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Money demand of Paraguay: Estimation within an inflation-targeting framework

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Abstract

Stability and long-term equilibrium of the demand for real balances contribute to the proper functioning of the transmission channel of monetary policy and to reduce the risks of eventual inflationary pressures episodes. Therefore, this research examines whether the fundamentals of the real money demand of Paraguay has varied during 1994Q1-2014Q4 period and determines whether this theoretical long-term relationship have been stable despite the changes that took place in the monetary policy profile over the same period. Estimations were undertaken using the modification of the Cagan's demand model and by employing the cointegration methods of Engle-Granger and Johansen-Juselius through ordinary least square and vector error correction models techniques. Results indicate that the elasticities of demand for real balances relative to income, the interest rate and the semi-elasticity with respect to the parameter of financial innovation when approaching by the official M1 definition have a range of 1.15 ± 0.15, -0.15 ± 0.04, and -0.02, respectively. Additionally, when approaching by the broad M1 definition, the range is 1.90 ± 0.90, -0.16 ± 0.06 and 0.00 ± 0.01, respectively. Moreover, it is found that the real money demand for the same time span covered is stable.

Money Demand, Estimation, Cointegration, Inflation Targeting

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Introduction

The full and updated knowledge of the economy's Money Demand enables the central bank of a country contribute to calibrate monetary policy so that its implementation takes the expected impact on the key macroeconomic variables effectively and efficiently (Goldfeld, 1994). Therefore, regardless of the context of implementation of that policy is found under a scheme of inflation targeting or someone else.

Such it is so an imbalance of the money demand in real terms, given by the difference between the current and the long term values, could well affect the effectiveness of monetary policy long term rate from its effects on the product and/or inflation (Valadkhani, 2005).

Furthermore, the behavior of monetary aggregates is an important element in the transmission mechanism of monetary policy on the economic activity and prices, especially, in times of innovation and financial stress (Calani et al., 2013). Similarly, one of the main arguments is that monetary policy acts not only through the channel of the interest rate, but also, the demand for money provides valuable information regarding allocations portfolio of agents in the economy (Bae and De Jong, 2007).[1] Consequently, the imprecise knowledge of the demand for money may imply inflationary pressures in the economy, thereby risking the expected performance of the economy, by weakening the anchoring of expectations of economic agents and thus, by provoking a failure of the central banks in its task of keeping inflation within the target range on the horizon of time (King, 2001; Valadkhani, 2005; Kahn and Benolkin, 2007; Valadkhani, 2008; Hossain, 2012).

In particular, the Central Bank of Paraguay (BCP, for its abbreviation in Spanish) since May 2011 formally adopted the scheme of inflation targeting, after since 2004 would come using a protocol based on an intermediate target scheme, through monetary aggregates, where an objective of inflation targeting medium and long term with a tolerance range above and below the central target was established (BCP, 2013).[2]

Moreover, the existence of the consensus that financial innovations cause instability in the money demand function of developed countries (Hossain, 2012). And that, even in a scheme of inflation targeting, the analysis of the demand for money and its estimation are a fundamental tool for monetary policy of central banks (Mies and Soto, 2000; Bahmani and Kutan, 2010). Therefore, is considered relevant to conduct this research.

Additionally, given the changes in the stance of the monetary policy and financial environment that have taken place in recent years, it is necessary to analyze whether the fundamentals of demand for money in Paraguay have changed.

Specifically, the objective of this paper is to analyze whether the elasticities that explain the demand for money in Paraguay have undergone a variation and determine whether the relationship have been stable over the period 1994Q1-2014Q4.

In this way, the main contributions of this paper are the update of the estimations of the money demand of Paraguay that have been published in not peer-reviewed working papers before the implementation of the inflation targeting regime.

[1] A deepening on the importance of the role of money demand within the mechanism of monetary policy and in the context of money and financial markets can be found at (Chadha et al., 2010).

[2] The adoption of the scheme of inflation targeting is the establishment of an "inflation target" as a nominal anchor of the economic agents' expectations of the central bank in the management of its policy and towards the fulfillment of its goal through changes in its benchmark short-term interest, known as the Monetary Policy Rate (MPR).

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Evenly, the analysis of its foundations and estimations in aggregate and per capita terms using two definitions of demand for real balances (the official domestic and international definitions), as detailed further.

The methodological approach implemented in this research was undertaken by estimating the money demand for Paraguay using the theoretical approach for transactional reasons, proposed by Cagan in 1956, in aggregate and per capita terms using the cointegration methods proposed by Engle and Granger and Johansen and Juselius.

Estimations were performed by applying ordinary least squares (OLS) and vector error correction (VEC) estimation techniques. While, the demand for real balances was approximated by employing the official definition adopted by the BCP (the M1) and a broader definition of M1 (hereinafter referred to as M1_a), constructed for comparative purposes to further studies.

Based on the obtained results, it may be pointed out that the range elasticities of demand for real balances relative to income, the interest rate and the semi-elasticity with respect to the parameter of financial innovation when approaching by M1 are 1.15 ± 0.15, -0.15 ± 0.04 and -0.02 ± 0.00, respectively.

Likewise, when it is approximated by the M1_a are 1.90 ± 0.90, -0.16 ± 0.06 and 0.01 ± 0.00, respectively, for the same period. Lastly, it was found that the demand for real balances for the same time span covered was stable.

This article continues with Sect. 2, which shows the review of the literature; Sect. 3, with the presentation of the methods and estimation techniques and data used; Sect. 4, where the obtained results are described; Sect. 5, in which the discussions and conclusion are stated.

And, finally, with Sect. 5.3 that exhibit complementary information employed throughout the development of this research.

An overview of the empirical literature

The aim of this section is to present an indicative summary of the scientific work done recently on this area from a scientific and technical perspective.

Notwithstanding, the reader could deepening about this topic by following the evolution of the money theory along the time in Judd and Scadding (1982); Boughton (1992); Sriram (1999); Mies and Soto (2000); Serletis (2013). Or, taking a review on previous studies carried out for advanced economics. For example, in Fair (1987); Boughton (1992); Mehra (1997); Clausen (1998); Laidler (1991); Sriram (2000); Browne et al. (2005).

Regarding recently developed empirical studies that focus on the estimation of money demand for emerging countries, Bahmani and Kutan (2010) estimate the real demand for money for each of the seven emerging economies of Eastern Europe on a quarterly basis (ranging, on average, from 1995Q1 to 2006Q2), using Pesaran et al. (2001) error correction and cointegration estimation technique.

The applied specification is based on the theory of demand for currency substitution, approximated by each country's M2, gross domestic product (GDP), inflation and nominal effective exchange rate. As a result, they conclude that their estimations are consistent with the theory and that the real money demand in each country is stable.

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Anwar and Asghar (2012) based on the technique of autoregressive distributed lag (ARDL) examine the long-term real money demand of Pakistan taking as arguments the real GDP, the Implicit Price Deflator Index of the GDP (as opportunity cost money) and the nominal exchange rate (domestic currency against the US dollar). Employing annual data for the period 1975-2009, both authors find that the real demand for money for M2 has signs in line with the theoretical postulates and that it is stable. Although, their approach lacks of stability for M1.

Bahmani-Oskooee et al. (2013) according to quarterly data from 1995-2010 for six emerging countries of Central and Eastern Europe and four other emerging economies, found that the demand for money (given by M2 in terms real) is stable and correctly specified. The arguments that they used for their model include the inflation, nominal exchange rate, GDP volatility and the volatility in the money supply. While their specification adopted was based on Choi and Oh (2003) and the applied estimation technique relied on Pesaran et al. (2001).

Other authors who introduce innovations in this field and that confirm the stability of money demand and of their related parameters according to the theoretical postulates are: Foresti and Napolitano (2013); Sarwar et al. (2013).

The first performs panel data technique proposed by (Mark and Sul, 2003; Pedroni, 2001) for nine countries of the International Organization for Economic Development (OECD). In the mean time, the second authors do the same for Pakistan but, by using Vector Autoregressive Models (VEC) approach.

For its part, Ivanov et al. (2015) simulate the super neutrality of money based on Sidrauski (1967) and estimate the money demand of Macedonia in quarterly frequency for the 2002-2012 period using a cointegration approach and M2 as a proxy.

Calani et al. (2013) under the systemic approach of the consumer theory estimate the demand for money as a liquid asset for Chile through four estimation techniques (for sub-samples, recursive, state-space and non-parametric procedures) confirm stability and consistent parameters with the theoretical models used for the 1990-2006 period.

Recently, Ferrada et al. (2014) estimate the demand for money in Chile under three specifications based on the analyzes and empirical applications of Tobin (1956); Corbo L (1980); Feenstra (1986); Matte and Rojas (1989); Arrau and Gregorio (1993). The specification of the demand for money is deducted from the optimization of a representative agent approach which maximizes consumption and money demand for transaction purposes. To do this, the use quarterly and monthly seasonally adjusted data and not seasonally adjusted data, as well, in order to check data robustness and make projections. Finally, by using the method Vector Error Correction (VEC) these authors find that long-term elasticity of money demand is about 2 with respect to income and a semi-elasticity of -0.12 in relation to the interest rate for the period 2000-2014.

In the same line, but for an advanced economy, it is worthy to note the work of Lucas Jr. and Nicolini (2015), who examine the stability of money demand by implementing a new empirical construction of this aggregate for the United States during 1915-2012 but taking in to account the effects resulted from changes in the regulation of the banking sector in early the 1980s.

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Thereby, there is a long list of current peer reviewed works that deepen the study of money demand in which they show its full force as an influential factor in the transmission mechanism of monetary policy. Regarding this, recent main results of studies published as working papers related directly or indirectly on the money demand of Paraguay are referred to below.

At the regional level, Carrera et al. (2008) conducted a study to estimate the demand for money for 15 countries in Latin America (Paraguay among them) covering the period 1948-2003 in annual frequency by applying the method Fully Modified Ordinary Least Squares (FMOLS) developed by Pedroni (2002) for panel data. The reduced theoretical specification used and proxied is the Keynesian approach which was defined for the M1 of each country. The results indicate that income elasticity and semi-elasticity with respect to the interest rate for the analyzed countries, on average, are 0.94 and -0.01, respectively. While for Paraguay correspondingly values are in 0.44 and -0.009 for the same elasticities, respectively.

At the national level, it should be noted that, according to the review of the literature done in this research, no published peer-reviewed studies on estimates of the money demand for Paraguay were found and, since 2007 no more non-peer- reviewed studies have been done.

In general, these late studies belong to the category of workingpapers. Among them are those authored by Colmán (2005); Rojas and García (2006); Colmán (2007).

The first author, Colmán (2005), estimate the real money demand based on the traditional specification suggested by Fisher (1896) under the Engle and Granger (1987) approach with monthly frequency data.

The dependent variable is approximated by the real M1 aggregate (deflated with the consumer price index), while the arguments of the function are compose by the real income (approximated with the monthly indicator of economic activity), the interest rate (proxied by the average of the interest rate market) and a trend variable (taken as a measure of financial innovation). Both functions (one, with seasonal dummies and other, with seasonally adjusted variables) are estimated monthly basis for the period between 1994: 01 and 2004: 12, finding significantly income elasticities of 0.51 and 0.65 and semielasticities for the interest rate of -0.42 and -0.46 for both models, respectively.

Similarly, Rojas and García (2006), who propose the use of monetary aggregate M1 in an extended version to approximate the demand for money in nominal terms. They replicate Iguini and Licandro (2003)‘s work by using theoretical specifications of the money in the utility function suggested by Sidrauski (1967); Clower (1967); Lucas (1980) for cash in advanced model and by Wilson (1979) for transaction costs model. These, ultimately, are modifications made to the original model proposed by Cagan (1958).

Then, by means of cointegration techniques (and inclusion of dummy variables for the crises of 1997 and 2002), theses authors confirm stability of the parameters estimated using Ordinary Least Squares approaches, Two Stage Least Squares and Vector Error Correction Models. Moreover, they conclude that the coefficients estimated using quarterly data for the period 1994-2005 are 0.77 for the income, -0.23 for the interest rate and -0.005 for technological factor.

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Finally, Colmán (2007) estimates the real money demand (with M1) for 1991-2003 period using Engle and Granger (1987) approach for the traditional theoretical specification of Fisher (1896) by adding dummy variables to capture the national financial crisis of 1995 and the seasonality of the money demand. Their results indicate an elasticity of 0.40 for income, a semi-elasticity of -0.75 for the interest rate and stability of the quarterly and seasonally relationship estimated.

In summary, these three works performed nationwide agree on the stability of money demand during 1991-2005. In terms of estimated parameters, they have magnitudes within a range of 0.40 to 0.77 and from -0.23 to -0.75 for income elasticity and semi-elasticity of the interest rate, respectively.

Methodological aspects

This section presents the methodological framework and the technique to be applied in order to estimate the money demand for the Paraguayan case. Likewise, a description about the layout, source and evolved characteristics of the data are developed.

The model

According to Sriram (2000), very important points to take into account when modeling and estimating the demand for money are the selection of the theoretical (or analytic) specification, the estimation technique and the variables that will play as arguments of the function.

In view of the relevance of the preceding points, the selected theoretical approach corresponds to that proposed by Cagan (1958), who poses mathematically the inclusion of the concept of financial innovation as a factor affecting the demand for real balances but which is independent of its other fundamentals.[3]. Hence, the omission of this factor could lead to unsuitable specifications for real money balances modelling that could show unstable parameters and autocorrelation errors (Arrau and Gregorio, 1993; Valadkhani, 2005).

Therefore, this function of real balances is part of the theoretical line of the transaction money demand reasons and it is formulated from the conception of money in the utility function supported by Sidrauski (1967). Moreover, according to Iguini and Licandro (2003) who used this same model, they sustain that it is consistent with the transaction costs model of Wilson (1979) and with the cash-in advance model of Clower (1967) and Lucas (1980).

This theoretical line is adopted because of the primary status of the relative development process of Paraguayan's capital market, which leads to assume that the demand for real balances is, especially, due to transactional and precautionary reasons more than to speculative reasons.

Methodologically, the theoretical specification selected begins as of the maximization of the utility of a representative agent of the economy given its consumption requirements and real balances (real money holding that can buy goods and services) restricted by its budget availability.

[3] For financial innovation, as Arrau and Gregorio (1993), state: "is understood as any factor that produces changes in the demand for real balances that are not explained by its fundamentals (income or consumption and the opportunity cost for using money). Clear innovative factors of this kind are the technological advances of transactions and financial regulations of regulatory or deregulatory nature. The latter may have a negative or positive effect on the demand for real balances"

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As a result of the optimization process and consideration of financial innovations in the economy, the long term demand for real balances in linear terms and natural logarithm is determined by the functional relationship presented in Equation 1 (which can be expressed in aggregates and / or per capita terms).

$$Ln(m_t) = \beta_0 + \beta_1 Ln(c_t) + \beta_2 Ln(\delta_t) + \beta_3(\theta_t) + \upsilon_t \quad (1)$$

Where the arguments of the demand for real balances, m_t, are given by a scale variable (which in real terms can be the consumption or the income), c_t, is the opportunity cost of using money, δ_t, the parameter financial innovation, θ_t, and an error term, υ_t (which is assumed normally distributed with zero mean and constant variance).

Also for β_i parameters (with $i = 0,1,2,3$) for the intercept, the elasticities with respect to real income and the opportunity cost of money and for financial innovation semielasticity parameters, respectively.

In this research, as similar to those carried out at national and international levels (already mentioned in the literature review), as a scale variable is used the real gross domestic product as a proxy for the real income; the nominal interest rate as an approximation of the contemporary opportunity cost for the use of money; and, a trend variable to capture the effects of financial innovation.

Relationship among the demand for real balances with each one of the three selected variables and the reasons for their choice are mentioned below.

Firstly, the theoretical behavior expected between the demand for real balances is positive respect to the real income and, this is because as it gets greater, so the amount of real balances required to perform a larger number of transactions will be (Sriram, 1999). Additionally, taking into account the characteristics of the Paraguayan econ omy, which has an economic model based on the agro-export, and following to Khan (1980), here the real gross domestic product is used as a proxy for non-permanent real income.

Second, as the opportunity cost of use of money is greater, the theoretical relationship stipulates that real balances holding gets lesser because of the existence of better alternatives for the use in the economy. Thus, the interest rate[4] will be the variable that measures the opportunity cost of money. That is, one that quantifies the cost incurred by the trade-off (or dilemma) between holding cash in hand (in the pocket) or money transformed as a financial asset (eg bonds, fixed-term savings, participation in mutual funds, etc.). Therefore, the elasticity with respect to this variable should be negative.

Additionally, the reason because the nominal interest rate, i_t, in contemporary terms has been chosen is because, according to Arrau and De Gregorio (1993), it is desirable to consider the present accumulated effect of the interest rate on the demand for real balances and not the future cumulative effect (given by its expression as a ratio, $i_t/(1 + i_t)$. Besides this, the characteristics and level of development of the capital market of Paraguay (as mentioned above), justify the use of this variable which is wide used, as well, in the empirical literature reviewed before (Sriram, 1999).

[4] It is important to note that in developing country it is usual to replace the interest rate as a proxy of the opportunity cost of using money for the inflation rate. This practice is mainly due to the low degree of financial market development and speculations that are made in the commodities markets (Bahmani and Kutan, 2010).

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The use of a trend variable has become quite common in the empirical literature of money demand estimation, as it has shown good performance when trying to capture financial innovations. For example, see Arrau et al. (1995) and Iguini and Licandro (2003). In addition, other techniques have been proposed to try to bring financial innovation without the use of trend as is by Arrau and De Gregorio (1993).

Therefore, it is important to mention that the contribution made by this research to national literature is twofold, in the sense that, besides estimating Equation 1 in aggregate and per capita terms with the variables listed above, also it is estimated using two definitions of demand for real balances: the official domestic and international definitions, as detailed below.

Estimation techniques

In order to obtain the basic parameters of the demand for real balances of the Paraguayan economy and see if this has the property of stability.

Equation 1 is estimated in aggregate and per capita terms using the econometric techniques of Ordinary Least Squares (OLS) and Vector Error Correction (VEC),[5] accompanied by the Engle and Granger (1987) and Johansen and Juselius (1990) cointegration methods, respectively.

These two last methods help to avoid potential biases in the estimation as a consequence of the technique chosen for the empirical estimation of the real money demand (Hofman, Rasche and Tieslau, 1995).

In this regard, the co-integration method developed by Engle and Granger (1987), known as the approach based on the residues as well, consists of three steps. In the first one, it is necessary to conduct a unit root test to determine the order of the integration of the variables which compound the long term relationship of the demand for real balances stated in Equation 1.

Secondly, once it is verified that the variables have the same order of integration, for example, that all of them are not stationary (e.g. integrated of order one). Then, the long term relationship of the real money demand (given by the Equation 1) can be estimated using the OLS technique. After that, the integration order of the residues are checked with the ADF Test and, if they are integrated of one order lesser (e.g. of order zero, I(0)) according to the Engle and Yoo (1987) tables, then the existence of a long term relationship is confirmed, i.e. there is cointegration. By this way, the equation estimation becomes the cointegrating equation.

In the third step, a second equation is estimated in first differences with OLS.

This becomes called the error correction model because it incorporates the residue generated in the first estimation which, actually, contains cointegrating equation. Finally, it must be verified that the model meets all the OLS assumptions.

On the other hand, the Johansen and Juselius (1990) method or method based on the MLE approach is composed of four steps.

In the first, the order of integration of each of the variables of Equation 1 is verified in the same way as the former method.

[5] A detailed and analytical explanation of the first technical can be found in Greene (2000) and, in Enders (2009) for the second.

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In the second step, once it is confirmed that there is an only order of integration of these variables in the previous step, the number of optimal lags are determined by estimating a Vector Autoregression (VAR) and it is proceeded to estimate cointegrating vectors by the method Johansen (1991, 1995). Subsequently, standard cointegration vectors (in the long-term model) and adjustment parameters (in the short-term model) are analyzed.

In the last step, besides verifying the fulfilling of VEC estimation model assumptions, one can optionally carried out the accounting analysis of innovation (analysis of impulse response functions and variance decomposition).

As for the method of testing unit root (in levels and in first differences) for the variables specified in the theoretical model of the demand for real balances (in Equation 1), it is proposed the use of Dickey and Fuller (1979) and Kwiatkowski et al. (1992) tests.

Similarly, in order to check the property of stability of the demand for real balances the approaches of CUSUM and CUSUMQ, originally proposed by Brown et al. (1975), will be used.

Additionally, the econometric examination was supplemented by a prior and comparative statistical analysis of the variables used in this research to provide support and contrast the results.

In short, Equation 1 has two definitions of demand for real balances (M1 and M1 a) with two proposed estimation techniques (Engle and Granger and Johansen and Juselius) and two forms of expression (in terms aggregate and per capita). Consequently, eight specifications (models) of the demand for real balances were estimated.

Additionally, the econometric examination was supplemented by a prior and comparative statistical analysis of the variables used in this research to provide support and contrast the results.

Lastly, the variables that approximate financial innovation were built following recommendations and practices of international literature in which the ratios of M2 over total GDP and M2 are used in relation to M1.[6]

Data

The data used are quarterly frequency and cover the period 1994Q1-2014Q4. Selecting this period of study was essentially due to the availability of data, which have as a source to different statistical annexes published by the Central Bank of Paraguay for monetary and financial data; and the General Directorate of Statistical Surveys and Census (DGEEC) for demographic data.

In this regard, nominal series of monetary aggregates published and defined by the Central Bank of Paraguay are used: M0 (including bills and coins in circulation or, in other words, notes and coins held by the public plus reserves in private banks); M1, the money supply (which includes bills and coins held by the public plus private sector current account in local currency); and, the money supply M2 (which includes M1 and quasi money added to the composed by sight deposits, also called savings deposits, time deposits and savings certificates).

The fact of using the definition of narrow money (M1) is consistent with the concept of money on utility function model (Sidrauski, 1967) and with the liquidity degree of M1 for transactions (Basu and Salyer, 2001).

[6] See Ireland (1995); Arrau et al. (1995); Carby et al. (2012) for a deepening of financial innovation and guidance on the use of indicators.

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And, according to Anwar and Asghar (2012), numerous studies in developing country consider a best practice the use of M1 instead of M2, given the nascent development process of their financial sector and the weakness of their banking system (Moosa, 1992; Hossain, 2012). Although this last reason has not been the case of Paraguay for more than a decade.[7]

In addition, here it is employed the series of nominal gross domestic product (NGDP), private consumption, consumer price index (CPI) based in December 2007, the annual deposit rate (weighted average) of the financial system (R), nominal exchange rate Guarani (PYG) to the US dollar (USD) and data total population of Paraguay.[8] Except for the interest rate and the total population, other variables are seasonally adjusted with the X-13 ARIMA method.

The CPI variable is re-scaled to a base year, to 1994, coinciding with the current official basis year used by the BCP (in 2015).

Additionally, in this paper a monetary aggregate that include M1 plus sight deposits is defined in order to get an extended version for comparative purposes. This is the M1 a, and the reason for this definition is because most of the foreign monetary authorities define their M1 in this way.

Following the practices employed by most authors in the empirical literature to obtain variables in real terms, the demand for money (given by M1 and M1 a), income and consumption in aggregate levels and per capita, have been deflated by the CPI.[9]

Moreover, the values of M1, M1 a and the interest rate are calculated as averages for each period. And the original monetary variables (without changes) are expressed in domestic currency (in millions of Guarani PYG).

Finally, with respect to the nominal interest rate used, note that this corresponds to the deposit rate paid as deposits, fixed-term deposits, securities issued and certificates of deposit savings calculated as a weighted average of balances as of 2003.[10]

And, given the short and medium terms characteristic of these deposits and securities in the financial system of Paraguay, this interest rate corresponds to its contemporary expression, i_t, and the narrow definition of the demand for real balances suggested in this research. Moreover, the use of the long-term interest rate is for broader definitions of the demand for real balance with the purpose of capturing possible financial assets substitutes of the money Valadkhani (2005), which clearly, does not correspond to the objective of this paper.

[7] See the study by Jimnez and Manuelito (2011) and Reports Financial Stability Central Bank of Paraguay until 2015.

[8] This last variable is available in annual frequency but is converted to quarterly terms using the Quadratic-match average conversion method.

[9] Based on estimations made in this research for the period 1994Q-2014Q4 and the proposed specifications for the case of Paraguay, theoretical model highlights that have achieved better results by deflating with the CPI instead of the Implicit GDP deflator. One of the probable reasons that could explain this fact is that money demand is modeled on the side of the transactions. That is, on the side of purchases, based on the identity of the Quantity Theory and Cagan's model.

[10] Prior to 2003, the interest rate used was calculated based on flows, which could have some effect on the estimates made in this investigation. However, based on estimations made for various temporary cuts within the study period and contrasting with earlier estimates made at the national level, no significant differences were found.

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Results

During the period 1994Q4-2014Q4 can be seen that GDP, M1, M1 a and all other variables presented in the Graphic A1 of the Annex have an evolution characterized by a growing trend (except for the rate of interest), intercept and breaks throughout its history.

In general, these breaks are products of the business cycle, on the one hand, and changes in the profile of monetary policy, on the other. Specifically, during the quarters 1997Q4, 2002Q3, 2003Q2 and 2008Q3 in which some breaks are mainly due to adverse economic results from the performance of the national agricultural sector, domestic banking crisis and impact of financial crises occurred internationally.

However, the regime changes or breaks occurred in 2004Q1 and 2011Q2 quarters, they are coincident with changes in monetary policy profile. The first, given by the abandonment of monetary policy scheme based on control of monetary aggregates that was handled to the previous quarter and the adoption of a monetary policy rule based on an inflation target management through monetary aggregates.

The second is due to the full adoption of a rule based on monetary policy rate control (BCP, 2013).[11]

In this sense, changes in monetary policy are reflected in the statistical properties of the main monetary variables (in quarterly frequency) used in the model of the demand for real balances. Specifically, compared to the period 1994Q4-2003Q4 during the period 2004Q1-2014Q4 lower volatilities are observed in money growth (M1 and M1 a).

Inflation and its quarter to quarter variation and interest rate and its quarterly respective variation (Table A2 in Annex).[12]

Also decreases in average levels of inflation and interest rates accompanied by increased money growth are verified. These facts are consistent with a greater economic dynamism given by a higher economic growth rate average in a context of a greater exchange rate volatility, as well.

On the other hand, throughout the period of analysis, it is checked that the money speed was not constant due to the observed changes in the interest rate and greater financial innovation (Graphic A2). The increase of the latter variable is approximated, as is customary to do so internationally by its main indicators are the M2 to GDP and as a proportion M2 M1. In this case, as a proportion of M1 and M1 expanded official definition of national banking matrix (Graphic A3).

Likewise, advances in terms of financial innovation (technological innovation or technological processes) can be displayed by increasing the amounts of use of credit cards and the average amount consumed (Graphic A3).

Similarly, in correlational terms, higher and meaningful relationships between variables are verified long term in Equation 1, which occurred after migration policy towards inflation targeting scheme (2004Q1-2014Q4 period, Table A3). Positive, between the growth of demand for real balances M1 and M1_a with growth (0.37 and 0.37, respectively); and negative, to the changes in the interest rate (-0.59 and -0.58, respectively).

[11] The Chow Test 1960 applied to long-term equations using the methodology of Engle and Granger yield p-values equal to $p = 0.0000$ for all regime changes (or structural breaks) tested for each quarter indicated. With the p-value indicated above, a rejection of the null hypothesis of no breaks or changes of regime in the quarter tested is performed.

[12] Table A2 presents only aggregated data variables due to correlations with their peers expressed in per capita terms are equal to one. That is to say, there is a perfect linear relationship there-between.

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On the other hand, according to the cointegration methodology formulated, the unit root analysis practiced to the variables in aggregate and per capita terms were carried out by the ADF and KPSS test, confirming that, except for the CPI and inflation are integrated of order two and all the other series are integrated of order one (Table A1 in Annex). In other words, all series follow a non-stationary process.

Thus, once verified that the variables approximate the demand for real balances, income and interest rates are integrated of the same order, then, it was proceeded to testing for the existence of a long term relationship. That is, to perform cointegration tests for the variables that compose Equation 1.

In this respect, as indicated in the methodology, the tests were conducted by the method of Engle and Granger, on one hand, and on the other, by the Johansen and Juselius method.

For the first, the long-term equation of the demand for real balances in aggregate (M1 and M1_a) and per capita (M1_pc and M1_a_pc) terms were estimated with this method. And once the residue of each of the four regressions were obtained, the ADF Test was performed obtaining four ADF statistical (ADF^a, in the Table A4b of the Annex), which were compared with the critical values Engle and Yoo (1987) tables for cointegration test based on the approach of the residue.

In general, after the null hypothesis of no cointegration have been rejected at 5% of statistical significance (with a respective critical table value equal to -4.11), therefore, it was found cointegration in each of the four estimated equations. The results of this test can be seen in Table A4b of the Annex, in the column where the estimation method (Engle and Granger, E&G) and statistical ADF (ADF^a) corresponding to each long-term equation residue is indicated.

Similarly, with the second method of cointegration (Johansen and Juselius), having checked a homogeneous integration order of the variable that compounds the long-term relationship, the number of cointegrating vectors was estimated. The contrast based on the Maximum eigenvalue statistical indicated a rejection of the null hypothesis of no cointegration at 1% and 5% significance level. Accordingly, it is concluded that these variables have a long-term relationship with one cointegrating vector (Table A6 of the Annex).

Thus, as it was found the existence of a long-term relationship with both tests, the use of the method of cointegration is duly justified and the estimation of the dynamic model (joint relations long and short term) formulated in Equation 1 was carried out.

In that regard, the results of the estimations obtained with the method of Engle and Granger for the long-run elasticities of demand for real balances approximated by the official domestic definition of M1, on average, are 1.3, -0.11 and -0.015 for the real income, the interest rate and for the parameter of financial innovation, respectively. The latter, is expressed in terms of semielasticity.

For the same approximation and respective parameters, using the method of Johansen and Juselius, the significant coefficients of elasticities and semielasticities, on average, are 1.00, -0.19 and 0.015, respectively.

Meanwhile, the results found for the demand for real balances using the expanded M1 approximation indicate that the basic parameters given by the elasticities of real income, the interest rate and the semi-elasticity in relation to the parameter of financial innovation have significant values and equal to 2.83, -0.11 and -0.01, respectively.

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While the estimations base on the Engle and Granger method; and equal to 1.00, -0.22 and 0.01, respectively, when is estimated by the Johansen and Juselius method.

As for the speed of adjustment (in the short term) towards the equilibrium (in the long term), the estimated models with both cointegration methods indicate a 10%, on average and, a range between 8% and 15% per quarter (see Table A4a, A4b). On the other hand, the error correction model (or short-term equation) of each regression performed with Engle and Granger method can be seen in Table A5.

In summary, the demand for real balances elasticities relative to real income, the interest rate and the semi-elasticity with respect to the parameter of financial innovation when they are approximated by the M1 have a range of 1.15 ± 0.15, -0.15 ± 0.04, and -0.02 ± 0.00, respectively. And a range of 1.90 ± 0.90, -0.16 ± 0.06 and 0.01 ± 0.00, respectively, when is approached by the M1_a in the same period.

The results of the statistical tests applied to the residues of each regression confirm the acceptance of the null hypothesis respective the absence of serial correlation (LM Test), non-omission of nonlinearities in the specified model, existence of normality (Jarque-Bera Test) and existence homocedasticity (ARCH Test) with a 95% confidence level, respectively. These results account for a performance in line with the provisions of econometric theory (they can be seen in Table A4 of the Annex). Similarly, statistical data Durbin-Watson (DW), adjusted regression coefficient (R^2a) and Standard Error (SoE) of each regression (can be viewed in the same table).

Finally, the contrasts performed by the CUSUM and CUSUMQ tests prove that the demand for real balances has remained stable throughout the period 1994Q1-2014Q4 (Graphic A4).

Discussion and Conclusion

Discussion

Both economic performance and changes given by the monetary authority in managing its policy can be appreciated along the paths of the variables that approximate the demand for real balances, real income and interest rate. Similarly, the existence of these changes has been proven statistically and econometrically by comparing their statistical properties for periods and application of tests.

In the 2004Q4-2014Q4 period was observed a slightly greater exchange rate volatility after the adoption of the inflation targeting framework. But this is because when the interest rate is controlled by the monetary policy, generally, the exchange rate volatility increases; something which constitutes a typical fact that have taken place in most countries which have embraced this type of monetary regime.

Similarly, it was visualized an expansionary monetary policy with a lower interest rate which was accompanied by a higher demand for real balances due to an increase in the economic activity. Likewise, as shown in the empirical literature, it was seen a higher economic growth but, in this case, followed by a slight rise in the product volatility. This latter fact, despite not being all contrary with stylized facts, here is mainly explained by the agricultural sector behavior which still is subject to climatic conditions.

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Similarly, the highest significant correlations for the same period between the foundations of this money demand are solidified according to determined theoretically by the rule of Poole, which states that in a context of managing interest rate as optional instrument of the monetary policy, monetary shocks or aggregate demand are softened by this kind of assumed governed by compared to control monetary aggregates scheme (De Gregorio, 2007).

Moreover, the fact that the velocity of money has not remained constant throughout the study period covered in this investigation, contrary to the provisions of the Quantity Theory of Money Fischer (1896), this event yet it is consistent with the theory of demand for real balances held by Cagan (1956) which takes into account the distortions that financial innovation causes on the demand for real balances.

In addition to being a fact empirically proven, as mentioned in previous sections. Therefore, this empirically found evidence justifies the use of the latter theory proposed to conduct econometric analysis in the field.

Found elasticities of demand for real balances approximated by the M1 and M1_a are similar with respect to the opportunity cost of using money and is located between -0.11 and -0.19, taking a least value of -0.22 for broader definition of money, given by the M1_a.

The latter magnitude is consistent with the definition used. This is because as broader this definition gets, it is natural to expect that the use of money costs also increases given the increment of the range of money substitutes. Similarly, this magnitude of elasticity is very close to that found by Rojas and Garc´ıa (2006) of -0.23 and complies with the terms recorded in the external empirical evidence.

For its part, the elasticity of demand for real balances with respect to real income, is between a range of 1 to 1.30 (statistically significantly) and equal to unity, so that, with the evidence obtained elasticity is fulfilled under unitary model Cagan (1956) and empirical records of relevant literature.

Also worth highlighting that two distinctly accented events occur. First, there are differences in the estimations compared to previous work at national level but, currently, there are resemblances at the international level. And, second, there are some differences between the elasticities found with the Engle and Granger and Johansen and Juselius methods employing the definitions of M1 and M1_a

In this sense, the case of the first fact of an elasticity with respect to income between 1 and 1.30 it is found. A result which is opposite to those found in the two non peer-reviewed papers published prior to 2008 at the national level that found elasticities lower to the unity. However, this current result is explained by the theory of the demand for real balances which postulates that if the velocity of money possesses a downward trend, it is expected that the elasticity with respect to income be equal to or greater than one.

Empirically, this downward trend in the velocity of money can be observed in Graphic A2, where as of 2003 the growing trend charged a turning point. So, this growing trend is the fact that explains the income elasticities obtained in the two aforementioned works.

Also, as previously indicated, the downward trend in the velocity of money, it is also consistent with the larger phenomenon of financial development and innovation. This result is similar to that obtained by Ferrada et al. (2014) and Ivanov et al. (2015) for countries with an inflation targeting framework, as well.

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Consequently, by estimating the elasticity with respect to real income, the first change is observed in the magnitude of this fundamental parameter of the demand for real balances for the 1994Q4-2014Q4 period.

But for the second fact, disparities found in the elasticities with the method of Johansen and Juselius show that the restrictions imposed do hold and that the estimations carried been out in the long-term model are correct. A similar conclusion is gotten for the estimations done with the Engle and Granger method. Therefore, the found outcomes would not be affected by the estimation techniques implemented here.

As for the semi-elasticity coefficient of financial innovation, the results for approximating demand using the official definition of M1 compared to that of M1 a, have proven to be robust and maintain the expected theoretical sign and magnitudes between -0.01 and -0.02. Clearly, this is a sign that technological advances have reduced the requirements of demanding real balances.

However, the robustness of the results obtained for this parameter does not apply to the demand for real balances when is approximated by the expanded definition of M1 (which is M1 a), since the sing proves not to be stable, but in terms of absolute value it remains similar.

Moreover, this last result of instability in the sign and magnitude found in the parameter of financial innovation using the M1 a definition, is alike to that found in Rojas and García (2006). Also, these authors indicate that this parameter could have had more accurate outcome estimation if a narrower definition of money would have been used. And, precisely, that is why this parameter is stable when the official definition of M1 is employed as a narrower proxy for the real money demand.

Furthermore, the verification of the stability of the demand for real balances throughout the period 1994Q1-2014Q4, although contrary to some authors' predictions about that real money demand in the context of inflation targeting tends to be unstable, here it is confirmed that it was stable for the referred period and that is consistent with similar results found in countries with inflation targeting schemes. A recent example of this is the case of Chile (Ferrada et al., 2014).

A probable explanation of why the elasticity of the demand for real balances relative to the real income for the whole analyzed period is located between the unit and about three decimals above, it would be due to the achievement of a stable macroeconomic regime. This latter, was obtained by means of fiscal reforms and major liquidity injections made in the economic system that explain a greater elasticity.[13]

For its part, the quarterly adjustment average of the found money velocity was equal to 10%, with a range of 8% and 15% per quarter. These numbers are lower and practically more than a half of the measurements obtained in the previous cited working papers (with an average calculated, approximately, in 30% per quarter) at the national level.

The reason for this different finding has to do with a minor dynamic observed in the use of cash for purchases during each quarter (considering the period 1994Q1-2014Q4). That is to say, at a lower velocity of money from 2003Q1 quarter in comparison to previous studies that covered a maximum time frame until 2005Q4.

[13] See series of economic reports of the Central Bank of Paraguay.

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Finally, as of the results obtained here, it can be inferred from a theoretical perspective that the stability of the real money demand contributed to a good performance of the monetary policy transmission channel and that it was unlikely that inflationary pressures would arise through this via neither during the same analyzed period of time nor for the consecutive short-term.

Conclusions

This research presents estimations of the real money demand of Paraguay and an analysis of the evolution of its foundations during the 1994Q1-2014Q4 period in which, besides the own changes resulting from the economic cycle and international financial environment, some changes in the way that the monetary policy is conducted also took place.

Estimations are made in aggregate and per capita terms, under a modified version of the theoretical approach of the demand for transactional reasons proposed by Cagan (1958). To do so, the ordinary least square and vector error correction model estimation techniques are applied following the cointegration methods designed by Engle and Granger (1987) and Johansen and Juselius (1990). While, for the approximations of the demand for real balances, is adopted the official definition employed by the central bank (M1) and a wider definition for international comparative purposes (the expanded M1 or M1_a).

Based on the obtained results, it can be highlighted that the elasticities of demand for real balances relative to income, the interest rate and the semi-elasticity with respect to the parameter of financial innovation when approaching by the official M1 definition have a range of 1.15 ± 0.15, -0.15 ± 0.04, and -0.02, respectively. Additionally, when approaching by the broad M1 definition, the range is 1.90 ± 0.90, -0.16 ± 0.06 and 0.00 ± 0.01, respectively.

Furthermore, it is found that the real money demand for the same time span covered is stable.

Eventually, these findings suggest that the transmission channel of monetary policy of Paraguay has had a good performance according to the provisions of the literature and that no feasible inflationary pressures could have arisen by this way neither during the same analyzed period of time nor for the next short-term after the same interval of time covered in this research.

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Annexes

Variables	ADF Test [a]				KPSS Test [b]					I(?)
	Prob.	Lag	Max Lag	Obs	Test Statistic	CV: 1%	CV: 5%	CV: 10%	Lag/s	
In levels										
LM1	0.70	1	11	82	0.26	0.22	0.15	0.12	6.00	I(1)
LM1_pc	0.71	1	11	82	0.27	0.22	0.15	0.12	6.00	I(1)
LM1_a	0.89	1	11	82	0.25	0.22	0.15	0.12	7.00	I(1)
LM1_a_pc	0.89	1	11	82	0.25	0.22	0.15	0.12	7.00	I(1)
LPIB	0.47	0	11	83	0.27	0.22	0.15	0.12	6.00	I(1)
LPIB_pc	0.59	0	11	83	0.28	0.22	0.15	0.12	6.00	I(1)
LR	0.49	1	11	82	0.17	0.22	0.15	0.12	6.00	I(1)
LIPC	0.96	0	11	83	0.30	0.22	0.15	0.12	6.00	I(2)
LPYG_USD	0.92	2	11	81	0.27	0.22	0.15	0.12	7.00	I(1)
In first differences										
ΔLM1	0.00	0	11	82	0.24	0.74	0.46	0.35	3.00	I(0)
ΔLM1_pc	0.00	0	11	82	0.27	0.74	0.46	0.35	3.00	I(0)
ΔLM1_a	0.00	0	11	82	0.26	0.74	0.46	0.35	4.00	I(0)
ΔLM1_a_pc	0.00	0	11	82	0.28	0.74	0.46	0.35	4.00	I(0)
ΔLPIB	0.00	0	11	82	0.13	0.74	0.46	0.35	2.00	I(0)
ΔLPIB_pc	0.00	0	11	82	0.18	0.74	0.46	0.35	2.00	I(0)
ΔLR	0.00	0	11	82	0.10	0.74	0.46	0.35	4.00	I(0)
ΔLIPC	0.09	4	11	78	0.70	0.74	0.46	0.35	4.00	I(1)
ΔLPYG_USD	0.00	1	11	81	0.44	0.74	0.46	0.35	3.00	I(0)

Source: Author's calculations.

Note. The ADF and KPSS unit root test are specified with intercept and trend for the series in levels (according to their properties). Series in first differences are specified only with intercept for the KPSS Test without intercept and trend for the ADF Test. Abbreviations: Prob = is the p-value of the calculated ADF statistic; CV = Critical Value; I(?) = tests' conclusion.

[a]The presented ADF Test selection was done with the optimal number of lags based on Schwarz Information Criterion. [b]The number of lags for the KPSS Test are chosen using Bartlett Kernel Bandwidth and the Newey-West selection criteria.

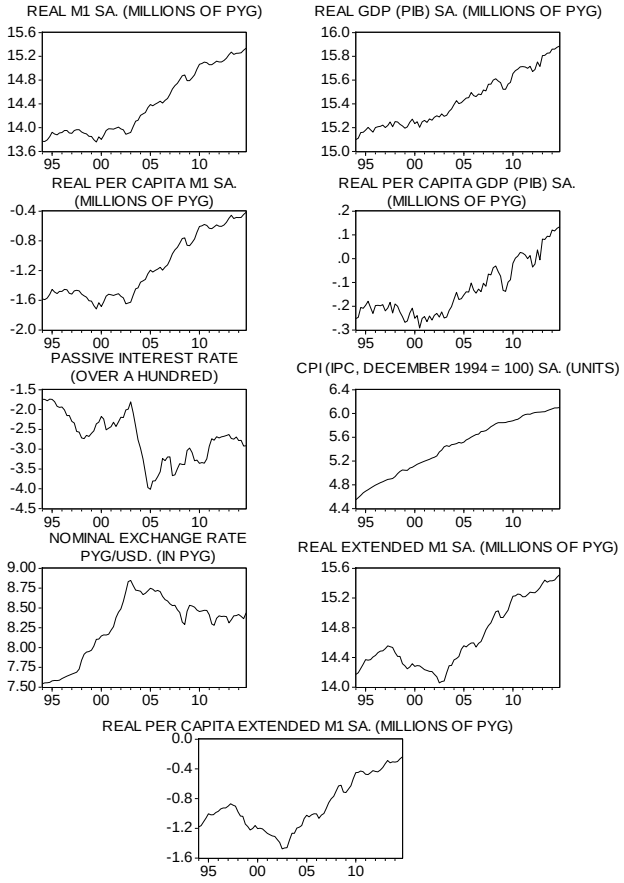
Table 1 ADF and KPSS unit root tests practiced to the variables of interest

1994Q1-2014Q4 Period								
Var/Stat.	gM1	gM1_a	gPIB	R	ΔR	π	Δπ	gUSD
Average	0.02	0.02	0.01	0.07	0.00	0.02	0.00	0.01
St. Dev.	0.04	0.04	0.03	0.04	0.01	0.01	0.02	0.05
J-B (P-V)	0.71	0.64	0.80	0.01	0.00	0.02	0.25	0.06
Observat.	82	82	82	82	82	82	82	82
1994Q1-2003Q4 Period								
Var/Stat.	gM1	gM1_a	gPIB	R	ΔR	π	Δπ	gUSD
Average	0.009	0.003	0.006	0.109	-0.003	0.023	0.000	0.031
St. Dev.	0.044	0.044	0.025	0.033	0.015	0.015	0.019	0.044
J-B (P-V)	0.530	0.922	0.448	0.240	0.486	0.182	0.506	0.420
Observat.	38	38	38	38	38	38	38	38
2004Q1-2014Q4 Period								
Var/Stat.	gM1	gM1_a	gPIB	R	ΔR	π	Δπ	gUSD
Average	0.028	0.028	0.012	0.045	0.000	0.014	-0.001	-0.006
St. Dev.	0.038	0.039	0.029	0.016	0.007	0.012	0.015	0.050
J-B (P-V)	0.071	0.299	0.618	0.197	0.895	0.606	0.657	0.001
Observat.	44	44	44	44	44	44	44	44

Source: Author's calculations with data from the Central Bank of Paraguay.

Note. Abbreviations: Var/Stat. = Variables/Statistics; St. Dev. = Standard Deviation; J-B (P-V) = Jarque-Bera Test p-value; Observat. = number of observations. Variables: g = quarterly growth; Δ = quarterly change; π = inflation.

Table 2 Statistical properties of the economic variables for periods (in quarterly frequency)



Graphic 1 Evolution of key macroeconomic variables (in logarithm). Source: Author's calculations with data from the Central Bank of Paraguay and the General Directorate of Statistical Surveys and Census (DGEEC)

Graphic 2 Velocity of the money in Paraguay (1994Q4-2014Q4 period). Source: Author's calculations with data from the Central Bank of Paraguay

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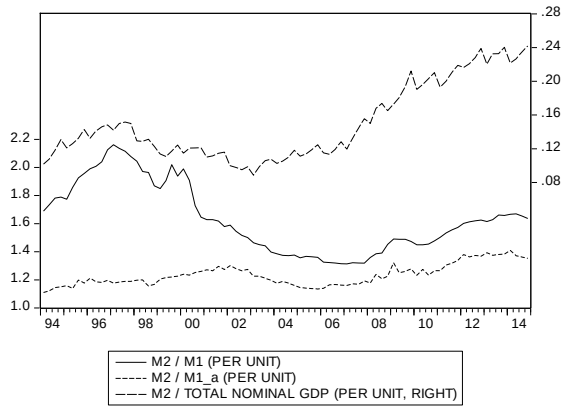

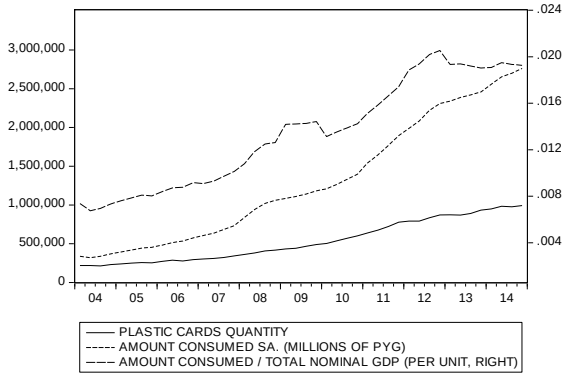

Graphic 3 Key Indicators of Financial Innovation (2004Q1-2014Q4 period). Source: Author's calculations with data from the Central Bank of Paraguay

1994Q1-2014Q4 Period								
Variables	gM1	gM1_a	gPIB	R	ΔR	π	Δπ	gUSD
gM1	1.00	0.87	0.27	-0.16	-0.45	-0.30	-0.37	-0.49
gM1_a	0.87	1.00	0.31	-0.11	-0.40	-0.29	-0.32	-0.50
gPIB	0.27	0.31	1.00	-0.06	-0.11	-0.09	-0.04	-0.13
R	-0.16	-0.11	-0.06	1.00	0.01	0.35	-0.03	0.26
ΔR	-0.45	-0.40	-0.11	0.01	1.00	0.33	0.26	0.24
π	-0.30	-0.29	-0.09	0.35	0.33	1.00	0.60	0.11
Δπ	-0.37	-0.32	-0.04	-0.03	0.26	0.60	1.00	0.21
gUSD	-0.49	-0.50	-0.13	0.26	0.24	0.11	0.21	1.00
1994Q1-2003Q4 Period								
Variables	gM1	gM1_a	gPIB	R	ΔR	π	Δπ	gUSD
gM1	1.00	0.76	0.12	0.17	-0.49	-0.26	-0.52	-0.57
gM1_a	0.76	1.00	0.21	0.45	-0.43	-0.19	-0.42	-0.59
gPIB	0.12	0.21	1.00	0.08	-0.14	-0.09	-0.03	0.09
R	0.17	0.45	0.08	1.00	0.17	0.40	-0.03	-0.15
ΔR	-0.49	-0.43	-0.14	0.17	1.00	0.44	0.37	0.53
π	-0.26	-0.19	-0.09	0.40	0.44	1.00	0.62	0.35
Δπ	-0.52	-0.42	-0.03	-0.03	0.37	0.62	1.00	0.41
gUSD	-0.57	-0.59	0.09	-0.15	0.53	0.35	0.41	1.00
2004Q1-2014Q4 Period								
Variables	gM1	gM1_a	gPIB	R	ΔR	π	Δπ	gUSD
gM1	1.00	0.98	0.37	-0.28	-0.59	-0.24	-0.19	-0.36
gM1_a	0.98	1.00	0.37	-0.26	-0.58	-0.27	-0.22	-0.32
gPIB	0.37	0.37	1.00	-0.04	-0.13	-0.03	-0.05	-0.22
R	-0.28	-0.26	-0.04	1.00	0.17	-0.34	-0.12	0.11
ΔR	-0.59	-0.58	-0.13	0.17	1.00	0.33	0.03	0.02
π	-0.24	-0.27	-0.03	-0.34	0.33	1.00	0.63	-0.35
Δπ	-0.19	-0.22	-0.05	-0.12	0.03	0.63	1.00	0.06
gUSD	-0.36	-0.32	-0.22	0.11	0.02	-0.35	0.06	1.00

Source: Author's calculations with data from Central Bank of Paraguay.
Note. Abbreviations: g = quarterly growth; Δ = quarterly change; π = inflation.

Table 3. Correlations matrix of key macroeconomic variables by periods

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Explained variable	Explanatory variables

Real money demand approximated by M1 in aggregate and per capita terms (M1_pc)

Ln(m1)	β_0	β_1	β_2	β_3	D1997Q4	D2008Q3		$EC_{(t-1)}$
	-6.43	1.34	-0.11	0.01	-0.23	-0.22		-0.15
SE	4.72	0.31	0.03	0.00	0.07	0.07		0.05
t-S	-1.36	4.30	-3.60	2.06	-3.40	-3.13		-2.75
P-V	0.18	0.00	0.00	0.04	0.00	0.00		0.01
Ln(m1)	β_0	β_1	β_2	β_3	D1997Q4	D2008Q3		$EC_{(t-1)}$
	2.23	-1.00	0.19	-0.02	-0.04	-0.12		-0.09
SE			0.09	0.00	0.02	0.04		0.03
t-S			1.96	-6.64	-1.95	-3.03		-2.82
Ln(m1_pc)	β_0	β_1	β_2	β_3	D1997Q4	D2008Q3		$EC_{(t-1)}$
	-1.28	1.34	-0.11	0.01	-0.22	-0.22		-0.13
SE	0.10	0.30	0.03	0.00	0.07	0.07		0.06
t-S	-12.71	4.50	-3.66	4.07	-3.33	-3.09		-2.15
P-V	0.00	0.00	0.00	0.00	0.00	0.00		0.03
Ln(m1_pc)	β_0	β_1	β_2	β_3	D1997Q4	D2008Q4	D2008Q4P	$EC_{(t-1)}$
	2.11	-1.00	0.18	-0.01	-0.05	0.01	-0.13	-0.11
SE			0.08	0.00	0.02	0.01	0.04	0.04
t-S			2.15	-3.33	-2.02	1.35	-3.13	-2.84

Real money demand approximated by the M1_a (extended version of M1) in aggregate and per capita terms (M1_a_pc)

Ln(m1_a)	β_0	β_1	β_2	β_3	D(D1997Q4)	D2002Q3	D2008Q3	D(D2008Q4P)	$EC_{(t-1)}$
	-29.20	2.89	-0.11	-0.02	0.17	-0.11	-0.37	-0.09	-0.09
SE	4.60	0.30	0.03	0.00	0.02	0.05	0.08	0.02	0.05
t-S	-6.35	9.58	-3.60	-4.95	7.49	-2.45	-4.70	-5.06	-1.94
P-V	0.00	0.00	0.00	0.00	0.00	0.02	0.00	0.00	0.06
Ln(m1_a)	β_0	β_1	β_2	β_3	D1997Q4	D2008Q4P	D2008Q4		$EC_{(t-1)}$
	1.81	-1.00	0.22	-0.01	-0.06	-0.13	0.02		-0.09
SE			0.10	0.01	0.02	0.04	0.01		0.02
t-S			2.15	-2.00	-2.75	-3.28	1.81		-3.90
Ln(m1_a_pc)	β_0	β_1	β_2	β_3	D(D1997Q4)	D2002Q3	D2008Q3	D(D2008Q4P)	$EC_{(t-1)}$
	-0.29	2.78	-0.11	-0.01	0.17	-0.11	-0.36	-0.09	-0.08
SE	0.10	0.28	0.03	0.00	0.02	0.05	0.08	0.02	0.04
t-S	-2.99	9.91	-3.82	-2.72	7.39	-2.47	-4.58	-5.46	-2.04
P-V	0.00	0.00	0.00	0.01	0.00	0.02	0.00	0.00	0.05
Ln(m1_a_pc)	β_0	β_1	β_2	β_3	D1997Q4	D2008Q4P	D2008Q4		$EC_{(t-1)}$
	17.19	-1.00	0.22	-0.01	-0.06	-0.13	0.02		-0.09
SE			0.10	0.01	0.02	0.04	0.01		0.02
t-S			2.10	-1.13	-2.75	-3.28	1.77		-3.91

Source: Author's calculations.

Note. Abbreviations: SE = Standard Error; t-S = t-statistic calculated; P-V = P value; The VEC models are specified with two lags based on the comparison of the performance of the estimated model post (with one or two lags) and the Akaike information criteria and Schwarz.

Table 5 Real money demand estimations results in aggregate and per capita terms for 1994q4-2014q4 period (cointegrating equations coefficients)

Explained variable	Long-term Equation Statistics		Short-term Equation Statistics		EM	ET
Real money demand approximated by M1 in aggregate and per capita terms (M1_pc)						
Ln(m1)						
	R2a	0.98	R2a	0.49	E&G	OLS
	SEoR	0.07	SEoR	0.03		
	DW	0.80	DW	1.79		
	J-B (P-V)	0.25	J-B (P-V)	0.47		
	ADF [a]	-4.57	LM Test [d]	0.75		
			HT ARCH [e]	0.97		
			R. RESET T. [f]	0.82		
Ln(m1)						
	R2a	0.17			J&J	VECR
	SEoR	0.10				
	LM Test (1-3) [b]	0.63				
	J-B (P-V)	0.94				
	LR Test (r=1) [c]	0.02				
Ln(m1_pc)						
	R2a	0.97	R2a	0.54	E&G	OLS
	SEoR	0.07	SEoR	0.03		
	DW	0.80	DW	1.96		
	J-B (P-V)	0.27	J-B (P-V)	0.96		
	ADF [a]	-4.58	LM Test [d]	0.73		
			HT ARCH [e]	0.69		
			R. RESET T. [f]	0.66		
Ln(m1_pc)						
	R2a	0.16			J&J	VECR
	SEoR	0.10				
	LM Test (1-3) [b]	0.57				
	J-B (P-V)	0.95				
	LR Test (r=1) [c]	0.05				
Real money demand approximated by the M1_a (extended version of M1) in aggregate and per capita terms (M1_a_pc)						
Ln(m1_a)						
	R2a	0.96	R2a	0.45	E&G	OLS
	SEoR	0.09	SEoR	0.03		
	DW	0.89	DW	1.81		
	J-B (P-V)	0.18	J-B (P-V)	0.23		
	ADF [a]	-4.79	LM Test [d]	0.79		
			HT ARCH [e]	0.26		
			R. RESET T. [f]	0.78		
Ln(m1_a)						
	R2a	0.29			J&J	VECR
	SEoR	0.09				
	LM Test (1-3) [b]	0.46				
	J-B (P-V)	0.81				
	LR Test (r=1) [c]	0.43				
Ln(m1_a_pc)						
	R2a	0.94	R2a	0.47	E&G	OLS
	SEoR	0.09	SEoR	0.03		
	DW	0.86	DW	1.87		
	J-B (P-V)	0.17	J-B (P-V)	0.56		
	ADF [a]	-4.67	LM Test [d]	0.92		
			HT ARCH [e]	0.30		
			R. RESET T. [f]	0.81		
Ln(m1_a_pc)						
	R2a	0.29			J&J	VECR
	SEoR	0.09				
	LM Test (1-3) [b]	0.46				
	J-B (P-V)	0.81				
	LR Test (r=1) [c]	0.41				

Source: Author's calculations.

Note. Abbreviations: EM = Estimation Method; ET = estimation technique; OLS = Ordinary Least Squares; VECR = Restricted Vector Error Correction Model; R2a = adjusted R-squared; SEoR = Standard Error of the Regression; DW = Durbin-Watson statistic; J-B (P-V) = p-value statistic of the Jarque-Bera normality test; ADF = Dickey-Fuller Test statistic with lags chosen according to Schwarz Information Criterion. VEC models are specified with two lags as of the performance comparison of the post estimated model (with one or two lags) and the Akaike and Schwarz information criteria.

[a]Corresponds to the Statistical Calculated values of the Test ADF (without intercept or trend) practiced to the residue. The null hypothesis of the test is that the tested serie has a unit root (i.e., is a stationary serie). Critical values calculated by Engle and Yoo (1987) for the ADF Statistic when there are three variables in the cointegration relationship with intercept are -4.84, -4.11 and -3.73 at 1%, 5% and 10% significance level, respectively.

Whereas, the calculated critical values for two variables I(1) in the right member of the relationship multicointegration linear trend of Engsted, Gonzalo and Harldrup (1997) are -5.47 and -4.74 at 1% and 5% significance levels, respectively. [b]Presents the lowest p-value obtained from the Serial Autocorrelation LM Test for the VEC model' residue between 1 and 3 lags. The null hypothesis test postulates absence of serial autocorrelation. [c]Shows the p-value for the LR test for contrasting the compliance of the restrictions imposed on the VEC with rank equal to one. The null hypothesis is that the restrictions imposed do hold. [d]It shows the p-value of the serial autocorrelation LM test applied to the first 4 lags of the model's residue. The null hypothesis is that there is no serial autocorrelation. [e]It shows the p-value of the F statistic test for Heteroskedasticity under the ARCH specification with one lag. The null hypothesis indicates no heteroscedasticity. [f]It shows the lowest value (p-value) among t, F and Likelihood Ratio statistics corresponding to Ramsey's Reset Test whose null hypothesis is that there are not omission for nonlinearities in the specified model.

Table 6 Real money demand estimations results in aggregate and per capita terms for 1994q4-2014q4 period (cointegrating equations statistics)

Real money demand approximated by M1 in aggregate and per capita terms (M1_pc)

DL1(m1)		SE	t-S	P-V
C	0.01	0.01	1.55	0.13
DL1PIBN_D11_D	0.42	0.09	4.88	0.00
DLR	-0.09	0.02	-5.07	0.00
DLR(-1)	0.09	0.02	5.14	0.00
DL1GDOLAR	-0.28	0.10	-2.77	0.01
EC(t-1)	-0.15	0.05	-2.75	0.01
D2004Q1	0.02	0.01	2.57	0.01
D2011Q2	-0.01	0.01	-1.84	0.07
DL1(m1_pc)		**SE**	**t-S**	**P-V**
C	-0.01	0.01	-0.87	0.39
DL1M1_D11P_D(-1)	0.22	0.10	2.33	0.02
DL1PIBN_D11P_D	0.32	0.11	2.89	0.01
DLR	-0.07	0.02	-3.74	0.00
DLR(-1)	0.07	0.02	3.90	0.00
DL1IPC94_D11	-0.75	0.19	-3.90	0.00
DL1IPC94_D11(-1)	0.98	0.22	4.52	0.00
EC(t-1)	-0.13	0.06	-2.15	0.03
D2004Q1	0.03	0.01	4.14	0.00
D2008Q4P	-0.12	0.01	-12.93	0.00
D2011Q2	-0.02	0.01	-2.38	0.02

Real money demand approximated by the M1_a (extended version of M1) in aggregate and per capita terms (M1_a_pc)

DL1(m1_a)		SE	t-S	P-V
C	0.03	0.01	2.30	0.02
DL1M1_A_D11_D(-1)	0.27	0.10	2.58	0.01
DL1PIBN_D11_D	0.32	0.12	2.56	0.01
DL1R	-0.08	0.03	-2.37	0.02
DL1R(-1)	0.03	0.03	0.94	0.35
DL1IPC94_D11	-0.47	0.37	-1.27	0.21
DL1GDOLAR	-0.27	0.09	-3.00	0.00
EC(t-1)	-0.08	0.04	-1.93	0.06
D1997Q4	-0.01	0.01	-1.27	0.21
D(D1998Q4P)	-0.05	0.02	-2.31	0.02
D(D2000Q1)	-0.03	0.01	-3.13	0.00
D2008Q4	0.00	0.01	0.12	0.90
DL1(m1_a_pc)		**SE**	**t-S**	**P-V**
C	0.03	0.01	2.34	0.02
DL1M1_A_D11P_D(-1)	0.28	0.11	2.62	0.01
DL1PIBN_D11P_D	0.32	0.12	2.58	0.01
DL1R	-0.08	0.03	-2.38	0.02
DL1R(-1)	0.03	0.03	0.99	0.33
DL1IPC94_D11	-0.50	0.35	-1.42	0.16
DL1GDOLAR	-0.27	0.09	-3.03	0.00
EC(t-1)	-0.08	0.04	-2.04	0.05
D1997Q4	-0.01	0.01	-1.32	0.19
D(D1998Q4P)	-0.05	0.02	-2.30	0.02
D(D2000Q1)	-0.03	0.01	-3.54	0.00

Table 7 Real money demand estimations results in aggregate and per capita terms for 1994q4-2014q4 period (Error Correction models). *Source: Author's calculations*.

Note. Abbreviations: SE = Standard Error; t-S = t-statistic calculated; P-V = P value. The VEC models are specified with two lags based on the comparison of the performance of the estimated model post (with one or two lags) and the Akaike information criteria and Schwarz

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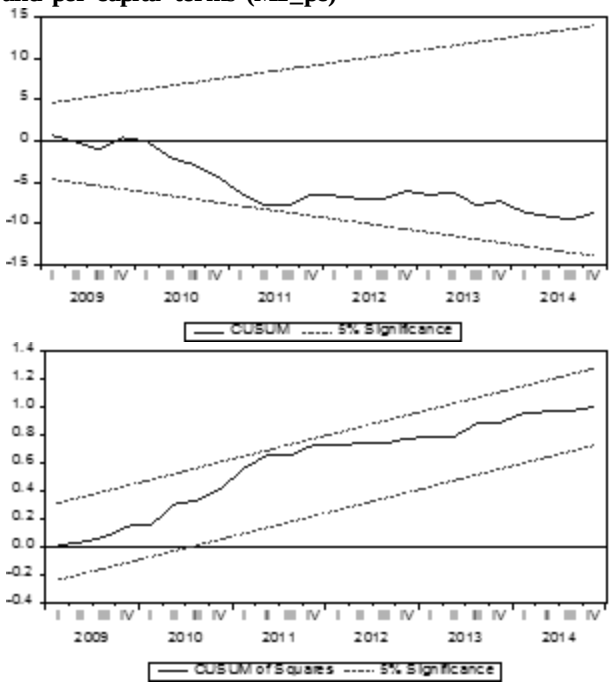
Endogenous variables	H0	Eigenvalue	Maximum Eigenvalue Statistic	Critical Value	Prob.
LM1	0	0.302	29.102	25.823	0.018
LPIB	1	0.120	10.374	19.387	0.579
LR	2	0.044	3.631	12.518	0.795
LM1_pc	0	0.301	29.022	25.823	0.018
LPIB_pc	1	0.113	9.720	19.387	0.649
LR	2	0.041	3.411	12.518	0.824
LM1_a	0	0.330	32.439	25.823	0.006
LPIB	1	0.162	14.352	19.387	0.231
LR	2	0.014	1.114	12.518	0.998
LM1_a_pc	0	0.330	32.436	25.823	0.006
LPIB_pc	1	0.158	13.917	19.387	0.260
LR	2	0.011	0.869	12.518	1.000

Source: Author's calculations.
Note. Maximum eigenvalue test applied for the 1994Q1-2014Q4 period using co-integration trend, a dummy variable for 2003Q2 and a total of 81 observations. The null hypothesis test establishes the absence of cointegration for each number (0, 1 and 2). H0 = Null hypothesis; Obs. = Observations; Prob. = P-value of the maximum eigenvalue statistic.

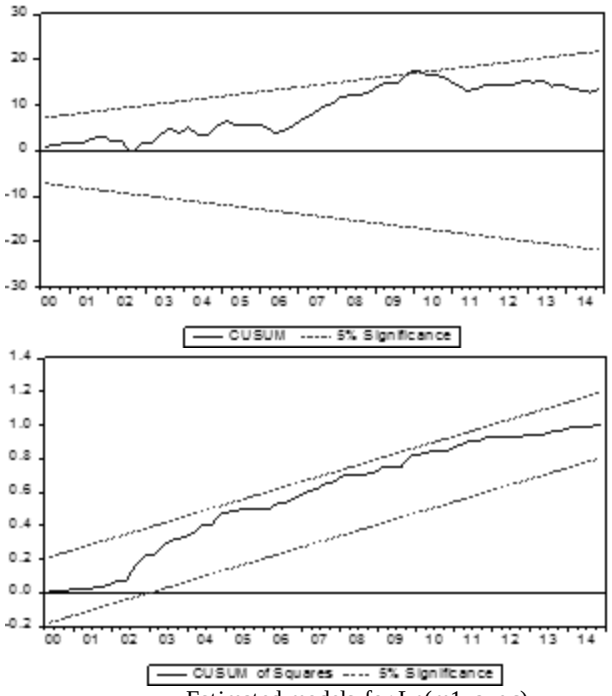
Table 8 Johansen cointegration test results: Maximum eigenvalue.

Real money demand approximated by M1 in aggregate and per capita terms (M1_pc)



Estimated models for Ln(m1_a)

Real money demand approximated by the M1_a (extended version of M1) in aggregate and per capita terms (M1_a_pc)



Estimated models for Ln(m1_a_pc)

Graphic 4 CUSUM and CUSUMQ stability tests applied to the real money demand estimated models for the 1994Q1-2014Q4 period. Source: Author's calculations

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