MONETARY MODEL OF EXCHANGE RATE FOR ARGENTINA: AN AUTOREGRESSIVE DISTRIBUTED LAG (ARDL) APPROACH

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Abstract

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This study examines the monetary model of exchange rate determination for the Argentinian peso exchange rate against US dollar. In the study we utilize Autoregressive Distributed Lag (ARDL) over the period 2004Q1 to 2018Q4. The estimation results show that there is a short and long relationship among variables of the monetary model for Argentina. According to the results, positive sign of relative money supply and interest rate Argentina and USA and negative sign of relative GDP growth rate between Argentina and USA confirm monetary model of exchange rate.

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1.INTRODUCTION

Monetary models of nominal exchange rate determination were a main issue of international economics in the 1970s. Many researchers have tested the validity of the model over the last 40 years. This is due to the fact that after the adoption of the floating or flexible exchange rate system in 1973, the fluctuations of exchange rate have become more violent than ever (Chang and Su, 2014). In the case of fluctuations, it is difficult to anticipate the movements of exchange rate. Subsequently, being able to understand or even predict the movement of exchange rate is crucial for policy makers. It is important for policy maker to monitor and manage the movement of exchange rate so that it will have the same or not too different trend with economic fundamentals. Otherwise, it would be harmful to the main macroeconomic indicators.

Economists have special concern with Argentina since the early days of nation-building in the 19th century, it can be easily said that Argentina has been a laboratory for monetary economics. Throughout the last century there have been a so many economic episodes because of political instability in the country: from rapid development in the Belle Epoque of 1880-1930 to economic crisis, from gold-standard stability to chronic monetary disorder, recurrent balance of payments crises, speculative attacks on the currency, hyperinflation episodes and debt defaults. Because of this noteworthy variety of macro policy experiments and monetary events making Argentina a special country for economic historians and applied economists (Magliano, 2010).

The factors which determine the reason of volatility of exchange rate have become one of the main issues of economic literature. Few models have been put forward in the literature to understand the exchange rate movement. Among others, the flexible-price monetary model, which postulates that exchange rate may be determined by the money supplies, aggregate incomes and interest rates of domestic and foreign countries, has received much attention in the literature.

It is important to determine exchange rate volatility in line with monetary model because countries are using monetary fundamentals in the case of expansionary or restrictive monetary policy. If the exchange rate moves in line with monetary model, policymaker will predict that by using monetary policy will lead to an appreciation or depreciation of currency.

The exchange rate of Argentina has been volatile for two decades. The aim of this study is to analyze the empirical validity of the monetary model of exchange rate in Argentina to determine whether Argentina Pesos - US dollar exchange rate movements are in line with monetary fundamentals. In the literature, I have only one studies which examine the validity of the monetary model of exchange rate for Argentina Pesos - US dollar exchange rate movements. For this purpose, Autoregressive Distributed Lag (ARDL) model is applied to identify a long and short run equilibrium relationship between nominal exchange rate and macroeconomic fundamentals.

This study is organized as follows. In the first section we summarize monetary model of exchange, Autoregressive Distributed Lag (ARDL) and a review for economy of Argentina. The second section literature review is given. In the third section, we give information about methodology. In the fourth, empirical results and their interpretation are provided. Finally, concluding remarks are given in the last section of the paper.

1.1.Monetary Model of Exchange Rate

In this section, we describe the main features of the monetary approach to exchange rate determination in its flexible-price formulation (Frenkel, 1976; Bilson, 1979, and Mussa, 1976, 1979).

In the flexible price monetary model, output is at its natural level, but prices are flexible and adjust instantly in response to excess demand. It is assumed that the domestic interest rate is exogeneous in the long run and determined by world market because of perfect capital mobility (Sarno and Taylor, 2002).

Monetary model assumes a stable real money demand function in domestic and a foreign country:

$$m_t = p_t + \theta y_t - \vartheta i_t \qquad (1)$$

$$m_t^* = p_t^* + \theta^* y_t^* - \vartheta^* i_t^* \qquad (2)$$

Where m_t, p_t, y_t, and i_t denote the log-levels of the money supply, the price level, real income, and the level of the interest rate, respectively, at time t; θ and ϑ are positive constants; asterisks denote foreign country variables and parameters.

Another property of the monetary model is absolute purchasing power parity (PPP), which assumes that goods markets will be in equilibrium because exchange rate moves will equalize the goods market prices in both countries. For example, if U.S. goods are more expensive than Argentinian goods, U.S. and Argentinian consumers will tend to purchase more goods in Argentina and fewer in the United States. The increased relative demand for Argentinian goods will tend to make the peso appreciate with respect to the dollar and equalize the dollar-denominated prices of U.S. and Argentinian goods. The monetary model assumes that PPP holds continuously, so that

$$s_t = p_t - p_t^* \tag{3}$$

Where s_t is the log-level of the nominal exchange rate which is the domestic price of the foreign currency.

The domestic money supply determines the domestic price level and hence the exchange rate is determined by relative money supplies. Subtracting equation (2) from equation (1), solving for $(p_t - p_t^*)$, and inserting the result into equation (3) provides the solution for the nominal exchange rate:

$$s_t = (m_t - m_t^*) - (\theta y_t - \theta^* y_t^*) + (\vartheta\, i_t - \vartheta^* i_t^*) \tag{4}$$

Which is the fundamental equation of the monetary model. The model is often simplified by assuming that the income elasticities and interest rate elasticities of money demand are the same for the domestic and foreign country so that equation (4) reduces to

$$s_t = (m_t - m_t^*) - \theta(y_t - y_t^*) + \vartheta(i_t - i_t^*) \tag{5}$$

Equation (5) implies that an increase in the domestic money supply relative to the foreign money stock causes a depreciation of the domestic currency in terms of the foreign currency. In other words, the nominal exchange rate, s_t, increases. Conversely, an increase in domestic real income creates an excess demand for the domestic money stock. To increase their real money balances, domestic residents reduce expenditure and prices fall until money market equilibrium is achieved. Via PPP, the fall in domestic prices implies an appreciation of the domestic currency in terms of the foreign currency (Sarno and Taylor, 2002).

1.2.Autoregressive Distributed Lag (ARDL) Model

A lot of techniques are available to test for the existence of long-run equilibrium relationships in the levels among variables. Until 2000s, the analysis, which tested long run relationship between variables, has been based on use of cointegration techniques. The most common cointegration techniques was Engle-Granger (1987) test and Johansen (1991) test. Engle-Granger is the two-step residual-based procedure for testing the null of no-cointegration whereas Johansen test has provided full information for the maximum likelihood cointegration approach.

Compare to other cointegration method, The ARDL model is more preferable because of many reasons. The first one is that the ARDL does not need that all the variables under study must be integrated of the same order and it can be applied when the underlying variables are integrated of order one, order zero or fractionally integrated. The second advantage is that the ARDL test is relatively more efficient in the case of small and finite sample data sizes. The last and third advantage is that by applying the ARDL technique we obtain unbiased estimates of the long-run model (Harris and Sollis, 2003).

1.3.Economic Review of Argentina, 2004-2018

In 1971 the Nobel prize-winning economist Simon Kuznets said to have remarked that there were four types of countries: the developed, the underdeveloped, Japan and Argentina (Saiegh, 1996)

With rich natural resources, an export-oriented agricultural sector, and a diversified industrial base, Argentina was one of the richest countries in the world until the first half of 19th century, After that time, because of politic instability, Argentina have suffered from economic crises, constant fiscal and current account deficits, high inflation, mounting external debt, and capital flight.

One of the main reasons of these economic crisis is the currency instability because poor fiscal policies have often led to a massive inflation that caused a downward trend in Argentina currency. These currency depreciations in turn make foreign debt near impossible to repay, causing further devaluations which can ultimately result in economic collapse. Currency crises like this occurred in 1982 and 2001, both have resulted in severe economic depressions.

Political instability has important effect on economic stability in Argentina and after each election term there has been a crucial change in economic policies because of this reason, we divide the period of the study into three sub-period to give information about the economic situation of Argentina.

The first period cover 2004 until 2009. Before this period, Argentina experienced a severe economic crisis which caused several structural changes that affected its macroeconomic regime. Before the crisis, Argentina used convertibility regime for exchange rate. According to this regime, Argentina Pesos pegged to U.S. dollar 1 to 1. After the collapse of convertibility regime in January 2002, the Government decided to use managed float regime for exchange rate and defaulted on the sovereign debt and abandoned the currency board, depreciated peso 300% against US dollar. After the crisis, economic policy regime shifted dramatically from trade openness, privatization, deregulation and supply-side policies to "competitive real exchange rate" and demand driven policies (Manzo, et.al, 2017). After implementing these policies, the Argentine economy experienced an important recovery in its GDP per capita level, which was particularly strong until 2007. The average increase of GDP per capita growth was nearly 7,5 percent (Figure 1).

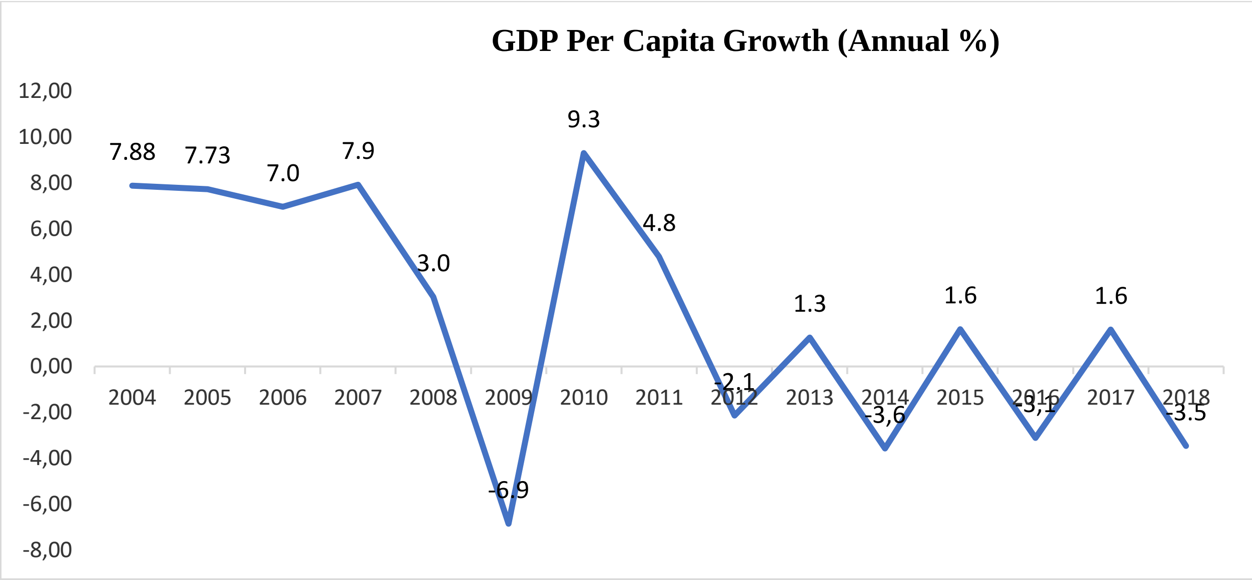

Figure 1: GDP Per Capita Growth in Argentina between 2004 - 2018

Inflation was brought down to the single digits in 2003 and 2004 but accelerated in 2005 (Figure 2). Fiscal policy retained surpluses, and monetary policy was broadly consistent with inflation objectives. The exchange rate stabilized and stayed below 3 pesos per dollar (Figure 3), with sustained current account surpluses. The main goal of government's fiscal and trade policies aimed to generate a fiscal surplus as well as a trade surplus. In each of 2004, 2005 and 2006, Argentina recorded a trade surplus while the government generated fiscal surpluses primarily through increased tax collections contributed by exports (Figure 4).

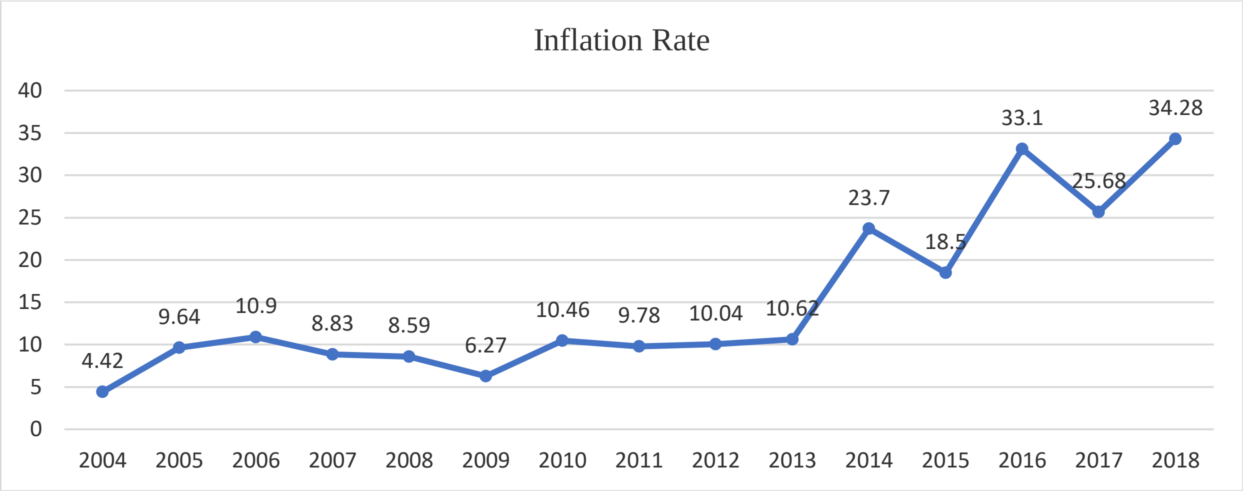

Figure 2: Inflation Rate in Argentina between 2004 - 2018

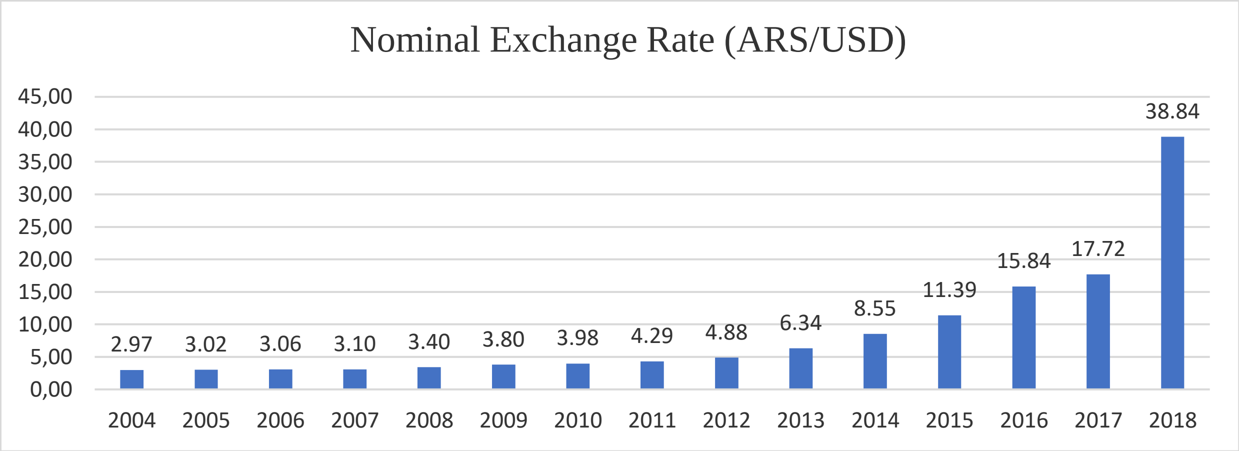

Figure 3: Nominal Exchange Rate in Argentina between 2004 - 2018

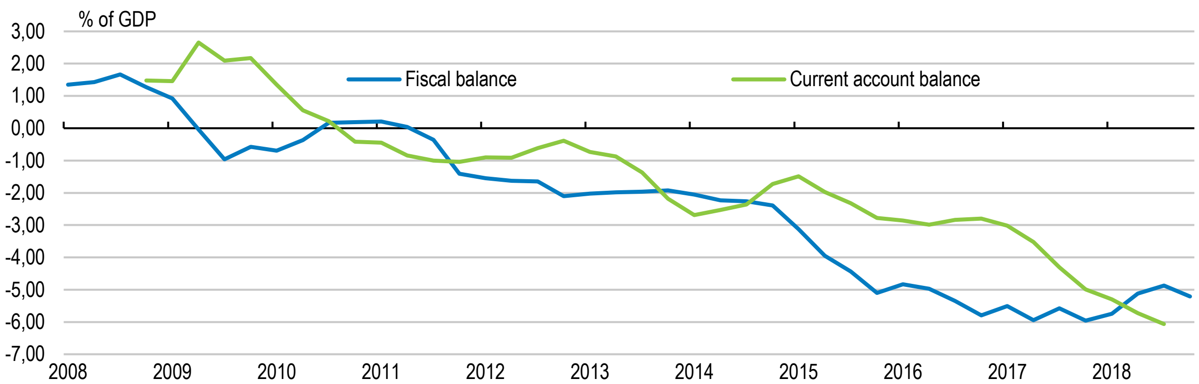

Figure 4: Fiscal and Current Account Balance in Argentina between 2008 - 2018

Source: INDEC, Ministry of Economy, CEIC.

In 2008, the rapid economic growth of previous years slowed sharply as government policies held back exports and the world economy fell into recession. Over the 2008-2009 period, the economy suffered the consequences of the emerging global financial crisis with growth decelerating to 3 percent in 2008 and then 0 percent in 2009.

The second period start from 2009 to end of 2014. In this period, government used expansionary monetary and fiscal policy, but these instruments led to high inflation. From 2008 to 2015 the average annual inflation rate was around 20 percent (figure 2). Since real interest rate was negative, capital flow thorough the country decreased. In addition, domestic savings was undermined. Government's ability to obtain debt from outside was limited because of unsolved defaulted debt problem with international capital markets. Resulting of these imbalances caused to in the Government's growing dependence on Central Bank peso financing and the use of Central Bank foreign currency reserves to service public debt. Central Bank foreign reserves dropped $21.3 billion from a high of $52.7 billion (Figure 5).

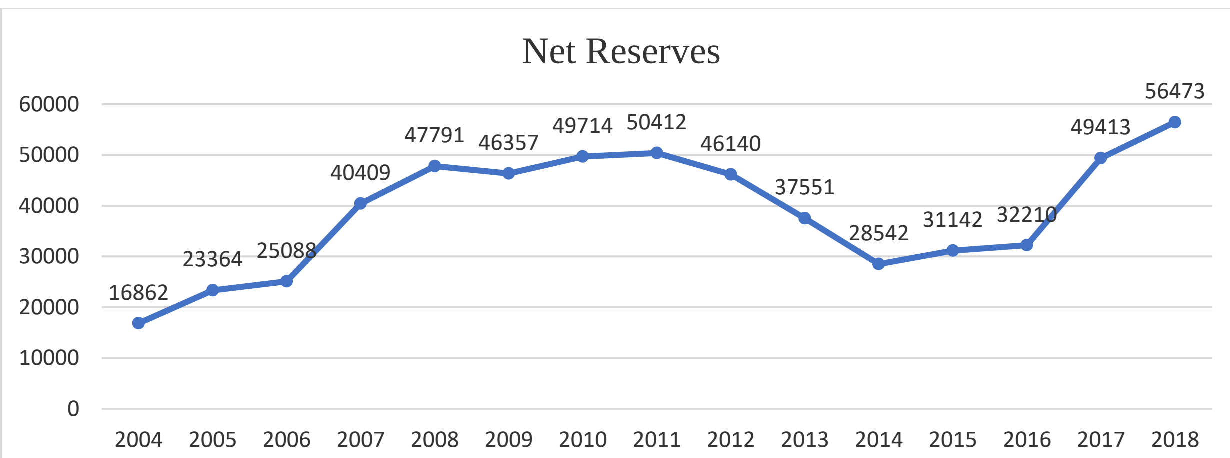

Figure 5: Net Reserves in Argentina between 2004 – 2018. (Mn USD)

In 2014, the fiscal deficit grew continuously, as total expenditure growth outpaced revenue growth, primarily as a result of an increase in the Government's social benefit and pension payments with a fiscal deficit of 5.1 percent of GDP in 2015 (figure 4). In the same year, the Central Bank allowed the peso to depreciate by a nominal 7% in one day which moved rapidly to prices, and in the latter year, there was sharp increase in inflation, and it reached around 40%. The main reason of this was a dramatically increase in food prices in the domestic market which also had an impact the following year in which sharp increases in fuels and in utility tariffs.

In order to deal with these problems, the government expanded state intervention in the economy: it nationalized the oil company YPF from Spain's Repsol, expanded measures to restrict imports, and further tightened currency controls in an effort to bolster foreign reserves and stem capital flight. (Libman and Palazzo, 2019).

After election in 2015, Argentina started a historic political and economic transformation, as new administration took steps to liberalize the Argentine economy, lifting capital controls, floating the peso, removing export controls on some commodities, cutting some energy subsidies, and reforming the country's official statistics. Obtaining debt from international market was a big problem for government and to overcome this problem the government started to negotiate debt payments with holdout bond creditors, continued working with the IMF to shore up its finances, and returned to international capital markets in 2016 (Buera and Nicolini, 2019).

After 2015, a more flexible exchange-rate regime was adopted. The liberalization of the capital account caused an important devaluation of about 36 percent in December 2015. Devaluation of peso leaded to a sharp increase inflation. Within this period the average inflation rate was 27 percent (Figure 2). After the large depreciation, there were significant pressures towards appreciation, which explains why the current-account deficit was rising. The initial low level of external debt reduces some of the concerns, but during 2016–2017 foreign-currency-denominated debt started to increase (Figure 6).

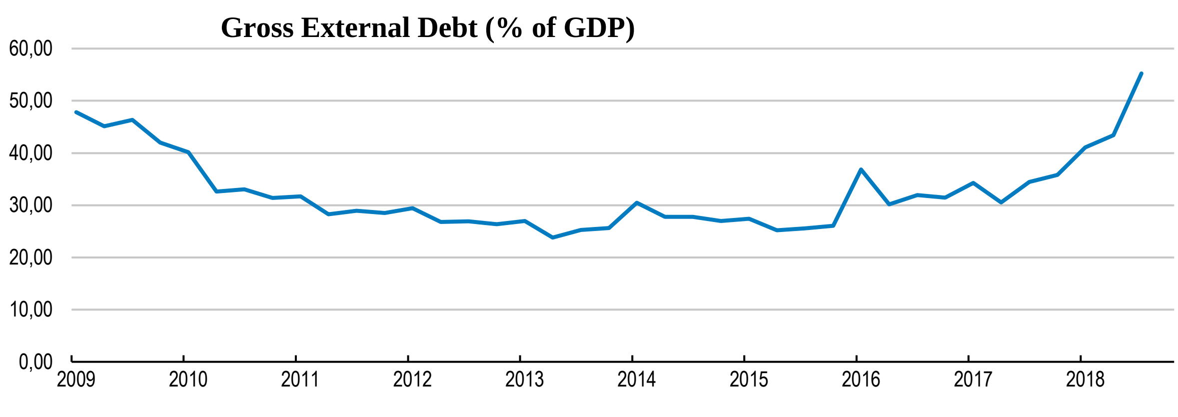

Figure 6: Gross External Debt of Argentina between 2009 – 2018 Source: IMF, CEIC.

In 2017, Argentina's economy emerged from recession with GDP growth of nearly 3.0%. The government passed important pension, tax, and fiscal reforms and it also signaled its intention to cut the fiscal deficit, re-establishing a coherent system of public-service tariffs. Unfortunately, this also accelerated the inflation rate. Since 2018, Argentina has experienced an annual rate of inflation above 34 percent. The situation was aggravated by the fiscal deficit of 6.4 percent of GDP and the repressed inflation due to the frozen tariff of public services.

During 2018, Argentina's economy was adversely affected by several external and internal factors that ultimately resulted in a crisis of investor confidence. In response, the Government had agreement with IMF with totaling approximately U.S. $50 billion, this agreement provided support to the administration's economic program, helping build confidence, reduce uncertainties and strengthen Argentina's economic prospects. But this agreement did not alleviate pressure on economy. In 2018, interest rate was increased to 40 % by central bank (figure 7). Moreover, peso depreciated against the U.S. dollar approximately 8 percent.

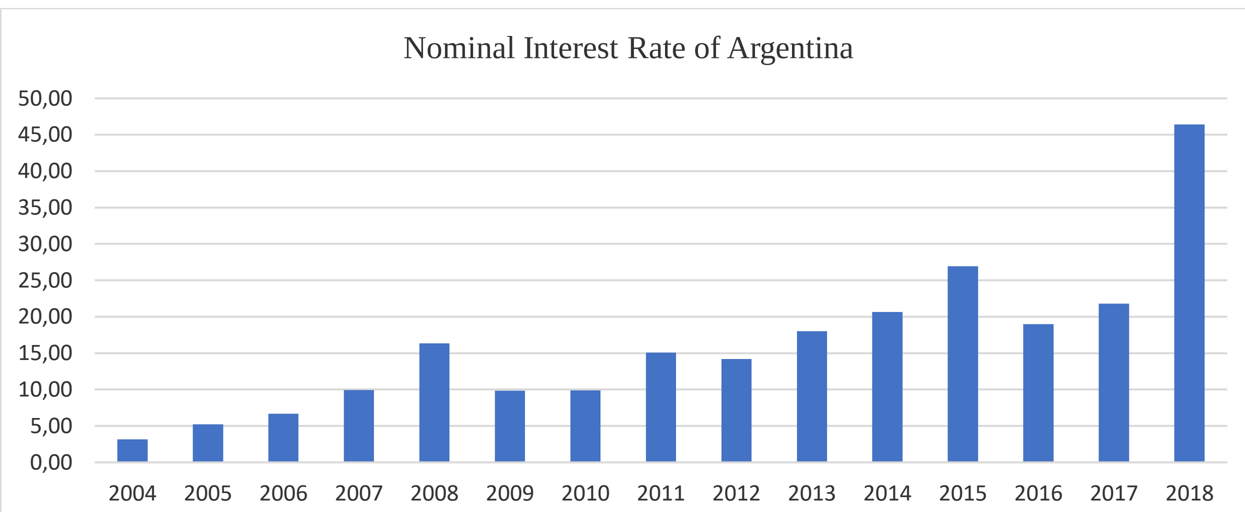

Figure 7: Nominal Interest Rate in Argentina between 2004 – 2018

As a summary, until 2015 especially between 2002 to 2009, Argentina refused to accept IMF support and implemented own economic policies. Although with limited access of international debt opportunity and relatively small direct foreign investment, GDP per capital increased nearly 100% between these years. Exchange rate was remained stable, this led to current account surpluses. Whereas after change in administration in 2015, liberal economic polices implemented. Poor fiscal policy was adopted. Unlike the previous administration, the first aim of the new administration is to pay the foreign debts. These policies caused a severe economic crisis in Argentina with nearly 60% inflation rate, 75% interest rate, 30% depreciation in peso against U.S. dollar and 5% decrease in GDP.

2.LITERATURE REVIEW

After collapse of the Bretton Woods system in the early 1970s, many countries started to use flexible exchange rate. At this decade, monetary models were developed to determine the volatility of the exchange rate and many economists started to test the monetary model of exchange. For example, Frenkel (1976) found a strong supportive evidence for the flexible price monetary model in order to explain German hyperinflation of the 1920s. In addition, Frankel (1979) supported the real interest differential model. At that time, it was difficult to obtain data for explanation of variations in exchange rate, however in the 1980s decade, many countries confronted a considerable volatility in their foreign exchange markets. Consequently, the flexible price model did not provide a good explanation of variations in exchange rate data. After examined the model, the estimated equations provided poor fits and showed incorrectly signed regression coefficients. Frankel (1982) called it a mystery of multiplying mark and gave a tentative explanation that current account fluctuations during the period might create wealth effects, which could not be adequately captured by simple monetary models.

Similarly, Meese and Rogoff (1983) examined the performance of the monetary models and posited that it can be better and sometimes worse than the predictions obtained, assuming that the exchange rate follows a random walk. Although these studies tested the monetary models only for the short term, the defender of the monetary models show them as a long – term equilibrium condition. According to Bilson (1979), monetary models have underperformed for the short –term mainly due to three reasons. Firstly, uncovered interest parity and purchasing power parity conditions do not hold in the short – run. Secondly, monetary models fail during the floating period as relative price shocks and money supply fluctuations remain incapable of explaining the volatile behavior of exchange rates. Finally, the assumptions of exogenous interest rates do not exist in the real world. The upshot is that monetary models have performed poorly due to failure of their assumptions.

Some researchers have claimed the reason of this failure is due to econometric misspecifications. Moreover, ignoring the non-stationary nature of the relevant time series as the most the time series have been found to be non-stationary can be another reason for finding inconsistent results for the monetary models in many previous studies.

After that period, many researchers tested the model by using new econometric technique. The results of the studies provide mixed results about the validation of the monetary models. Some researchers were in favor of the monetary model for example, MacDonald and Taylor (1993) found support for monetary models by applying multivariate co-integration analysis technique. Rapach and Woher (2004) used data for post Bretton Woods era, exert that monetary models hold for the floating rate era if panel techniques are applied rather than undertaking the simple country analysis. Further, Frankel and Rose (1996) and Taylor and Sarno (1998) posited that monetary models are based on long – run PPP condition, which is found to hold in panel estimations in the recent floating era. Applying more appropriate estimation techniques also validates PPP condition and the monetary models even in the time series data also (Garces-Diaz, 2004). Civcir (2003) examined the validity of the monetary model of exchange rate determination as an explanation of the Turkish Lira-United States dollar relationship. The results are suggested in favor of the monetary model. The equilibrium relationships are used to construct an equilibrium measure of the lira. Results indicate that a sensible estimate about the equilibrium value of the Turkish lira/US dollar exchange rate can be obtained. Chin, Azalia and Matthews (2007) used monetary approach for exchange rate determination to explain movements in Malaysian-ringgit-USD exchange rate. Results of the study confirm existence of long-run relationship between ringit-USD exchange rate and variables of monetary model. Therefore, empirical results are consistent with Bilson’s version of the monetary approach to determination of exchange rate. Bitzenis and Marangos (2007) tested the flexible-price monetary model is examined for the Greek drachma-US dollar exchange rate. The Johansen multivariate technique of cointegration is applied to an unrestricted form of the monetary model. Using quarterly data covering the period 1974–1994, strong evidence is found in favor of the existence of co-integration between the nominal exchange rate, relative money supply, relative income and relative interest rates. The monetary model is validated as a long-run equilibrium condition. Shylajan, Sereejesh and Suresh (2011), using the Johansen cointegration technique, examined the link between the Indian rupee-US dollar exchange rates and the macroeconomic fundamentals using the flexible-price monetary model. The outcomes reveal the existence of long-run relationship between exchange rate and the macroeconomic variables, validating the flexible-price monetary model. Nonetheless, no short-run causal relationship was found, using the vector error-correction model. Dutt and Ghosh (2000) applied Kwiatkowski-Phillips-Schmidt-Shin (KPSS) (Kwiatkowski et al., 1992) and Johansen approaches to determine the cointegration relationship between nominal Japanese yen-US dollar exchange rates and monetary fundamentals (money supply, interest rates and income), in the fixed exchange rate regime (1959M1 to 1973M1). Empirical evidence in favor of monetary model is obtained in this study. Islam and Hasan (2006) tested the validation of monetary model in the determination the dollar-yen exchange rate by applying cointegrating methodology. The results confirm the empirical validity of the monetary model as a long-run explanation of the nominal dollar-yen exchange rate.

Conversely, a strand of the literature finds little evidence in support of the monetary exchange rate model. For example, Cusham (2000) finds a cointegrating relationship for the monetary model using Canadian–US dollar exchange rate in which the estimated cointegrating coefficients are inconsistent with the monetary model predictions. Thus, he concludes that the monetary model is not validated.

The literature on exchange rate analysis for Argentina is comparatively scarce. In addition, given the many changes in monetary regimes and macroeconomic conditions in the last decades, empirical studies from some years ago may not have explanatory power, and perhaps even lower forecasting capabilities (Manzo, et.al, 2017).

Idil and Dalan (2009) examine exchange rate determination for Argentina, Brazil, Taiwan and Turkey. They find support for the monetary models in the panel sample but weak evidence of monetary models in single-country samples. For Argentina, the coefficient of the interest rate differential or the price differential is positive and significant in the OLS or DOLS method but negative and significant in the JOH-ML method, and the coefficient for the money supply differential or the output differential is not presented. In the VECM, interest rate is a significant variable in correcting the long-run disequilibrium in Argentina and Taiwan whereas the money supply in Brazil and the price in Turkey are the significant variables in correcting the disequilibrium.

Hsing (2016) applied the demand and supply model by using the EGARCH model and he find that the ARS/USD exchange rate (units of the Argentine peso per U.S. dollar) is positively affected by the Argentine interest rate, U.S. real GDP, the U.S. Stock price, the Argentine inflation rate and the expected exchange rate, and it is negatively associated with the U.S. interest rate, Argentine real GDP, the Argentine stock price and the U.S. inflation rate. In the monetary models, the positive sign of the interest rate differential confirms the Frenkel-Bilson model, and the positive sign of the inflation rate differential confirms the Dornbusch-Frankel model.

Long and Samreth (2008) examined the validity of both short run and long run monetary model of exchange rate for the case of Philippines by using ARDL model. In the analysis, first they posited that there are robust short run and long run relationship between variables in the monetary exchange rate model. Second, the stability of the estimated parameters is confirmed by CUSUM and CUSUM of square stability test. Third, the PPP condition is not hold. Last, all the monetary restrictions are rejected. Therefore, they concluded that the estimation result of the monetary model of exchange rate might suffer from a number of deficiencies; it is not appropriate to estimate the exchange rate model before the monetary restrictions are confirmed.

3.METHODOLOGY

In this section, the structure of ARDL model is explained. For example, when analyzing possible relationships between two or more variables the researcher often postulates specifications according to e.g. equation 6, where Y is the dependent variable and X is a vector of independent variables and f is some function.

$$Y = f(X) \tag{6}$$

The ARDL model tries to capture the relationship in $f(X)$. Following the work by Pesaran and Shin (1999) and Pesaran et al. (2001), the ARDL(q,p) model of equation 6 can be specified by equation 7 where y_t is the dependent variable and x_t is the independent variable and q,p are the respective lags.

$$\Delta y_t = \beta_0 + \sum_{i=1}^{q} \delta_j \Delta y_{t-i} + \sum_{J=0}^{p} \omega_j \Delta x_{t-j} + \mu_1 y_{t-1} + \mu_2 x_{t-1} + \varepsilon_t \tag{7}$$

The coefficients β_0 is the constant term and ε_t is the error term. The coefficients δ_j and ω_j for all j corresponds to the short-run relationship while the μ_i, j = 1, 2 corresponds to the long-run relationship.

There are two steps to conduct for ARDL model. The first step is that estimate equation 7 to conduct a F-bounds test for a long-run relationship between the variables. The next step is to derive Error Correction Model (ECM) from ARDL model.

3.1.F-Bounds Test

After we obtain results from equation 7, it is possible to determine if a long-run relationship exists among the variables. To decide the existence of a long-run relationship an F-test is performed. The test involves computing equation 7 and analyze if the coefficients for the one period lagged variables i.e. μ_1 and μ_2 are jointly zero. Thus, the following hypothesis test is performed:

H_0 : μ_1 = μ_2 = 0: A long-run relationship does not exist

H_1 : $\mu_1 \neq 0 \ \cup \ \ \mu_2 \neq$ 0: A long-run relationship exist

The F-test in the ARDL framework has a non-standard distribution that depends on:

1. The mix of $I(0)$ and $I(1)$ independent variables.
2. The number of independent variables
3. If the model includes an intercept and/or trend term.

The hypothesis test has upper and lower bounds of critical values and the test has three different cases. The results of the F-test compare with the critical values tabulated in Pesaran et al. (2001). If the computed F-statistic is greater than the upper bound the null hypothesis is rejected and the existence of a long-run relationship between the variables regardless of the order of integration of the variables is evident. If the F-statistic falls below the lower bound the null hypothesis cannot be rejected and the presence of cointegration is not significant. Finally, if the F-statistic fall in between the upper and lower bound the test is inconclusive (Pesaran et al. 2001):

$$Fail\ to\ Reject\ H_0\ < Inconclusive\ \ < Reject\ H_o \qquad (8)$$

3.2. Error Correction Model

Banerjee et al. (1998) and Kremers et al. (1992) suggested to test the error correction term in the case of inconclusive results of F-bounds test. To define an ECM-term there are few assumptions of this term. Given that the F-bound test produce satisfactory results it is possible to determine the long-run equilibrium relationship without spurious regression as the linear combination of the non-stationary variables are stationary in a simple OLS framework (Haq and Larsson, 2016):

$$y_t = \beta_o + \beta_1 x_t + \varepsilon_t \tag{9}$$

To capture the convergence of the model towards equilibrium an error correction term is defined by

$$ECM_{t-1} = y_{t-1} - \widehat{\beta_0} - \widehat{\beta_1}\, x_{t-1} \tag{10}$$

where $\widehat{\beta_s}$ are the estimators from equation 10. Note that $ECM_{\,t-1}$ is the residuals from equation 10. Furthermore, if the model is moving towards equilibrium in the long run the difference between the independent and dependent variables $(ECM)_{t-1}$ cannot increase as that would impose divergence. Hence the difference must decrease. Furthermore as x_t , y_t , β_j are all given from the regression in equation 11, ECM_{t-1} becomes a new data series.

In order to obtain the short-run dynamics, we insert the lagged variables x_t , y_t with the error correction term ECM_{t-1} into equation 7 and estimate it. The equation can be specified as follows:

$$\Delta y_t = \beta_0 + \sum_{i=1}^{q} \delta_j \Delta y_{t-i} + \sum_{i=0}^{p} \omega_j \Delta x_{t-j} + \lambda ECM_{t-1} + \varepsilon_t \tag{11}$$

The main goal of the estimation is to get a model which converge to equilibrium. If the ECM coefficient λ is statistically significant and negative the we can say that our model converges to equilibrium. In addition, a significant ECM coefficient confirms the existence of a stable long-run relationship and cointegration between the independent and dependent variables. The coefficient also determines the speed of adjustment towards equilibrium, for instance, assume we have annual data and $\lambda = -0.3$. Then y will after a shock in x return to equilibrium in the long run with a speed of 30% per year.

3.3. Unit Root Tests

To test the time series data for stationarity a common method is to apply an Augmented Dickey-Fuller test (ADF) (Dickey & Fuller 1979) to test for a unit root. A time series with a unit root is said to be non-stationary. There are other common methods for determining the stationary of a variable such as the Phillips-Perron (PP) test. The test is similar to the ADF test but with a few alternations in order to allow for autocorrelated residuals. In our study, we will use both of the tests.

Although, in the ARDL framework does not require pre-testing variables to be done, unit root tests could tell us about the order of integration for each variable and convince us whether ARDL model should be used or not and to investigate the order of integration for each variable. In the presence of I(2) variables, the computed F statistics provided by Pesaran et al (2001) are not invalid. Because the bound test is assumed that the variables are I(0) or I(1). Hence, the implementation of unit root test in the ARDL procedure might still be necessary to ensure none of variables are I(2) or beyond.

3.4. Lag Selection

Similar to the unit root tests, the lag selection is important as it determines the results of the model. There are several methods to obtain the optimal lag for each variable. However, the Schwarz Information Criteria (SIC) provides slightly better estimates than the Akaike Information Criteria (AIC) in small samples in the ARDL framework (Pesaran & Shin 1999). The AIC criteria also tends to overestimate the number of lags to be included, which is not favorable in small samples as by increasing the lag the number of observations decrease. Thus, in order to establish a coherent model, the SIC criteria will be used to select the optimal lag length for both the ADF test as well as for the ARDL model.

3.5. Diagnostic Tests and Stability Test

The ARDL model tries to find the best linear unbiased estimator (BLUE) and thereby diagnostic tests need to be conducted. In order to check if model is strong enough, finally, we will adopt Breusch-Godfrey test for non-autocorrelation of residual, Breusch-Pagan test for heteroskedasticity and Reset Specification test for functional misspecification. If the model contains none of the below biases and the model provides satisfactory results, we are satisfied with the results and we can conclude that the results can be used for analysis.

In addition, the ARDL model is quite sensitive to structural breaks and as we are using time series that are sensitive to worldwide events the stability of the coefficients needs to be analyzed. To assess the stability of the long-run and short-run coefficients CUSUM and CUSUMSQ tests proposed by Brown et al. (1975) can be used.

3.6. Data

This study covers the period from 2004 to 2018 to examine the behavior of ARS/USD exchange rate and relationship of exchange rate behavior with relative monetary variables. Data for the study have been collected from the official websites of World Bank World Development Indicators, Central Bank of Argentina (BCRA), International Monetary Fund (IMF), The National Institute of Statistics and Censuses (INDEC) and U.S. Department of the Treasury. The variables used are the nominal exchange rate (e) is the quarterly average price of one dollar in Pesos (ARS$/US$). As for money supply, we used the monetary basis M3, quarterly averageof three months, which comprises instant liquidity liabilities (m). For the GDP (y), we used the quarterly current values of the gross domestic product in current values (Pesos) then these values are converted to US dollar. For the GDP of USA, current values used. The interest rate in the U.S. is represented by the U.S. Treasury bill rate. During the study period, interest rate for treasury bills of Argentina was not stable. The central bank used different interest rate parity. For the study:

- From 08 Aug 2018 to 31 Dec 2018 7 Day Liquidity Bills (LELIQ),
- From 2 Jan 2017 to 07 Aug 2018: Middle of the corridor of repo rate,
- From 16 Dec 2015 to 1 Jan 2017: Central Bank issues at issue, 35 days,
- From 29 Jan 2014 to 15 Dec 2015: Central Bank issues, 3 months,
- From 11 Sep 2009 to 28 Jan 2014: Central Bank 7-day reverse repo operations,
- From 26 Feb 2007 to 10 Sep 2009: Central Bank issues, closest to 1 year,
- From 14 Jun 2004 to 25 Feb 2007: Central Bank 7-day reverse repo operations,
- From 1 Jan 2004 to 13 Jun 2004: Money market 1-week interbank loan is used.

Summary of statistics for data which is used in the analysis is shown in the table 1.

Table 1. Summary of Statistics

Summary of Statistics							
	Nom_Exch Rate ARS/USD	**Nominal GDP of ARG (mn$)**	**Nominal GDP of USA (Mn$)**	**Nominal Interest Rate (ARG) (%)**	**Nominal Interest Rate (USA) (%)**	**Monetary Base of ARG (M3)**	**Monetary Base of USA (M3)**
Mean	7,55	112435,67	4012697,37	15,96	1,38	9,754E+11	9,558E+12
Standard Error	0,93	5385,45	78282,34	1,63	0,22	1,346E+11	3,383E+11
Median	4,10	119826,77	3897455,00	9,50	0,38	5,489E+11	9,155E+12
Standard Deviation	7,20	41715,54	606372,38	12,62	1,72	1,043E+12	2,620E+12
Sample Variance	51,85	1740186483,83	367687464393,66	159,36	2,96	1,087E+24	6,866E+24
Kurtosis	5,58	-1,30	-0,78	2,79	0,27	2,607E+00	-1,001E+00
Skewness	2,26	-0,37	0,33	1,52	1,27	1,708E+00	1,716E-01
Range	34,48	130892,74	2389290,00	61,38	5,17	4,423E+12	9,752E+12
Minimum	2,55	37992,39	2922104,00	1,31	0,08	1,205E+11	4,542E+12
Maximum	37,03	168885,12	5311394,00	62,68	5,25	4,544E+12	1,429E+13
Count	60	60	60	60	60	60	60

Before conducted economic analysis, we try to explore the presence of break in exchange rate. To do we run basic OLS regressions with exchange rate as a dependent variable and use the recursive residual test to investigate the presence of breaks in exchange rate. The results are shown in Table 3, firstly we employ the Bai and Perron (2003) test for multiple unknown breakpoints. We test the null of no structural change against an unknown number of breaks by employing F statistics. The upper panel of Table 3 display three structural changes in exchange rate, in 2009Q2, 2014Q1 and in 2016Q2. After finding these results, we conducted Chow test to reinsure the structural breakpoint periods. The results confirm that these breaks are significant and decisively rejects the null hypothesis of no structural change for exchange rate (Table 3, Panel B). To capture the effect of non-monetary factors on exchange rate, a dummy variable for these periods has been used as determinants which with the effects of economics crisis in Argentina.

Table 2. Structural Breaks Test

(A) Bai - Perron test for unknown of breaks

Break Test	F-Statistics	Critical Value**
0 vs 1*	241.3913	8.58
1 vs 2*	52.48485	10.13
2 vs 3*	40.52771	11.14
3 vs 4	8.633912	11.83

* Significant at the 0.05 level. ** Bai-Perron critical values)

Break Dates	Sequential
1	2014Q1
2	2016Q2
3	2009Q2

(B) Chow Test for structural breaks

Period	F-Statistics	P - value
2009Q2	40.62895	0.0000
2014Q1	241.3915	0.0000
2016Q2	126.3506	0.0000

3.7. Econometric Modelling

Based on monetary model of exchange rate we will use the following regression model in this study.

$$lner_t = C + \beta_1 \, DUM_t + \beta_2 ln\left(\frac{money}{money^*}\right)_t + \beta_3 ln(\frac{GDP}{GDP^*})_t + \beta_4(\,interest - \,interest^*)_{ti} + \,\varepsilon_t \quad (12)$$

Variables with star (*) are related to USA and without star represent the corresponding variables relating to Argentina. The dependent variable is nominal exchange rate expressed as ratio of Argentina Peso per unit of US Dollar. First determinant of exchange rate is the stock of relative nominal money (M3) of the respective country measured in terms of the respective country's currency. Second explanatory variable is the relative GDP in nominal prices measured in terms of US Dollar for both countries. Third determinant of exchange rate is difference of interest rates between countries. Dummy variables are used for structural breaks period.

From the above regression model, to confirm the monetary model of exchange rate for Argentina, it is expected positive sign between monetary base, M3, and nominal exchange rate, negative relation between relative GDP in nominal prices and nominal exchange rate and positive relation between interest rate and nominal exchange rate.

The ARDL model is applied to our data and the general equation is presented and explained. The lag selection necessary in order to obtain good results is described as well as the specific F-bound test.

Following the description above and equation 7 the applied ARDL model is given in equation 13, in that equation exchange rate is denoted as ln(er) in the equations. All data is expressed as the natural logarithms except interest rate as it is in percentage form. The logarithm is taken in order to ease the interpretation of the results and to reduce possible heteroscedasticity.

$$\begin{aligned} \Delta \ln(er)_t = {} & C + \theta DUM_t + \sum_{i=1}^{p} \beta_{1i}\, \Delta ln(er)_{t-i} + \sum_{i=0}^{q_1} \beta_{2i}\, \Delta \ln GDP_{t-i} \\ & + \sum_{i=0}^{q_2} \beta_{3i} \Delta ln(money)_{t-i} + \sum_{i=0}^{q_3} \beta_{4i}\, \Delta(Interest)_{t-i} \\ & + \mu_0 ln(er)_{t-1} + \mu_1 \ln(money)_{t-1} + \mu_2 ln(GDP)_{t-1} \\ & + \mu_3 (Interest)_{t-1} + \varepsilon_t \end{aligned} \tag{13}$$

Where p lags are used for dependent variable and q lags used for independent variables, c is the intercept, ε is the white noise, DUM_t is a vector of dummy variables to allow for structural breaks; The remaining coefficients describe short-run and long-run relationships. The μ_j, j =0,1, …, 3 correspond to the long-run relationship while the short-run effects are captured by the coefficients for the first difference variables $i.e.\ \beta_i,\ i = 1,2,3,4$.

The corresponding error correction model equation can be seen in equation 14. The importance of each of the variables will be determined from the perspective of significance rather than from the magnitude of the coefficients or the p-value. This implies that if the variables are found to have an explainable relationship with the nominal exchange rate, they are considered to be important.

$$\Delta \ln(er)_t = C + \theta DUM_t + \sum_{i=1}^{p} \beta_{1i}\, \Delta ln(er)_{t-i} + \sum_{i=0}^{q_1} \beta_{2i}\, \Delta lnGDP_{t-i} + \sum_{i=0}^{q_2} \beta_{3i} \Delta ln(money)_{t-i} + \sum_{i=0}^{q_3} \beta_{4i}\, \Delta(Interest)_{t-i} + \lambda(ECM)_{t-1} + \varepsilon_t \quad (14)$$

4.RESULTS

4.1. Unit Root Tests

Although the ARDL cointegration approach does not require unit root tests, nevertheless we need to conduct this test to ensure that none of the variables are the integrated of order 2, i.e., I (2), because, in case of I (2) variables, ARDL procedures makes no sense. If a variable is found to be I(2), then the computed F-statistics, as produced by Pesaran et al. (2001) can no longer be valid.

Table 3 and Table 4 show the unit root tests of the variables. The first table shows the Augmented Dickey-Fuller test results and then second shows the Phillips-Perron test results. Table 1 depicts the Dickey-fuller unit root test. The null hypothesis is the series has a unit root with none and with trend. In both cases, we can clearly accept the null hypothesis that the variables have a unit root at their level. So, we need to test with their first differencing, and this ensures that all the variables are I (1). Table 4 shows the unit root test proposed by Phillips and Perron (1990). The results resemble with the ADF test and with these tests we can proceed to the ARDL cointegration tests as all the variable are I(1).

Table 3. ADF Test Results

Variable	Intercept				Trend and Intercept			
	Level		First Difference		Level		First Difference	
	t-stat	p-value	t-stat	p-value	t-stat	p-value	t-stat	p-value
LnExchange	4.53	1.00	-4.88*	0.00	0.92	0.99	-6.18*	0.00
Interest	-1.51	0.99	-5.38*	0.00	-1.73	0.73	-5.64*	0.00
LnGDP	-2.15	0.22	-9.27*	0.00	-0.98	0.94	-9.87*	0.00
LnMoney	3.88	1.00	-4.82*	0.00	1.36	1.00	-5.72*	0.00

Critical value for the ADF statistic with an intercept but not a trend = - 2.9121730 (5%)

Critical value for the ADF statistic with an intercept an Trend = - 3.489228 (5%)

Table 4. Philips - Perron Test Results

Variable	Intercept				Trend and Intercept			
	Level		First Difference		Level		First Difference	
	t-stat	p-value	t-stat	p-value	t-stat	p-value	t-stat	p-value
LnExchange	4.23	1.00	-4.82*	0.00	0.74	0.99	-6.15*	0.00
Interest	1.51	0.99	-5.38*	0.00	-0.91	0.95	-5.64*	0.00
LnGDP	-2.14	0.23	-9.451*	0.00	-0.04	0.99	-11.99*	0.00
LnMoney	3.39	1.00	-4.76*	0.00	1.13	0.99	-5.56*	0.00

Critical value for the PP test with an intercept but not a trend =- 2.912 (5%)

Critical value for the PP test with an intercept an Trend =- 3.489 (5%)

4.2. Lag Selection

After finding the integrating order, the two-step ARDL cointegration procedure has been employed. In the first stage, AIC, SBC and likelihood ratio (LR) criteria are utilized to select the optimal lag length of vector autoregressive (VAR). The results are being presented in Table 5. Since the objective is to select optimal order for the VAR, it is important that at this stage we select high enough order to ensure that the optimal order will not exceed it. Six VAR (p), p = 0, 1,2,3,4,5 models have been estimated over the sample period of 2004-2018. SBC is known as parsimonious model, as selecting the smallest possible lag length and it minimizes the loss of degree of freedom as well. Because of these reasons, we used SBC for lag selection; lags two are selected for this study.

Table 5. VAR lag order selection criteria

Lag	LogL	LR	FPE	AIC	SBC	HQ
0	86.73	NA	130e-10	-2.90	2.64	-2.80
1	437.57	599.62	2.25e-15	-13.88	-11.83*	-13.09
2	508.68	103.42	1.10e-15	-14.68	-10.85	-13.20
3	579.84	85.40	6.19e-16	-15.49	-9.86	-13.31
4	683.80	98.29*	1.38e-16	-17.48	-10.07	-14.62
5	771.67	60.71	8.87e-17*	-18.90*	-9.70	-15.34*

Note 1. LR: Likelihood ratio; FPE: Final prediction error; AIC: Akaike information criterion; SBC: Schwarz Bayesian criterion; HQ: Hannane Quinn criterion.
Note 2. * Indicates Optimal lag length.

4.3. F-Bounds Test

Now that has been established that none of the selected series I(2) or beyond and the determination of the optimal order of lag, presence of the long run cointegration has been tested using bounds test. The results of the ARDL bound test of cointegration are displayed in table 5. The F-statistics has a higher value (16.78) than the upper bound critical value, provided by Pesaran et.al (2001), is 4.43 (at 1% significance level) hence we have sufficient reasons to reject the null hypothesis of no long-run relationship at 1% significance level and perhaps the existence of cointegration among the studied variables.

Table 6. ARDL Bound Test of Cointegration

Variables	F-Statitics	Decision
F(exchange, money, GDP, Interest, D1,D2,D3)	**16.78**	Cointegration exist
Critical Value Bounds (significance)	Lower Bound (I0)	Upper Bound (I0)
10%	2.12	3.23
5%	2.45	3.61
2.5%	2.75	3.99
1%	3.15	4.43

4.4. Estimation Short-Run and Long-Run Relationships

4.4.1. Short-Run Relationship

The short run results are presented in Table 7. It is evident that all the determinants are statistically significant. Moreover, the coefficient of ECT_{t-1} is negative, as expected, and statistically significant. The significance of the lagged error correction term implies a long-term causality from all variables in the monetary model towards nominal exchange rate. The coefficient of error correction term is around -0.38 and which indicates that around 38 % of the disequilibrium in the nominal exchange rate in the short-term is corrected quarterly. To be more specific, it takes less than a year to correct short-term disequilibrium and to restore long-term equilibrium of Argentina's previous year's shock adjust back to the long-term equilibrium of nominal exchange rate.

Existence of a short-term relationship between exchange rate and a monetary fundementals of the monetary model is evident from the outcome of the error correction model. Exchange rate with lags 1, GDP growth rate, interest rate and dummy1 with lags 1 are significant at the 95% confidence level. This shows that there is short-term causality from these variables to the nominal exchange rate.

Table 7. Short run Coefficients (Error Correction Model)

Dependent Variable : ln(Exchange)				
Variables	Coefficients	Standart Errors	t-stat	P-value
C	0.306	0.061	4.984	0.0000*
Δ(lnexchange(-1))	-0.380	0.063	-5.990	0.0000*
Δ(lnmoney)	0.414	0.068	6.050	0.0000*
Δ(lnGDP)	-0.464	0.058	-7.954	0.0000*
Δ(interest)	0.001	0.000	-2.713	0.009*
Δ(Dummy1)	0.019	0.015	1.268	0.2107
Δ(Dummy2)	0.025	0.024	1.074	0.2880
Δ(Dummy3)	0.008	0.017	0.501	0.6188
Δ(Dummy1(-1))	0.113	0.025	4.465	0.0000*
Δ(lnGDP(-1))	-0.295	0.049	-6.012	0.0000*
ΔCointEq(-1)	**-0,380**	**0.033**	**-11.480**	**0.0000***

4.4.2. Long-Run Relationship

The long-run results are presented in Table 8. The coefficient of money is 1.09 and it is statistically significant which implies that 1% increase in relative money supply will lead to 1.09% increase in nominal exchange rate in the long run. The coefficient of relative GDP growth rate is -0.78 and it is statistically significant which implies that 1% increase in relative GDP growth rate will lead to 0.78% appreciation in nominal exchange rate in the long run. The coefficient of relative interest rate is 0.003 and it is statistically significant which implies the effect of interest rate on nominal exchange rate is nearly zero in the long run. The coefficient of dummy variable for period

2009Q2 is 0.30 and statistically significant. In addition, the coefficient of dummy variable for 2014Q1 is positive but for 2016Q2 is negative and both of them are not significant.

Table 8. Long run Coefficients of ARDL

Dependent Variable : ln(Exchange)				
Variables	Coefficients	Standard Errors	t-stat	P-value
money	1.087	0.052	21.022	0.0000*
GDP	-0.776	0.062	-12.548	0.0000*
Interest	0.003	0.001	2.568	0.0133*
Dummy1	0.298	0.071	4.193	0.0001*
Dummy2	0.067	0.067	0.996	0.3241
Dummy3	0.022	0.043	0.051	0.610

4.5. Diagnostics Tests

Different diagnostic test values demonstrated at table 9 and it shows that ARDL model identically full fitted model for long run as well short-run result for testing monetary model of exchange rate for Argentina. Serial correlation under correlogram with insignificant value squared correlogram negligible value, and Breusch Godfrey LM test illustrates F-statistics (0.025) at probability values (0.9747) which denoted that residuals serially uncorrelated and normally distributed. Likewise, findings of heteroscedasticity test declared that data series are homoscedastic, because the Breusch-Pagan-Godfrey F-statistics (1.1987) and probability value (0.3173), cannot discard null hypothesis of homoscedasticity of variables. The model passes the Reset Specification test with 2.4212 F-statistics value and 0.078 probability value which implies no functional misspecification in the model.

Table 9. Diagnostic Tests Results

Statistics	**F-statistics**	**P-value**
Serial Correlation	0.0256	0.9747
Heteroskedasticity	1.1987	0.3173
Reset Test	2.4212	0.078

4.6. Stability Tests

Finally, the cumulative sum of recursive residuals (CUSUM) and the CUSUM square (CUSUMSQ) tests, proposed by Brown, Durbin, and Evans (1975), are employed to investigate the stability of the model. As seen in Figure 8 and 9, the plot of the CUSUM or CUSUMSQ line do not break the limits which imply that the coefficients are stable.

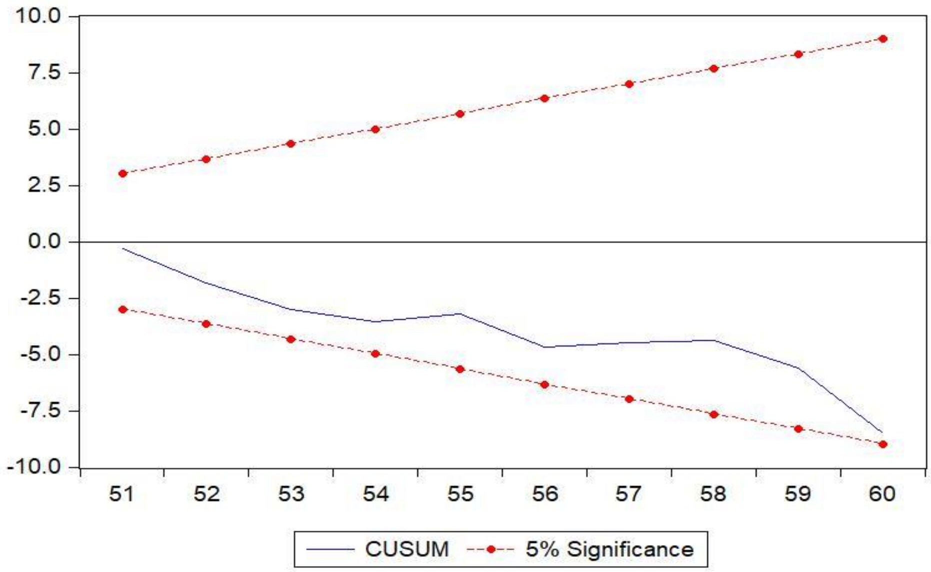

Figure 8. CUSUM Test

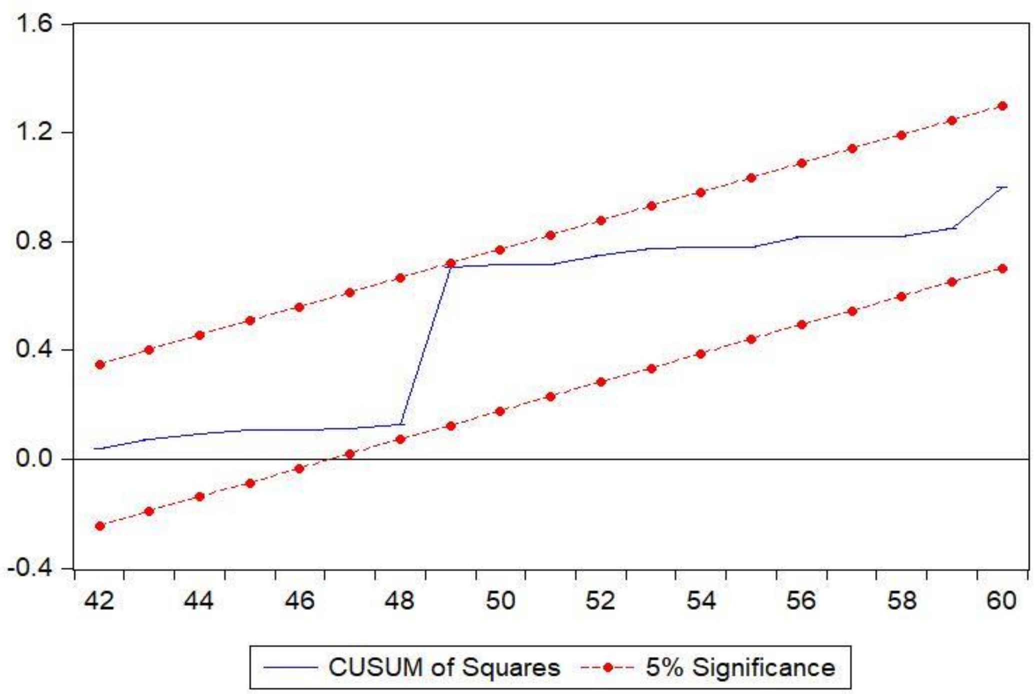

Figure 9. CUSUM of Squares Test

5.CONCLUSION

In this paper, the empirical validity of the monetary model of exchange rate has been tested to determine whether Argentina Pesos - US dollar exchange rate movements are in line with monetary fundamentals. Money supply, Gross Domestic Product and interest rate in Argentina and USA have been chosen as an independent variable, nominal exchange rate expressed as ratio of Argentina Peso per unit of US Dollar has been chosen as a dependent variable of the model. The model tested under the Autoregressive Distributed Lag (ARDL) approach is used over the period 2004 to 2018.

To confirm the monetary model, we expect positive sign between monetary base, M3, and nominal exchange rate, negative relation between GDP growth rate and nominal exchange rate and positive relation between interest rate and nominal exchange rate.

From the estimation results, in the short run, it is found that all the variables in the estimated model have significant effect on the exchange rate with consistent coefficient sign as expected in economic theory. In the long run, the results imply that there is a long run relationship among variables of the monetary model of exchange rate for Argentina case. The error correction term is strongly significant with the right sign (negative); this means that there is cointegration relationship (long run relationship) among variables of estimated model. Furthermore, the results suggest that all variables are strongly significant with the signs as expected. Additionally, the stability of estimated model is supported by the stability tests of CUSUM and CUSUMQ. Therefore, our results indicate that there exists a significantly, both statistically as well as economically, stable monetary model of exchange rate determination. The results determine that Argentina Pesos - US dollar exchange rate movements are in line with monetary model fundamentals.

There are several policy implications. The results for the money supply, M3, confirms that increase monetary base will lead to a demand for the USD which causes a depreciation of ARS. By the same way GDP growth in Argentina contributed to an exchange rate appreciation. This might be explained by the fact that GDP growth can suggest a consumption expansion which causes the excess demand for local currency. The results for the interest rates confirm that monetary tightening leading to a higher interest rate might cause a local currency to depreciate.

References

Bai, J., & Perron, P., (2003). Computation and analysis of multiple structural change models. J. *Applied Econometrics,* 18, 1–22.

Banerjee, A., Dolado, J. & Mestre, R. (1998). Error-correction mechanism tests for cointegration in a single-equation framework. *Journal of time series analysis, 19(3), 267-283.*

Bilson, J.F.O. (1979). Recent development in monetary models of exchange rates determination. *International Monetary FundStaff Papers*, 26, 201-23.

Bitzenis, A. & Marangos, J. (2007). The monetary model of exchange rate determination: the case of Greece (1974–1994). *International Journal of Monetary Economics and Finance*, Vol. 1, No. 1, pp.57–88.

Buera, F., J. & Nicolini, J., P. (2019). The Monetary and fiscal history of Argentina: 1960-2017. University of Chicago. *Becker Friedman Institute for Economics Working Paper*. http://dx.doi.org/10.2139/ssrn.3344793.

Brown, R. L., Durbin, J. & Evans, J.M. 1975). Techniques for testing the constancy of regression relationships over time. *Journal of the Royal Statistical Soci*ety, Series B, 37(2): 149–92.

Chang, M., & Su, C. (2014). The Dynamics relationship between exchange rates and macroeconomics fundamentals: Evidence from Pacific Rim Countries. *Int. Fin. Markets, Inst. And Money.* Volume 30, pp. 220–246

Chin, L. et.al. (2007). The monetary approach to exchange rate determination for Malaysia. *Applied Financial Economics Letters*, Volume 3, pp.91–94

Civcir, I. (2003). The monetary model of exchange rate under high inflation: the case of the Turkish lira/us Dollar. *Czech Journal of Economics and Finance*, vol.53, pp.3-4.

Cusham, D. O. (2000). The failure of the monetary exchange rate model for the Canadian – U.S. Dollar. *Canadian Journal of Economics*, 33(3), 591 – 603.

Dickey, D. A. & Fuller, W. A. (1979). Distribution of the estimators for autoregressive time series with a unit root. *Journal of the American statistical association* 74(366a), 427-431.

Dutt, S. D. & Ghosh, D. (2000). An empirical note on the monetary exchange rate model. *Applied Economics Letters*, 7, pp. 669671.

Engle, R. F. & Granger, C. W. (1987). Co-integration and error correction: representation, estimation, and testing. *Econometrica: Journal of the Econometric Society*, pp. 251-276.

Frenkel, J.A. (1976). The Monetary approach to the exchange rate: Doctrinal aspects and empirical evidence. *Scandinavian Journal of Economics*, 78(2), 200-24.

Frankel, J.A. (1979). On the Mark: A Theory of floating the exchange rates based on real interest differentials. American Economics Review, 69(4), 357-71.

Frankel, J.A. (1982). The Mystery of the multiplying marks: A modification of the monetary model. *The Review of Economics and Statistics*, 64, 515-19.

Frankel, J.A. & Rose, A.K. (1996). A Panel project on purchasing power parity: mean reversion within and between countries. *Journal of International Economics*, 40, 209-24.

Garces – Diaz, D. (2004). How does the monetary model of exchange rate determination looks, when it really works? Working Paper No. 2004 (60), North America Winter Meetings, Econometric Society.

Harris, R. and Sollis, R. (2003). Applied Time Series Modelling and Forecasting. Wiley, West Sussex.

Hsing, Y. (2016). Comparison of the fundamental and monetary model of the determination of the Argentina pesos/USA dollar exchange rate. *International Economics*, 69(4), 379-388.

Idil, U.Z. & Dalan, M. (2009). Monetary approach to exchange rate determination: The case of Argentina, Brazil, Taiwan and Turkey, 1986-2006. *Applied Econometrics and International Development*, 9(2), 53-62.

Islam, M.F. & Hasan, M.S. (2006). The Monetary model of the dollar-yen exchange rate determination: A cointegration approach. *International Journal of Business and Economics*, 5(2), 129-145.

Johansen, S. (1991). Estimation and hypothesis testing of cointegration vectors in Gaussian vector autoregressive models. *Econometrica: Journal of the Econometric Society*, pp. 1551-1580.

Kremers, J. J., Ericsson, N. R. & Dolado, J. J. (1992). The power of cointegration tests. *Oxford bulletin of economics and statistics*, 54(3), 325-348.

Kwaitkowski, D., Phillips, P., Schmidt, P. & Shin, Y. (1992). Testing the null hypothesis of stationarity against the alternative of a unit root. *Journal of Econometrics*, 54, pp. 159178.

Larsson, R., & Haq, S. (2016). The dynamics of stock market returns and macroeconomic indicators: An ARDL approach with cointegration. Master's Thesis. Retrieved from http://urn.kb.se/resolve?urn=urn:nbn:se:kth:diva-189993

Libman, E. & Palazzo, G. (2019). Inflation targeting, disinflation, and debt traps in Argentina. *European Journal of Economics and Economic*, 17, pp. 1-28.

Long, D. & Samreth, S. (2008). The Monetary Model of Exchange Rate: Evidence from the Philippines Using ARDL *Approach Economics Bulletin*, AccessEcon, vol. 6(31),1-13.

MacDonald, R. & Taylor, M.P. (1993). The Monetary approach to exchange rate: rational expectations, long- run equilibrium and forecasting. *International Monetary FundStaff Papers*, 40(1), 89-107.

Manzo, M.G., et.al. (2017). Monetary policy in the 21st century: The renaissance of Austrian monetary economics. Universidad Rey Juan Carlos I; Madrid, November 2nd and 3rd 2017. Conference.

Meese, R. & Rogoff, K. (1983). Empirical exchange rate models of the seventies: Do the fit out of sample. *Journal of International Economics*, 14, 3-24.

Mogliani, M., (2010). Residual-based tests for cointegration and multiple deterministic structural breaks: A Monte Carlo study. PSE Working Papers halshs-00564897, HAL.

Mussa, M. (1976). The exchange rate, the balance of payments and monetary and fiscal policy under a regime of controlled floating. *Scandinavian Journal of Economics*, *78*(2), pp. 229-48.

Mussa, M. (1979). Empirical regularities in the behavior of exchange rates and theories of the foreign exchange market, in Karl Brunner and Allan H. Meltzer, eds., *Carnegie-Rochester Conference Series on Public Policy: Policies for Employment, Prices and Exchange Rates*, Vol. 11.

Pesaran, M.H., & Shin, Y., (1999). An autoregressive distributed lag modelling approach to cointegration analysis. In: Strom, S. (Ed.), Econometrics and Economic Theory in 20th Century: The Ragnar Frisch Centennial Symposium. Cambridge University Press, Cambridge Chapter 11.

Pesaran, M.H., & Smith, R.P., (1998). Structural analysis of cointegrating VARs. *Journal of Economic Survey*, 12, 471–505.

Pesaran, M.H., Shin, Y., & Smith, R.J., (2001). Bounds testing approaches to the analysis of Level relationships. *Journal of Applied Econometrics*, 16, 289–326.

Phillips, P. C. B. & Perron, P. (1990). Testing for a unit root in time series regression, *Biometrika*, 75, 335–346.

Rapach, D. E. & Wohar, M. E. (2004). Testing the monetary model of exchange rate determination: A Closer Look at Panels. *Journal of International Money and Finance*, 23(6), 867-95.

Saiegh. S. M. (1996). The rise of Argentina's economic prosperity: An institutional analysis. Stanford University. (Master thesis) 2014-02-18. June 1996.

Sarno, L. & Taylor M.P. (2002). The economics of exchange rates. Cambridge and New York: Cambridge University Press, 2002, Chap. 4.

Shylajan, C.S., Sreejesh, S. & Suresh, K.G. (2011). Rupee-dollar exchange rate and macroeconomic fundamentals: An empirical analysis using flexible-price monetary model. *Journal of International Business and Economy*, 12, 89-105.

Taylor, M.P. & Sarno, L. (1998). The behavior of real exchange rate during the Post-Bretton Woods Period. *Journal of International Economics*, 46, 281-312.