and finally as a medium of exchange. This loss of properties is attributable to a prolonged period of very high inflation, which led to a long hyperinflation, during the period 2017-2021. There are no published academic studies on the dimension of the phenomenon. It is a serious problem that, in an economy with the high degree of de facto dollarization of the Venezuelan economy, economic agents do not have reliable, public estimates on the dollar circulating currency. The purpose of this paper is to demonstrate the application of an indirect time series model to estimate the amount of dollars circulating in the economy as a medium of exchange. The *money demand method* with *inflationary expectations* of Kamin and Ericsson (1993) is presented, which consists of a cointegrating regression with a ratchet variable that is recovered and used to reconstruct series estimates of the dollar as a means of payment, and a methodology is suggested for its application to the Venezuelan case.

Keywords: currency, dollar, time series model, Venezuela, dollarization.

INDEX

INTRODUCTION

The Venezuelan economy is de facto dollarized. Data from private studies show a high degree of dollarization of prices (100%), transactions (approximately 70%) and financial assets (56% of bank deposits). The only aspect where Venezuelan dollarization has been lagging behind is in the dollarization of credit or liabilities of economic agents.

However, there are no reliable and public estimates available on the dollar circulating currency, which is a serious and problematic absence, since the level and evolution of the monetary aggregates is fundamental information for agents, taking into account that, in practice, the dollar has replaced the bolivar as the preferred medium of exchange.

This paper aims to contribute to the solution of this problem by showing an estimation using a method based on a time series based on the estimation of the extended money demand equation with inflationary expectations according to Kamin and Ericsson, 1993. This method is based on the estimation of a money demand function that includes two sets of independent variables: on the one hand, the typical determinants of a demand function, and, on the other hand, a variable that incorporates the so-called ratchet effect or hysteresis. The hysteresis of dollarization refers to the irreversibility of the process, once a certain threshold of expected inflation rate is reached.

There are several direct and indirect methodologies for estimating the dollar circulating in an economy. One way that the consulting firm Ecoanalítica has been implementing is through surveys. However, this is a costly method and can lead to deviations with respect to the true level of the stock of currency in dollars, due to the fear of respondents to reveal information on their cash holdings in foreign currency. Among the indirect methods, two econometric methods most frequently used in the empirical literature on the subject stand out:

- Kamin and Ericsson's Demand for Money method, 1993.
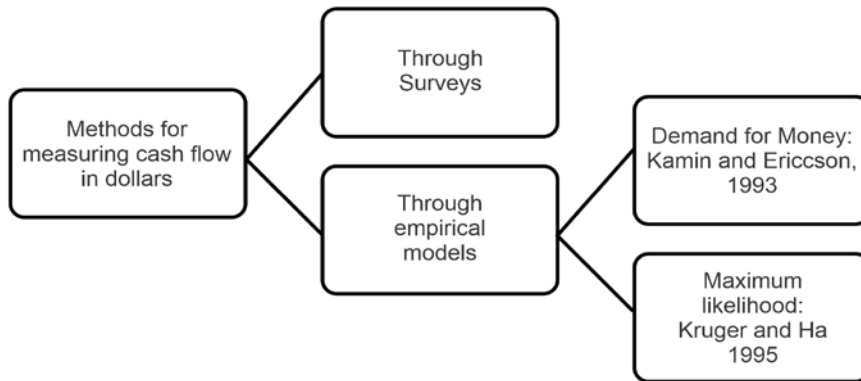- The maximum likelihood method by Kruger and Ha,1995

Fig. 1. Methods to measure the circulating currency in Dollarizations. Source: Own elaboration.

As previously indicated, this paper demonstrates how to implement the method of Kamin and Ericsson, 1993, which consists of estimating an extended money demand function with a variable to capture the ratchet effect. A stylized fact of the different historical experiences of de facto dollarization is its persistence or irreversibility. The ratchet variable is intended to capture this aspect of the phenomenon. Once the coefficient of the ratchet variable is obtained, it is used to reconstruct the estimates of the dollar circulation series.

The paper is structured as follows: after this introduction, a brief theoretical background on de facto dollarizations is presented. The third part, which constitutes the body or core of the paper, shows the methodology, the econometric specification and the variables or data suggested for the estimation applied to the Venezuelan case. Finally, some brief conclusions are presented.

THEORETICAL BACKGROUND

Dollarization is generically called the process of displacement of the local currency by the dollar in its properties as a store of value, unit of account and medium of exchange. Dollarization may be complete or de jure, or it may be de facto or partial. De facto substitution processes occur progressively: first the reserve of value property is lost and a substitution of financial assets in local currency for financial assets in foreign currency is observed; after a while, it is observed that the prices of expensive goods (real estate, automobiles) begin to be marked in dollars or indexed to the dollar, a process that becomes generalized to all goods and services in that economy; finally, when there is a sufficient accumulation of financial assets in dollars to pay and there is a generalization of the marking of prices in dollars, the substitution of the local currency as a means of payment or exchange is established.

The process of substituting financial assets in local currency for financial assets in dollars, i.e. the use of the dollar as a store of value instead of the local currency, is called "Financial Dollarization". This process reflects the loss of the "store of value" property of the local currency and its replacement by the dollar to fulfill this function. It is also called "Asset Substitution".

The process of substitution of the local currency for the dollar in the marking of market prices of goods and services or the indexation of prices and wages to the dollar is called "Real Dollarization". This process reflects the loss of the property of "unit of account" of the local currency and its replacement by the dollar to fulfill this function.

The process of substitution of the local currency for the dollar as a means of payment in transactions is called "Transactional Dollarization". This process reflects the loss of the "medium of exchange" property of the local currency and its replacement by the dollar to fulfill this function. It is also called "Currency Substitution".
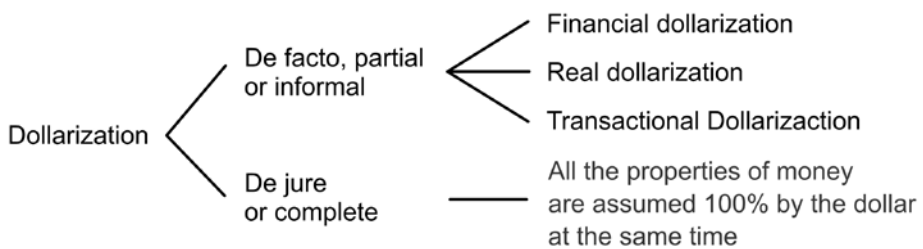
Fig. 2. Taxonomy of Dolarizations. Source: Bofinger, 2009.

These processes occur de facto or spontaneously in countries with unstable economies, where economic agents suffer the consequences of unsustainable or destabilizing policies that are reflected in very high inflation rates and even hyperinflation. These spontaneous, informal or de facto dollarization processes differ in some aspects with respect to full, formal or de jure dollarizations, but they also have certain similarities. The sequence or dynamics of the de facto dollarization phenomenon is as described above and presented in Fig. 3. First the property is lost as a store of value, then as a unit of account and finally as a medium of exchange.
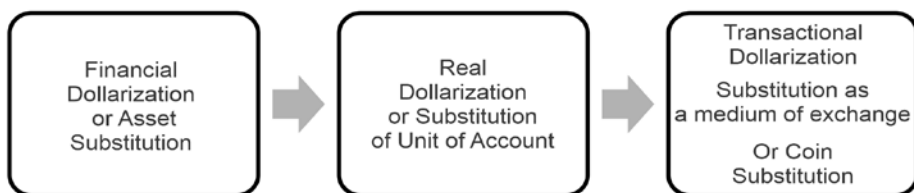
Fig. 3. Dynamics of Dolarizations. Source: Bofinger, 2009.

The theoretical literature on dollarization began with the study of the phenomenon as currency substitution, i.e., the use of the dollar as a medium of exchange in transactions, replacing or displacing the local currency. This tradition includes the seminal model of Calvo and Rodriguez (1977). According to this initial stream of research, the causes of dollarization lie in the instability of the economies where the phenomenon appears, particularly in terms of prices. In an environment of very high inflation or hyperinflation, agents substitute the use of the local currency for the dollar to protect themselves against the high opportunity cost. The opportunity cost of holding money in local currency is domestic inflation. The higher the inflation rate, the higher the opportunity cost of holding local currency, because the lower its power to purchase goods and services. The theories and models in the Currency Substitution tradition explain the degree of dollarization (θ) as a function (f) of the expected rates of inflation (π^e) and nominal exchange rate depreciation. $\left[\frac{\dot{E}}{E}\right]^e$

$$\theta = f\left(\pi^e, \left[\frac{\dot{E}}{E}\right]^e\right) ; \quad \frac{\partial\theta}{\partial\pi^e} > 0 , \frac{\partial\theta}{\partial\left[\frac{\dot{E}}{E}\right]^e} > 0$$

However, it soon became obvious that this theory was incomplete, as there are other motives for holding financial assets in dollars, beyond purely transactional ones. From this concern, the literature that explains dollarization from the point of view of "Asset Substitution" arises, which assumes that risk and return considerations on domestic and foreign currency denominated assets are responsible for the substitution of financial assets. From the portfolio perspective present in asset substitution models, it follows that the degree of financial asset dollarization (Ω) is explained or is a function (ϕ) by the relative volatilities of inflation σ_π^2 and of the depreciation of the real exchange rate σ_e^2

$$\Omega = \varphi\left(\frac{\sigma_\pi^2}{\sigma_e^2}\right)$$

The results of these portfolio models, such as the minimum variance model of Ize and Levi-Yayati (2003), suggest that financial dollarization is likely to persist as long as inflation volatility remains high relative to real exchange rate volatility, even in low inflation environments. At the same time and according to these models, stable domestic inflation and a volatile real exchange rate should make the domestic currency the economy's preferred store of value. This suggests that a flexible exchange rate could minimize incentives for dollarization, while a fixed exchange rate could encourage asset substitution.

A more recent hypothesis to explain dollarizations is the so-called "Institutional Approach". According to this view, the poor quality of institutions may serve as a catalyst for dollarization.

This hypothesis in its modern version is presented in Levi-Yeyati (2006), although its foundations can be traced back to Calvo and Guidotti (1990). According to this approach, the low credibility of the government and its economic policies puts pressure on investors to demand higher interest rates for _public debt_ denominated in local currency, which encourages the government to dollarize its debt in search of a lower debt service burden.
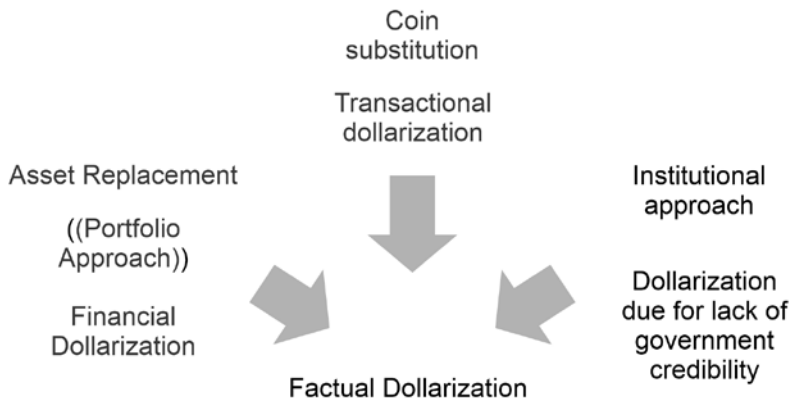

Fig. 4. Explanatory Theories of Dollarizations. Source: Bofinger, 2009.

MONEY DEMAND MODEL WITH INFLATIONARY EXPECTATIONS (KAMIN AND ERICSSON, 1993)

This method for the indirect estimation of the dollar float was originally applied by Kamin and Ericcson,1993 for Argentina[1] . The central idea is the estimation, by means of a time series regression, of a money demand function with the following specification:

$$Ln\left(\frac{M_t}{P_t}\right) = \gamma_0 + \gamma_1 R_t + \gamma_2 dLnP_t + \gamma_3 dLnE_t + \gamma_4 dLnP_t^{max} \quad (1)$$

Where:

- M_t : It is the nominal money approximated by some appropriate monetary aggregate. In the literature M1 or M2 is usually used.

- P_t : It is some price index suitable for deflating money balances to obtain them in real terms. The Consumer Price Index is generally used.

- $\left(\frac{M_t}{P_t}\right)$: These are the actual balances of money.

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1   The investigators found that the dollar currency in circulation was 4.5 times the pesos in circulation.

- R_t : This is some relevant real interest rate, used as a proxy for the opportunity cost of holding monetary balances.

- $dLnP_t$: It is the first difference of the logarithm of the Price Index, which is identical to the rate of inflation and a variable that approximates the opportunity cost of monetary balances in terms of goods and services.

- E_t : is the nominal exchange rate. It is usually included as the first difference of the logarithm to approximate the depreciation rate. Instead of holding currency balances, agents could choose to buy dollars.

- P_t^{max} : Included as the first difference of the logarithm, it is a "ratchet" type variable equal to the maximum inflation rate observed up to time t. It is intended to capture the irreversibilities of the dollarization process due to shocks to agents' inflationary expectations.

The expected signs of the coefficients are as follows:

γ_1 It is ambiguous a priori and will depend on the size of the proportion of term assets in the monetary aggregate used. In Venezuela the sign would be expected to be negative because of the negative real rates during the study period and the virtual disappearance of time deposits.

γ_2 It should be negative, because the higher the realized inflation, the higher the opportunity cost of maintaining real money balances in terms of the goods and services that are no longer purchased. In a context of high inflation, agents will prefer to buy goods rather than demand money.

γ_3 It should be negative a priori because dollars are money substitutes in agents' asset portfolios. It measures the opportunity cost of the demand for real balances of local money (bolivars) in terms of dollars not purchased at the nominal exchange rate. Depreciation discourages the demand for local money.

γ_3 It should be negative, attributable to the irreversibility effect of the reduction in the demand for money caused by the strong inflation and past devaluation.

Once the cointegrating regression is obtained, the coefficient of the ratchet variable is retrieved from it. γ_4 of the ratchet variable. With this coefficient it is possible to reconstruct the estimates of the circulating currency in dollars based on the following equations:

The difference between the demand for dollars and bolivars is given by:

$$Ln\left(\frac{M_t^*}{P_t}\right) - Ln\left(\frac{M_t}{P_t}\right) = \gamma_4 dLnP_t^{max} \quad (2)$$

By definition:

$$M_t^* = M_t + E_t Q_t \quad (3)$$

Where E is the nominal exchange rate, and Q is the dollar balance. Substituting this expression in equation (2) and using the estimated coefficient from γ_4,

we derive:
$$\widehat{Q_t} = \frac{M_t}{E_t}\left(e^{\hat{\gamma}_4 dLnP_t^{max}}\right) \quad (4)$$

According to Rodríguez Merlo (2009), the dollar balance estimated from this methodology corresponds much more to the use of foreign currency as a means of exchange than as a store of value.

SUGGESTED DATA AND ITS SOURCE:

To estimate equation (1), the following data and its source in monthly periodicity are used:

Variable	Source
Nominal Monetary Liquidity (M2)	BCV
National Consumer Price Index (NCPI)	BCV
Nominal Passive Interest Rate - Savings Deposits[2]	BCV
Average Nominal Exchange Rate	Dollar Today
Maximum Inflation of the Period[3]	Own calculations

The frequency of observations can be monthly or quarterly. An interesting and recommended study period could be 2017:01 to 2021:12 for monthly observations.

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2   The rate to be used in the model is the real counterpart of this rate, obtained through the Fisher equation.

3   In the studies where the technique has been applied, the maximum inflation rate observed during the 24 months prior to each period is used. Probably a shorter period (6, 12, 18 months) should be used in Venezuela, due to the greater severity of the inflation rate.
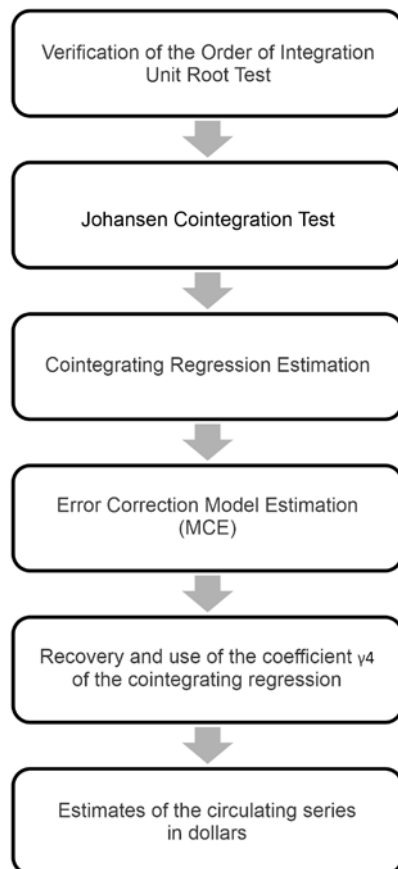
ESTIMATION METHODOLOGY:

In view of the fact that this is a time series regression and given the usual non-stationary behavior of the variables involved, the estimation must proceed under the criteria of a previous verification of the order of integration of the variables involved, the existence of at least one cointegration relationship by the Johansen method, the estimation of the cointegrating regression and the estimation of the Error Correction Model. The steps to be followed are described sequentially below.

VERIFICATION OF THE ORDER OF INTEGRATION:

Unit root tests must be performed under the ADF test, on all variables to be included in the regression, both in level and first difference, under the specification with intercept and trend.

Johansen Cointegration Test:

Given the multiple nature of the money demand regression, it is not possible to apply the Engle and Granger test. We proceed to verify the existence of at least one cointegration relationship by means of the Johansen test. The results of the test should show the existence of at least one cointegrating relationship by both the trace and the maximum eigenvalue methods. This result should prove that a time series multiple regression, such as the one given by equation (1) to be estimated in the next step, makes sense and is not spurious.

Verification of the Order of Integration
Unit Root Test

Johansen Cointegration Test

Cointegrating Regression Estimation

Error Correction Model Estimation
(MCE)

Recovery and use of the coefficient γ_4 of the cointegrating regression

Estimates of the circulating series in dollars

COINTEGRATING REGRESSION ESTIMATION (MONEY DEMAND EQUATION):

The time series regression for money demand is estimated using any econometric software. The signs should be those expected a priori, or else some problem of compliance with the assumptions would be evidenced[4] . It should be verified that the assumptions of no serial autocorrelation of the error, _non-heterocedastic_ residuals and normality of the residuals are met.

RECOVERY AND USE OF THE COEFFICIENT Γ4 OF THE COINTEGRATING REGRESSION.

The interest coefficient is $©_4$, whose value must be recovered from the run. With this value and applying equation (4) we can reconstruct series of the circulating currency in dollars taking as data the monetary aggregate in local currency used, the nominal exchange rate and the maximum inflation (see figure 1).

ESTIMATION OF CIRCULATING SERIES IN DOLLARS

Using the procedure described above, it is then possible to reconstruct the monthly dollar circulating currency series for the study period.

Graph 1

Source: Own estimation

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4   Multicollinearity, for example.

CONCLUSIONS

In this paper we have demonstrated the application of the *time series regression* and *cointegration* techniques to the estimation of the dollar circulating currency in Venezuela, using the method of Kamin and Ericsson, 1993. The technique provides a valid tool for the estimation of the dollar circulating currency in a de facto dollarized economy such as the Venezuelan one, in which there are no public and reliable estimates of the monetary aggregates in dollars, being this the currency preferred by economic agents. This type of estimates with time series are a good alternative to measurements through surveys, which are more costly to implement and require a previous sample design. Given the high inflation rate levels during the recent period, attributable to the Venezuelan hyperinflation, it is recommended to carry out the study with shorter periods to estimate the maximum inflation, testing with 6 and 12 months.

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