THE REASONABLENESS OF THE UNCOVERED INTEREST RATE PARITY THEOTY IN EXPLAINING THE FLUCTUATIONS OF THE EURO-DOLLAR EXCHANGE RATE: AN EMPIRICAL SYUDY FOR THE PERIOD 1999-2019

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Abstract

This paper examines the reliability of the uncovered interest rate parity (UIP) theory in explaining the fluctuations in the Euro/Dollar exchange rate for the period of 1999 (Q1)-2019 (Q4) using the analytical method, the ARDL approach for cointegration and the Granger causality test. The analysis of the relationship between the real Euro/Dollar exchange rate and the interest rate differentials between the US and the Euro area showed that there is a deviation from the parity condition in some sub-periods. As for the results of the empirical study, the results of the bounds test proved the existence of a long-run relationship between variables. However, the results of the estimated ARDL model revealed that the UIP holds only on the short horizon, which was confirmed by Granger's causality test results. As the UIP did not hold in the long run, this indicates that there are some obstacles and some controls imposed on the free movement of capital between the US and the Euro area.

Keywords: Euro/dollar Exchange Rate, UIP, ARDL, Bounds Test, Granger Causality Test.
Jel classification code: F31, C32.

1. INTRODUCTION

Studies highlighting the relationship between exchange rates and interest rates receive a great deal of attention from a wide cross-section of society across different countries and different time periods. That, gives an important role that the exchange rate and interest rate play is influencing the real and nominal economy, without mentioning the mutual interactions between them, effectively influence the economic and financial decisions of the various economic agents, dealers in the foreign trade sector, international financial markets, commercial banks and even at the level of policymakers from central banks and governments, which would affect in one way or another the various economic activities and then economic growth and the rest of the main objectives of macroeconomic policy.

In the context of a macroeconomic analysis, interest rate parity theory (IRP) is among the most important theories in international finance that discuss the issue of currency fluctuation, and provide a better explanation of how exchange rates are determined and the reasons for their volatility. Despite the relatively long time presenting this theory and the large number of theoretical and empirical studies that have tested the validity and credibility of this theory, it is still an interest to many macroeconomists and academics, and it is constantly a subject to examination and experimentation.

IRPT plays an important role in the foreign exchange markets, and this theory seeks to reveal the link between the domestic money market and the foreign exchange market. In other words, IRP is a basic relationship that provides a mechanism for linking interest rates and exchange rates. More precisely, in a world without restrictions on capital flows or transaction costs and with profit-oriented market players, IRPT assumes that, in equilibrium, two investments exposed to the same risk should have the same return, regardless of the level of interest rates (Mathur & Babu, 2014, p. 8). Accordingly, investors cannot obtain higher rates of return when investing their money in foreign investments with a higher interest rate than those that can be achieved in local investments with a lower interest rate. Therefore, IRPT refers to a no-arbitrage state in which investors are not different regarding the interest rate in two different countries.

On this basis, this theory provides an additional important theoretical framework for investors,. In order to gain a broader understanding of the prime motivations for international investment, and on the part of researchers, policymakers and others, it provides a framework for research and testing in order to ensure its reasonableness in explaining exchange rate volatility and determining its behavior in the future. From this standpoint, this paper aims to examine the theory of interest rate parity in terms of its reliability in explaining changes in the euro-dollar exchange rate using the ARDL methodology of joint integration. The remainder of this paper is organized as follows: Sections 2 and 3 respectively provide a theoretical and empirical review of interest rate parity theory (IRP), As for Section 4, it deals with the analytical framework of the (UIP) theory. While Section 5 presents the research methodology and data used, Section 6 presents and discusses the empirically study results.

2. Theoretical Review on the Interest Rate Parity

The origin of the interest rate parity theory is due to the British economist John Maynard Keynes, through his writing in the Tract on Monetary Reform (1923) who popularized the expression interest rate parity (Levich, 2017, p. 8). Where he explicitly referred (in words) to the mathematical concept of parity between the forward premium and interest differential, he also provided a list of the causes of parity violation at least in the period Keynes lived. The interest rate parity (IRP) theory seeks to reveal the link between the domestic money market and the foreign exchange market. In fact, any difference between the interest rates in two countries results is either an improvement or a deterioration of the local currency relative to the foreign currency (Guillochon, 1992, p. 189).

Interest rate parity (IRP) theory is an essential relationship linking interest rates and exchange rates. IRPT indicates potential financial arbitrage if there is a difference in interest rates between two currencies. If the differential interest rates differs from zero, then there will be opportunities for arbitration, so that investors can obtain a loan in the currency with a low interest rate and invest in a currency with a higher interest rate. If this arbitrage continues, this will be evidence of endless wealth (Ghalayini, 2014, P. 198). Therefore, it was necessary to find a way to equilibrium the differential interest rates between countries, and found that the exchange rate is the appropriate solution to this problem. Consequently, the IRPT is a no-arbitrage condition which represents an equilibrium state, in which investors are indifferent to the interest rates available on bank deposits in two countries (Aslan & Korap, 2010, p. 2). IRPT takes the following standard formula:

$$\frac{1+i}{1+i^*} = \frac{f_t}{s_t} \quad \ldots\ldots\ldots\ldots(1)$$

or

$$f = s \times \left(\frac{1+i}{1+i^*}\right) \ldots\ldots\ldots(2)$$

Where, f is the forward rate in time t, s is the spot rate in time t, i is the domestic interest rate, i^* is the foreign interest rate.

IRPT theory is based on the principle that in equilibrium, two investments that are exposed to the same risks must have the same return, regardless of the level of interest rates. In other words, the interest rate parity theory is trying to provide a basic idea that there is no opportunity to arbitrate in the foreign exchange markets, so that investors can not achieve additional gains by taking advantage of the interest rate differentials. Two types of interest rate parity can be distinguished: Covered and Uncovered Interest Rate Parity (CIP, UIP).

2.1. The Concept of Arbitrage

The most basic of activities pursued by private actors in any market is arbitrage, a trading strategy that exploits any profit opportunities arising from price differences. In the simplest terms, arbitrage means to buy low and sell high. If such profit opportunities exist in a market, then it is considered to be out of equilibrium. If no such profit opportunities exist, there will be no arbitrage; the market is in equilibrium and satisfies a no-arbitrage condition (Feenstra & Taylor, 2008, p. 43). In the special case of the foreign exchange market, arbitrage is defined as the simultaneous purchase and sale of currencies for the sake of making profit (Moosa, 2003, p. 1). In order to clarify the idea further, let us assume that an investor(s) is interested in trading in the dollar and the euro. In light of the free transfer and that the trading commissions are the same in the US and the euro area, and they are almost non-existent. Suppose, that the US exchange rate is E.US: £ / $ = 0.85 € per dollar, in Europe: E.Euro £ / $ = 0.95 € per dollar. This position provides an opportunity for profit, so the investor(s) can buy one dollar for 0.85 euros in the US, and then sell it in Europe for 0.95 euros in Europe to achieve immediate and risk-free profit. Hence, we can imagine the amount of profits made, given the possibility of arbitrage permanently, and with multiple currencies and a large number of investors. However, arbitrage occurs only if the spot exchange rates for different currencies differ in the Forex market. As for the case where the spot prices are equal, arbitrage will not happen, and we will be in the process of achieving the no-arbitrage condition for spot rates.

If the market were out of equilibrium, arbitrage would drive up the price in the low-price market and drive down the price in the high-price market. This process would continue until the prices converged, arbitrage ceased, and equilibrium was attained. In forex markets, these adjustments happen nearly instantaneously, whether in the high tech electronic markets of world financial centers or in the markets on street corners in the developing world (Feenstra & Taylor, 2008, pp. 44-45).

2.2. Arbitrage and Interest Rates

We previously discussed the concept of arbitrage activity arising from the different exchange rates of currencies, but there is another type of arbitrage activity that plays an important role in the Forex market, which is the interest rate arbitrage. In addition to the profit that can be achieved by taking advantage of the different exchange rates of multiple currencies, traders, investors and all dealers in the Forex market can obtain additional important profit by taking advantage of the interest rate differences on financial assets across different countries (currencies, securities, etc.).

For more clarification on the concept of arbitrage in the interest rate, let us assume that the investor(s) has the option to invest his capital (K) in the form of a deposit in dollars, for a period of three months, at an interest rate of 1% . Or in the form of a deposit in euros for the same period at an interest rate of 2%. This existing situation of differing interest rates on the two deposits will inevitably push the investor(s) to make financial decisions in a particular direction, which would cause significant changes to the demand for the dollar and the euro, and thus the bilateral exchange rate between them. The last phrases implicitly point to a very important idea, which is that the magnitude of change in demand for the two currencies, and then the fluctuation of the euro-dollar exchange rate ,depends mainly on the behavior of investor(s) towards the interest rate differentials between the US and the Euro area, and the extent of their willingness to bear exchange rate risk (exchange rate risk arising from uncertainties about the future euro-dollar exchange rate).

Going back to the previous example, it is clear that deposits in euros (or securities issued in euros, such as bonds, for example) for three months generate more profit than dollar deposits (or any type of debt instrument issued in dollars) for the same period. Therefore, it comes to mind at first sight that investor(s) (whether this investor(s) is located in the US, the euro area, or anywhere in the world) will turn their capital from deposits in dollars to deposits in euros (or convert their dollars into Euros to buy European bonds) to take advantage of the interest rate differential. This would increase the demand for the euro and increase the supply of the dollar, thus increasing the value of the euro against the dollar as a result. The exact opposite occurs if the interest rates on financial assets in the US rise compared to the returns of financial assets in the euro area. However, continuing interest rate arbitrage processes will ultimately lead to the elimination of interest rate differentials between US and European bonds. With capital leaking from the US to invest in the euro area, interest rates in the US tend to increase, and as capital flows to the euro area, interest rates tend to decrease. Thus, the differences between interest rates are gradually eliminated, which leads to discouraging the transfer of capital between the US and the euro area. At this point, the interest rate arbitrage cease and the equilibrium is restored again.

The investment process referred to above is called interest rate arbitrage, meaning that investors are trying to take advantage of the differences between the real interest rates in different countries to achieve additional returns as a result. Therefore, the arbitrage process in interest rates plays an important role in changing the demand for international currencies, and it is considered one of the main reasons for the fluctuation of foreign exchange rates in the Forex market.

There are two types of interest rate arbitrage, uncovered interest arbitrage and covered interest arbitrage. In the first type, the investor may prefer to conclude a spot contract. If this is done in practice, his financial position will be exposed to any changes that may occur in the exchange rate (i.e. more exposed to the risks of exchange rate fluctuations), whereupon his decision will be a case of risky arbitrage. For this reason, the investor must hedge or cover his position his position from any potential risks of exchange rate fluctuations. The arbitrage process in this case is called the covered interest rate arbitrage. This is done in several ways, for example, using forward contracts, or use "SWAP" as a instrument for hedging risk, or by entering into "Options" contracts, etc (Moosa, 2003, p. 111). These two ways of doing arbitrage lead to two important implications, called parity conditions, which describe equilibria in the forward and spot markets. Both will be discussed separately in the following paragraphs.

2.3. Covered Interest Rate Parity (CIP)

The covered interest rate parity theory maintains that in equilibrium the premium (or discount) on a forward contract for foreign exchange is related to the interest rate differential (Frenkel & Levich, 1975, p. 325). This type of interest rate parity is called covered interest parity (CIP), because all the risks associated with the exchange rate of a currency are "covered" by the use of forward contracts. Covered interest rates can be expressed in the following formula:

$$CIP: \quad \frac{i_d - i_f}{1 + i_f} = \frac{F_t^m - S_t}{S_t} \quad \ldots\ldots\ldots(3)$$

or

$$CIP: \quad \frac{F_t^m}{S_t} = \frac{1 + i_d}{1 + i_f} \quad \ldots.\ldots.(4)$$

Where, F_t^m and S_t are, respectively, the forward and spot exchange rates, i_d is the domestic rate of interest on a particular class of securities, and i_f is the foreign interest rate.

Covered interest parity (CIP) is a no-arbitrage condition that describes an equilibrium in which investors are indifferent between the returns on interest-bearing bank deposits in two currencies and exchange risk has been eliminated by the use of a forward contract (Feenstra & Taylor, 2008, pp. 44-48). It states that the difference between the interest rates available in two countries must equal the expected percentage change in the spot exchange rate with respect to the forward exchange rate available today (Ruthberg & Zhao, 2014, p. 3).

To illustrate how the covered interest rate parity works, let us assume that an investor is located in the US (the home country), and has the option to invest his available capital (k) in the form of a dollar deposit in a domestic bank for a certain period of time (t) at an interest rate (i_d) or an investment in the form of a deposit in euro In a European bank (Euro area as a foreign country) for the same period (t), at an interest rate (i_f), with assuming that the foreign interest rate (i_f) is greater than the domestic interest rate (i_d). If the investor chooses to invest in the European bank in the form of deposits in euros, then he must transfer his capital (k) from the dollar to the euro at the current spot dollar/euro exchange rate (S_t). And because the investor will have to convert his capital again from the euro to the dollar after the expiry of the investment period (t+n), and because the forward exchange rate often differs from the spot exchange rate, either by increasing or decreasing, and in order to avoid the risks of the dollar exchange rate falling against the euro at the end of the contract period, the investor will resort to hedging or covering these risks using the current forward exchange rate F_t^m. In general, the returns that an investor can achieve from these two options are expressed as follows:

- Possible returns from investing in a dollar deposit:

$$K(1+i_d)\ldots..(5)$$

- Possible returns from investing in a deposit in EUR:

$$K \times \frac{1}{S_t}(1+i_f) \times F_t^m \ldots(6)$$

In this case, the no-arbitrage condition stating that the covered interest rate parity holds, requires equality between the returns with similar risks illustrated above in (5) and (6), as follows:

$$K(1+i_d) = K \times \frac{1}{S_t}(1+i_f) \times F_t^m \ldots\ldots.(7)$$

After rearranging equation (p), a new relationship can be obtained for covered interest parity, which is widely used as a basis for calculating the forward exchange rate, as follows:

$$CIP: \qquad F_t^m = S_t \frac{1+i_d}{1+i_f} \ \ldots\ldots(8)$$

Taking into consideration the previous example, the forward euro-dollar exchange rate is higher than the spot rate, then it is said in this case that the euro is sold at a premium, that is, it is expected that the value of the euro will increase in the future, but if the forward exchange rate is less than the spot rate, We say that the euro is sold at a discount, that is, the euro is expected to depreciate. Therefore, the forward exchange rate premium (or discount) is equal to (approximately) the US interest rate minus the European interest rate. This phrase can be translated mathematically to obtain the most used relationship to the covered interest rate parity as follows:

$$CIP: \quad i_d - i_f = \frac{F_t^m - S_t}{S_t} \quad \dots \dots (9)$$

Where, $i_d - i_f$ is the interest rate differential and $\frac{F_t^m - S_t}{S_t}$ is the forward premium (or discount) on the foreign currency. If this ratio is greater than zero ($\frac{F_t^m - S_t}{S_t} > 0$), then it is called a forward premium, and if it is less than zero ($\frac{F_t^m - S_t}{S_t} < 0$), it is called a forward discount. In general, under normal circumstances, a currency that offers low interest rates tends to trade at a forward foreign exchange rate premium. Conversely, if the currency has a higher interest rate compared to another currency, it tends to trade at a forward discount (Lall, 1967, p. 189).

2.4. Uncovered Interest Parity (UIP)

Uncovered (or open) interest rate parity (UIP) is one form of interest rate parity (IRP) used in conjunction with a covered interest rate (CIP). It was so named, because the exchange rate risk was left uncovered by the investor's decision not to hedge against the exchange rate risk by using one of the hedging instruments previously mentioned, and instead the investor uses a spot contract at a specific point in time (MacDonald, 2007, p. 8). UIP theory states that the difference in interest rates between two countries will equal the relative change in currency foreign exchange rates over the same period (Nusair, 2006, p. 429). In other words, the UIP model theory states that differences between interest rates across countries are explained by the expected change in currencies (AbuDalu & Elsadig, 2011, P. 209). This theory takes the following formula:

$$UIP: \ 1 + i_d = 1 + i_f \left[\frac{E(S_{t+n})}{S_t}\right] \dots \dots \dots (10)$$

Where, $1 + i_d$ denotes the return of the domestic currency on the deposit in the domestic currency (or represents the dollar return on the dollar deposits, if we take into account the previous example), as for the other side of the equation, it expresses the expected return of the domestic currency on foreign currency deposits (or expected dollar return on euro deposits)

For illustrative purposes, an investor may prefer not to hedge against potential exchange rate fluctuations, wait until the end of the investment term and use any available exchange rate at the time. This risky decision is based on the investor's current expectation of the future spot exchange rate. Hence, another formula for uncovered interest rates can be obtained by replacing the forward exchange rate (F_t^m) in equation (9) with the expected future spot exchange rate [$E(S_{t+n})$] in equation (10), as follows:

$$UIP: \quad i_d - i_f = \frac{E(S_{t+n}) - S_t}{S_t} \quad \dots\dots(11)$$

If the uncovered interest rate parity relationship does not hold, then there is an opportunity to make a risk-free profit using currency arbitrage Therefore, the UIP is a no-arbitrage condition that describes an equilibrium in which investors are indifferent between the returns on unhedged interest-bearing bank deposits in two currencies (where forward contracts are not employed) (Orji, Anthony-Orji, & Ani, 2013, p. 28). The non-covered interest rate parity theory is often used to calculate the spot exchange rate. After rearranging equation (P), we find that the spot exchange rate is equal to:

$$UIP: \; S_t = E(S_{t+n})\left[\frac{1+i_f}{1+i_d}\right] \dots\dots\dots(12)$$

In general, the basic idea that can be concluded from the foregoing is that the interest rate parity theory in its two forms, covered and uncovered, argues that the country with the highest interest rate will face a decrease in the value of its currency against the currencies of countries with lower interest rates.

3. Empirical Review

When reviewing the literature, several studies can be found that have empirically discussed the validity of the UIPT hypothesis. These studies base their examination of the UIPT hypothesis on a variety of exchange rates, various interest rates, different time periods, different analysis methodologies, and of course reached different results. The relevant literature is summarized in the following paragraphs:

Equation (2) has been tested in terms of values and signs of its parameters by many researchers in the past, such as like Cumby & Obstfeld (1981), Davidson (1985), Loopesko (1984), Taylor (1987a), MacDonald & Torrance (1990); in all instances, UIP was very strongly rejected. While some attribute the reason for the failure of the theory to the maturity of heterogeneous bonds and the difference in risk sensitivity by investors, others attribute the cause of failure to the existence of a (time-varying) risk premium, while; others see that the reason for failure is mainly due to both risk factors and expectations.

Clostermann & Schnatz (2000) addressed empirically the medium and long-term forces driving the real euro-dollar exchange rate during the period 1975 -1998 using a synthetic euro-dollar exchange rate as dependent variable, and the international real interest rate differential, the real oil price, government spending and relative prices in the traded and non-traded goods sectors as fundamentals factors affecting exchange rate. The study applied the Johansson approaches of co-integration to estimate short and long-term effects. The results of the estimated VECM model indicate that a 1 percentage point increase in the real interest rate differential leads to a decrease in the real effective euro exchange rate by about 1.3% and 1.29% in the short and long term, respectively. This means that the UIP theory is hold.

Chinn & Meredith (2004) tested the UIP hypothesis in the G-7 countries using the Generalized Methods of Moments (GMM). In order to determine the validity of the theory in the short for the period 1980 (Q1)–2000 (Q4) and in the long term for the period 1983 (Q1)–2000 (Q4), a mixture of short-term interest rates (interest rates for 3, 6 and 12 months) and long-term interest rates (5 and10-Year Government Bond Yields) were used for the G-7 countries, and the exchange rates for the six countries were expressed on the US dollar. The results confirm the UIP failure over short horizons, but are largely valid on longer horizons.

Lothian & Wu (2005) studied the validity of uncovered interest-rate parity (UIP) using annual data for dollar-sterling and franc-sterling exchange rates, as well as long-term and short-term interest rates for France, the United Kingdom, and the US. The dollar-sterling exchange rate data span more than two centuries (209 years) between 1791 and 1999. The franc-sterling exchange rate starts in 1802 with 198 years of data. The interest rate data span just two centuries between 1800 to 1999. The study used different regressions which are: forward-premium regression, rolling window regression and regression conditional on large deviations. The results of the standard study indicate that the effect of UIP is only significant in the long term and depends on the maturity of the interest rate and becomes a weak when tested in the post-Breton Wood period.

Huismana et al (2007) applied Logit models to examine whether exchange rates tend to move in line with Uncovered Interest Rate Parity over the period from January 8, 1992 to May 16, 2006. The study used the following exchange rates against the U.S. dollar (USD): Australian dollar (AUD), Canadian dollar (CAD), Swiss franc (CHF), Euro [(EUR), For the

Euro, they took the German Eurocurrency rates prior to 1999)], British pound sterling (GBP), Japanese yen (JPY), Norwegian Krone (NOK), and Swedish Krona (SEK). The results indicate that the AUD, JPY and NOK tend to move away from UIP. Only EUR and SEK have the tendency to move in line with UIP, as for the rest of the exchange rates, they are moving in the opposite direction to the theory (UIP).

Aslan & Korap (2010) examined the uncovered interest parity (UIP) using four developed countries exchange rates vis-à-vis US dollar. The study used monthly frequency data over the period January 1987 to December 2006 for Australia dollar / US dollar (AU), Canadian dollar / US dollar (CA) and UK pound / US dollar (UK) data, while the period January 1989 to December 2006 is considered for the Japanese Yen / US dollar (JA) data. As for interest rates, short-term interest rates (i.e. 3-month interbank rate) and long-term interest rates (i.e. 10-year government bond yield) have been used for the same previous periods. Then the model was estimated using the Generalized Method of Moments (GMM). The results indicated the failure of the UIP hypothesis in short-horizon.

Omer et al (2013) tested Uncovered Interest Rate Parity (UIP) using LIBOR rates for the major international currencies for the period January 2001 to December 2008. For this purpose, the study applied several standard methods of analysis, such as co-integration testing, system SUR, System DGLS, System DOLS. The cointegration results support the presence of a long- run relationship between interest rates and the exchange rate. They found Based on these results, the researchers advise that attention should be paid to the interrelationship between currencies, and they also see that "state dependence" plays an important role for currencies with a negative interest differential vis-à-vis the US. Thus, they believe that "state dependence" could also be instrumental in explaining exchange rate overshooting. that UIP generally holds over a short-term horizon for individual and groups of currencies.

Arshed & Zahid (2016) used plate data models for 4 trading partners based on their contribution in Pakistan's trade and capital inflow, with the aim of integrating the spill over effects of trade and heterogeneous technology effects in long run and short run for the years of 1992 to 2012. The results of the estimated CMG model showed that interest rate differentials is significant in managing exchange rate, but it positively affects the exchange rates of these countries, which suggests that the UIP does not hold.

Güney (2018) presented an empirical investigation of the uncovered interest parity (UIP) between the Turkish Lira (TRY)/US Dollar (USD) and Turkish Lira/Euro (EUR) using ARDL approach for co-integration. The results of the empirical study do not provide evidence supporting the UIP hypothesis for either case. Moreover, the results indicate a one-way causation from the TRY/USD exchange rate return to the interest rate differential. The researcher justifies this result by the Turkish Central Bank's (CBRT) control of capital movements.

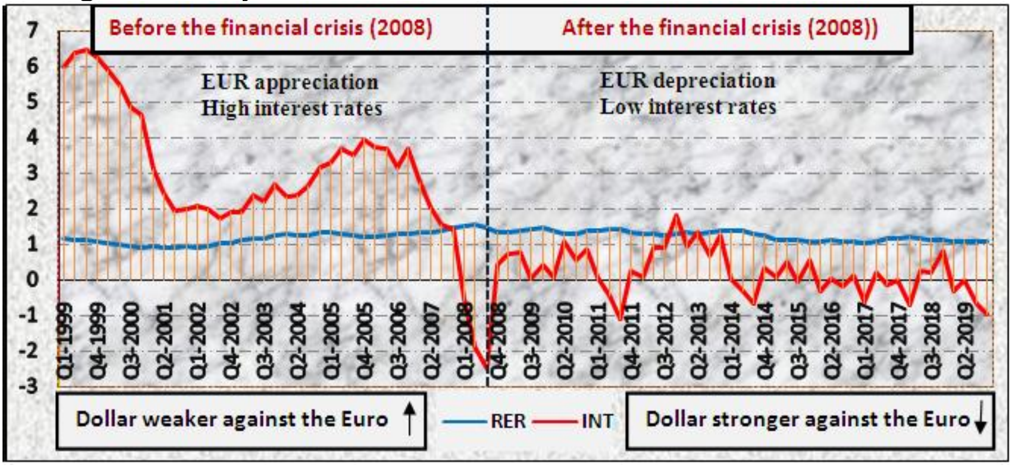
Papahristodoulou (2019) investigated whether the value of the Swedish krona (SEK) against the US dollar ($) and the Euro (€) can be explained by some standard theories and fundamentals, such as the purchasing power parity, the interest rate parity, the debt-ratio and the trade balance ratio, using different analysis methodologies and for different time periods. To examine UIP theory, the specific model was estimated using the NLS method, with 240 monthly observations and 60 quarterly observations (February 1999 - January 2019). The NLS estimates indicate that the UIP theory is rejected for both exchange rates, and the same is true for other theories. Therefore, the researcher argues that traders and investors ignore the fundamentals, speculate against the currency and keep it undervalued.

Despite substantial empirical research on interest rate parity theorem, the role of interest rates in determining currency rates remains a lot of mystery and raises a lot of controversy, especially in light of the more open economies that practice both conventional and unconventional monetary policies (ex. US and euro area).. Neither theoretical nor empirical literature have conclusively demonstrated whether the high domestic interest rate compared to the foreign interest rate really leads to a deterioration in the local currency exchange rate, or vice versa. Also, the economic reality in many cases provides strong evidence that exchange rates and interest rates were going hand in hand (rising together and falling together). This issue continues to be relevant to the understanding of the short-and long-run relationship between those two variables, the formulation of policy, and the applied literature in international trade and finance.

4. Analytical Framework for the UIP Theory

In order for the uncovered interest rate theory to be credible in explaining the fluctuations of the real euro-dollar exchange rate, the increase in interest rates in the US above its euro-area counterpart should lead to a decrease in the value of the dollar against the euro, and vice versa. In other words, the condition of no-arbitrage necessitates a positive relationship between the real exchange rate of the dollar against the euro and the interest rate differentials between the US and the Euro Area. Otherwise, the uncovered interest rate parity theory will be practically useless in explaining the fluctuations of the EUR / USD exchange rate, and cannot be used for the purposes of forecasting and policies analysis. For this purpose, in this part of the study, we will examine the reliability of the UIP theory in explaining the fluctuations of the real dollar-euro exchange rate for the period 1999 (Q1)-2019 (Q4), using the plots below that shows the development of both the real dollar-euro exchange rate (RER) and the real interest rate differential between US and Euro area (INT).

Fig.1. Quarterly Evolution for RER and INT for the Period 1999-2019



Source: Author's Calculations Based on OECD-Statistics

With the naked eye, it can easily be seen that real interest rate differentials between the US and the euro zone fluctuate in a wide range compared to the quarterly fluctuations in the dollar-euro exchange rate over the total period. Therefore, it is difficult to determine the nature of the relationship between RER and INT, and it is difficult to make a definitive decision on the validity of the theory or not. For this, it is necessary to address this relationship in a phased manner and in more detail. Since the formation of the euro-dollar pair, following the official launch of the European single currency (Euro) on January 1, 1999 until the end of 2019, we can distinguish between tow main periods in the history of the development of the relationship between the real euro-dollar exchange rate and real interest rate differences between the US and the euro area, interspersed with important structural breakpoints that we must stop at.

4.1. The Period Before the Financial Crisis of 2008

In general, the pre-financial crisis period of 2008 was marked by an increase in the value of the euro (the high appreciation of the euro against the dollar), except for the period 1999-2002, and it was also characterized by high real interest rates in both the US and the euro area. What distinguishes this period is that the real interest rate differentials were positive most of the time and in favor of the US compared to the euro area. However, this difference decreased by a large percentage from the beginning of the period until the year 2008, with a quarterly frequency, INT decreased by 141.98% during the period 1999 (Q1)-2008 (Q2). On the contrary, the dollar lost about 31.55% of its value against the euro during the period 1999 (Q1)-2008 (Q2), which means that there is a positive relationship between INT and RER. Thus, we conclude that the UIPT holds. However, the relationship between INT and RER was not on the same pattern during this period, so that:

4.1.1. The First Period (1999-2002):

The most important feature of this stage is that the EUR / USD exchange rate has been trading above the psychological level at level 1.0000 in the forex market since 1999 (Q1) until 2000 (Q1), and then the exchange rate of this pair began to decline below the level of purchasing power parity until 2002 (Q2). As for interest rates, they were always in favor of the US during this period, however real interest rate differentials gradually decreased from 1999 (Q3) to 2002 (Q3). These historical values for both the exchange rate and the interest rate require more scrutiny from us and more detail in order to reveal whether there is any deviation from the interest rate parity condition. For the first sub-period 1999 (Q1)-1999 (Q3), the euro started rising against the dollar from its first issuance in January 1999 until the third quarter of the same year. On the other hand, while interest rates in the euro area were gradually declining since 1999 (Q1), interest rates in the US were tending to rise significantly until 1999 (Q3). In numeric terms, despite the increase in INT by 7.95% (real interest rates in the US are greater than the real interest rates in the euro area), the value of the dollar rose against the euro almost at the same rate as the decrease in INT (i.e. by about 7.16%). This inverse relationship between RER and INT implicit indicates that the theory did not hold during this short period 1999 (Q1)-1999 (Q3). As for the period 1999 (Q3)-2002 (Q2), the real dollar / euro exchange rate and real interest rate differentials both decreased by 12.84% and 69.46%, respectively. This similar behavior of RER and INT suggests that the UIP theory holds during this period.

4.1.2. The Second Period (2000-2008):

What distinguished this period was the high appreciation of the euro against the dollar and other international currencies in general. This period was also characterized by the return of the euro-dollar exchange rate to trading above the psychological level at level 1.0000 since 2002 (Q3) and taking an upward trend until 2008 (Q2). With a numerical and reverse suspension, the real dollar-euro exchange rate moved from 0.96 in 2002 (Q2) to an all-time high of 1.57 in 2008Q2, meaning that the dollar lost about 63.54% of its value against the euro during this period. As for the real interest rate differential, after it was positive at 1.977% in 2002 (Q2) in favor of the US, it took a downward trend to become negative in favor of the euro area and reached its lowest level ever at -2.517 in 2008 (Q2), meaning that INT decreased by about 227.33% during this sub-period. However, Figure 3 clearly shows that the plot of the real interest rate differential during this period was not of the same pattern, and that its path includes a mixture of upward and downward movements. For this reason, it can be concluded in principle that there is a shift in the nature of the relationship between the exchange rate and the interest rate, which means that there is a deviation of the theory of interest rate parity at a certain point in time. For the period from 2002 (Q2) to 2005 (Q4), we can notice a positive correlation between RER and INT, and that RER appreciation of 26.46% coincided with the increase in INT by 100.35%. This positive relationship provides sufficient evidence that the UIP theory holds during this period. n contrast to the previous period, statistics for the period from 2005 (Q4) to 2008 (Q2) indicate that there is a negative relationship between RER and INT. While RER rose by about 28.55%, INT decreased by about 147.65%, which means that the interest rate differential did not explain the dollar’s decline against the euro during the period, and (i.e. UIP did not hold).

4.2. The Period After the Financial Crisis of 2008

As for the post-financial crisis period of 2008, it was generally characterized by the appreciation of the dollar against the euro, which can be translated by the decline in the real dollar-euro exchange rate by 31.36% during the period 2008 (Q2) – 2019 (Q4). This period also witnessed many governments and central banks in the major industrialized countries to take a set of financial and monetary procedures with the aim of stimulating their economic activities and getting out of the economic downturn caused by the financial crisis. On the part of monetary policy, both the US Federal Reserve and the European Central Bank have prepared a package of monetary procedures for this purpose, perhaps the most important of which is the adoption of low interest rate policies (the zero interest rate policy ZIRP, and the negative interest rate policy NIRP). The post-financial crisis portion of the interest rate differential plot [after 2008 (Q2)] clearly reflects these procedures, as for the statistics, they indicate that INT decreased by 48.35%, which means that INT explains the rise of the dollar against the euro during these Period (i.e. UIP holds). Given the large fluctuations in the interest rate compared to the exchange rate, it is certain that the no-arbitrage condition assumed by the UIP theory will not always be fulfilled, at least in some periods after the financial crisis. Therefore, we will examine the reliability of the UIP theory according to the following sub-periods:

4.2.1. The First Period 2008 (Q2) – 2010 (Q2):

RER and INT both decreased by 17.68% and 155.71% respectively, which confirms the plausibility of the theory in explaining the dollar's rise against the euro during this period.

4.2.2. The Second Period 2010 (Q2) – 2011 (Q3)

As for this period, the statistics indicate that there is a negative association between RER and INT. While RER increased by 9.72%, INT decreased by 206.85%, which is evidence of the lack of credibility of the theory during this period.

4.2.3. The Third Period 2011 (Q3)-2012 (Q4)

Unlike the previous period, the historical data for this period indicate a positive relationship between RER and INT. Both RER and INT decreased by about .58% and 258.45%, respectively, which means that the non-arbitrage mechanism works during this period.

4.2.4. The Fourth Period 2012 (Q4)-2019 (Q4)

During this period, we notice that the exchange rate and the interest rate exhibit the same behavior, so that each of them decreased by 18.65% and 154.75%, respectively. This symmetric behavior suggests that the UIPT holds.

As a general conclusion, the above analysis confirms that there is no uniform pattern in the path of the relationship between the real dollar-euro exchange rate and the real interest rate differential between the US and the region. In other words, the analysis indicates the existence of some structural breakpoints in the path of the positive relationship between the exchange rate and the interest rate differential, which means that there are some deviations from the interest rate parity condition in certain time periods.

5. Data and Methodology

5.1. Data

This study uses quarterly time series data for real exchange rate, real short-term interest rate differential between US and EA and money supply differential between US and EA for the period of 1999 (Q1) to 2019 (Q4). These three variables are measured as follows:

- The real euro-dollar exchange rate is calculated based on the theoretical proposition of absolute purchasing power parity, according to the following formula:

$$RER_t = NEX_t(HICP_t/CPI_t) \dots\dots\dots\dots\dots (13)$$

Where RER_t, NEX_t. $HICP_t$, and CPI_t denote the real exchange rate, the nominal exchange rate dollar /euro (in terms of dollar per euro), the harmonised index of consumer prices of the EA, and the consumer price index of the U.S, in the quarter (t) respectively.

- INT is calculated as the difference between short-term interest rate in US , divided by US CPI and short-term interest rate in Euro area divided by the harmonized CPI of EA. This ratio takes the following formula:

$$INT = (\text{nominal interest rate}_{US} / CPI) - (\text{nominal interest rate}_{EA} / HICP) \dots (14)$$

Where the nominal interest rate refers to the short-term interest rate (Three-month interest rate) in US and EA.

- The money aggregate differential is measured as the value of narrow money supply (M1) in US divided by the value of narrow money supply (M1) in Euro area after normalizing in the same currency (Euros have been converted into dollars using the nominal euro-dollar exchange rate). This ratio is expressed in the following formula:

$$MS = (M1_{US} / M1_{EA}) \dots\dots\dots\dots\dots (15)$$

The data on nominal euro-dollar exchange rate, nominal short-term interest rates, HICP,, CPI, $M1_{US}$, and $M1_{EA}$ are collected from OECD Statistics (*OECD stat*).

5.2. Research Methodology

Uncovered interest rate parity (UIP) predicts that high yield currencies should be expected to depreciate. It also predicts that, a real interest rate increase should appreciate the currency. The primary objective of this study is to verify the credibility and sustainability of the uncovered interest rate parity theory in the interpretation of fluctuations in the euro-dollar exchange rate. To this end, we will follow the following steps:

5.2.1. Model Specification

The theoretical foundation of the effects of changes in interest rates on exchange rates is associated with the uncovered interest rate parity theory (UIP) theory. Therefore, our empirical analysis to test the sustainability of the uncovered interest rate parity theory in explaining the fluctuations of the euro-dollar exchange rate is based on the content of the UIPT and the assumptions based on it. In light of this, the basic relationship of uncovered interest rate parity can be translated into the linear regression model that takes the following formula:

$$RER_t = \beta_0 + \beta_1 INT_t + \beta_2 MS_t + \varepsilon_t \dots\dots\dots\dots\dots\dots (16)$$

Where RER denotes the real euro-dollar exchange rate, INT refers to the real short-term interest rate differential between the US and the euro area, another control variable MS was added to the model, in which indicates the money aggregate differential between the US and the euro area, and ε_t is the stochastic term.

5.2.2. Unit Root Test:

When dealing with models that use time series data, it is important to perform unit root tests in order to check the properties of data, in order to avoid falling into the spurious regression that was reported by Granger & Newbold (1974) and Gujarati (2011). In fact, there are many unit root tests that are used in applied studies, both economic and financial. Notable among them are the Dickey-Fuller (DF) test (1979), the Dickey-Fuller (ADF) test (1981), the Phillips-Perron (PP) test (1988), the Kwiatkowsk-Phillips-Schmidt-Shin (KPSS) test (1992) and the Generalized Least Squares Dickey-Fuller (DF-GLS) test (1996). However, the current study is limited to the (ADF) and (PP) tests only in order to test the stationarity of time series used in this study, and to determine the order of integration of the studied variables. Both tests examine the null hypothesis that the time series contains the unit root (i.e. non-stationary).

5.2.3. ARDL Bounds Test of Cointegration

In this study, the Autoregressive Distributed Lag (ARDL) bounds test, which was developed by Pesaran et al (2001), is used to estimate the long-run and short-run relationships between the variables. The use of the ARDL model is justified by the fact that this new approach has many advantages compared to other methods of cointegration, which were introduced by Engle & Granger (1987), Johansen (1988) and Johansen & Juselius (1990). Among the most important features of this approach are the following: Among the most important features of this approach are the following:(i) It does not require unit-root pre-testing, therefore it is applicable irrespective of whether the regressors in the model are purely stationary I(0), purely non stationary I(1) or mixture of I(1) and I(0) (Narayan, 2004, pp. 6-7) (ii) The model performs better in testing for the long-run relationship in the small sample as compared to other methods (iii) The consistency and efficiency of estimates in the presence of endogenous regressors. (iv) The short-run and long-run coefficients of the model are estimated simultaneously. Therefore, this approach creates more flexibility compared to other methods of cointegration. The ARDL model based on the Unrestricted Error Correction Model (UECM) is expressed as:

$$\Delta RER = \beta_0 + \sum_{i=1}^{n} \beta_{1i}\, \Delta RER_{t-1} + \sum_{i=0}^{n} \beta_{2i}\, \Delta INT_{t-i} + \sum_{i=0}^{n} \beta_{3i}\, \Delta MS_{t-i} + \delta_1 RER_{t-1} + \delta_2 INT_{t-1} + \delta_3 MS_{t-1} + \varphi ECT_{t-1} + \varepsilon_1 \dots\dots\dots\dots\dots (17)$$

Where, Δ is the first difference operator, β_0 the drift component, and ε_1 is the error term that should be white noise. The coefficients (δ_1- δ_3) represent the long-run relationship whereas the remaining expressions with summation sign, (β_{1i}-β_{8i}) represent the short-run dynamics of the model, φ is the coefficient that measures the speed of adjustment to the equilibrium, and ECT denotes the residual obtained from estimated cointegration in equation.

According to the theoretical foundation, ceteris paribus, uncovered interest rate parity (UIP) predicts that high yield currencies should be expected to depreciate. In other words, the no-arbitrage condition requires a positive relationship between the real exchange rate and the interest rate differentials between the US and the euro area (Bekaert et al, 2007, p. 1038). Hence, we expect the coefficient of interest rate differential to take a positive sign (i.e. β_1>0). Likewise, we expect that the increase US money supply over euro area money supply will lead to a decrease in the value of the dollar against the euro (I.e., β_2>0).

To reveal the existence of long-run relationships among the RER, INT, and MS, bound testing under Pesaran et al (2001) procedure is used. The bound testing procedure is based on the Wald-test (F-statistic). The F-test is actually a test of the hypothesis of no co-integration among the variables against the existence of co-integration among the variables, denoted as:

$$H_0:\delta_1=\delta_2\ldots\ldots=\delta_8=0\ldots\ldots(18)$$

i.e., there is no co-integration among the variables.

$$H_1:\ \delta_1\neq\delta_2\ldots\ldots\neq\delta_8=0\ldots\ldots(19)$$

i.e., there is co-integration among the variables.

In the ARDL bounds test, the estimated F-statistics value is compared with the two sets of critical values of the upper- and lower-bounds. This two critical values are given by Pesaran et al. (2001) for the cointegration test. We accept the null hypothesis when F-statistics is less than the critical value for I(0) regressors and we reject null hypothesis when F-statistics is greater than critical value for I(1) regressors (Narayan, 2005, p. 1981). Whereas, if the F-statistics falls between these two sets of critical values, the result is inconclusive. The next step is to estimate the long-run and short-run coefficients of the same equation by using the the error correction model (ECM). We run this step only if we find a cointegration relationship among variables under study. This step determines the appropriate lag lengths for the independent variables. To ensure the convergence to the long-run equilibrium, the sign for the coefficient of the lagged error correction term (ECT_{t-1}) must be negative and statistically significant.

5.2.4. Diagnostic Test and Stability Tests

The study runs diagnostic tests to verify if the results of the model are reliable and efficient. The time series models have to satisfy the assumption of classical linear regression model. The tests of serial correlation (Breusch–Godfrey serial correlation LM test), normality test (Jarque-Bera), misspecification (Ramsey RESET Test) and heteroskedasticity test (ARCH test) are done. The diagnostic tests are performed in order to determine if the assumptions are not violated.

5.2.5. Causality Analysis

According to Granger (1988), if there is a long-run relationship between two variables, then there must be at least one-way causality between these two variants. Given that there exists a cointegral relationship between the real dollar / euro exchange rate (RER) and the real interest rate differences (INT), a bivariate Granger-causality model of the following form can be specified for testing causality between (RER) and (INT):.

$$\Delta RER = \alpha_0 + \sum_{i=1}^{p} \lambda_{1i} \Delta RER_{t-1} + \sum_{i=1}^{q} \lambda_{1i} \Delta INT_{t-1} + \varphi_1 ECT_{t-1} + \varepsilon_{1t} \ldots (20)$$

$$\Delta INT = \alpha_1 + \sum_{i=1}^{p} \lambda_{2i} \Delta INT_{t-1} + \sum_{i=1}^{q} \lambda_{2i} \Delta RER_{t-1} + \varphi_2 ECT_{t-1} + \varepsilon_{2t} \ldots\ldots (21)$$

where it is assumed that both ε_{1t} and ε_{2t} are uncorrelated white-noise error terms, and RER_t and INT_t are integrated of order 1, ECT_{t-1} is one period lagged error-correction term in the cointegral relationship and Δ represents the first difference to examine the short-run dynamic. The ECM is an important model that distinguishes the short- and long-run Granger causalities. The lag of the individual coefficients is utilized to test the significance of the short-run relationship. Furthermore, the coefficient of ECT_{t-1} is statistically significant and indicates long-run causality. Jointly-lagged coefficients and the ECT are used to verify joint causality between the variables.

6. Empirical Results and Discussion

6.1. Description of Study Variables

Table 1. Descriptive Summary of Data

	Mean	Std. Dev	Skewness	Kurtosis	Observation
RER	1.218414	0.160466	-0.141037	2.196303	84
INT	0.004915	0.016522	0.322604	2.046819	84
MS	0.391628	0.102082	0.602433	2.553239	84

Source: Author Estimations Using Eviews 9

Table (01) presents the descriptive statistics of the quarterly data for the variables used. As Table (01) shows, RER has the largest mean and the higher volatility. While INT has the smallest mean and less volatility compared to other variables. Moreover, from the first quarter of 1999 to the fourth quarter of 2019, the RER decreased by 28.47%, and likewise the INT decreased by 116.27%. Hence, we can conclude that UIP theory succeeds in explaining RER variation.

6.2. Unit Root Test

To determine the appropriate specification for the Autoregressive Distributed Lag (ARDL) model, the variables must be tested for the stationary process. The presence of non-stationary behavior in the autoregressive representation of the variable, i.e. the order of integration for each variable is determined using the Augmented Dickey-Fuller (ADF) and the Philip-Perron (PP) unit root tests.

Table 2. ADF and PP Tests for Unit Root

	ADF test		PP test	
	Intercept	**Intercept-trend**	**Intercept**	**Intercept-trend**
RER(I_0)	-1.9566 (0.3053)	-1.4287 (0.8451)	-1.2403 (0.6536)	-1.1241 (0.9183)
RER(I_1)	6.1786 ^{s} -(0.0000)	6.2178 ^{s} -(0.0000)	6.1513 ^{s} -(0.0000)	6.1369 ^{s} -(0.0000)
INT(I_0)	4.1741 ^{s} -(0.0013)	4.2487 ^{s} -(0.0060)	-2.2581 (0.1880)	-2.2126 (0.4762)
INT(I_1)	4.0781 ^{s} -(0.0018)	4.2561 ^{s} -(0.0059)	3.5613 ^{s} -(0.0087)	-3.7039 (0.0276)
MS(I_0)	-3.3897 (0.0143)	-0.8742 (0.9535)	-1.5598 (0.4985)	-1.0313 (0.9334)
MS(I_1)	7.4328 ^{s} -(0.0000)	7.6653 ^{s} -(0.0000)	7.5224 ^{s} -(0.0000)	7.6993 ^{s} -(0.0000)
Note: Critical value at the 1% significance level denoted by superscript 's', with intercept and intercept-trend				

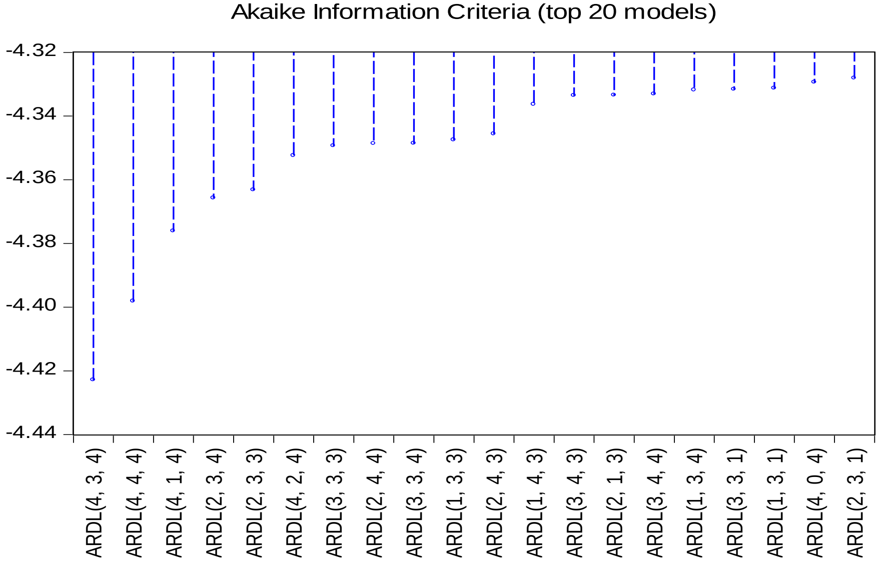
Source: Computed by Author Using Eviews 9

Table (02), above, provides the results of the ADF and PP tests for the three key variables. The results of the ADF tests reveal that INT is stationary at level, while RER and MS are non stationary at level, but they become stationary at the first difference. As for the results of the PP test, it indicates that all variables are stationary at the first difference, at the 1% significance level. Although there is a difference between the results of PP and ADF on the order of integration of INT, their results agree that none of the three variables is integrated at I(2), this implies that we can confidently apply the ARDL methodology for our model.

6.3. Cointegration Test of Pesaran et al. (2001)

Before applying ARDL model it is necessary to determine the optimal lag length of variables of the study. Akaike Information Criterion (AIC) and Schwarz Bayesian Criterion (SBC) are two famous methods to select best lags for variables. In this study, we used AIC for lags selection;

Fig.2. Choosing the Optimal ARDL Model



Source: Author Computations Using Eviews 9

Figure (02) indicates the result of lag selection criteria for Autoregressive distributed lag (ARDL) model. In fact, Akaike information criteria is based on implementation of 20 different ARDL models. The optimum model selection is based on the lowest value of AIC. In this study, it is evident that the ARDL(2, 4, 0, 4) model gives the lowest values for AIC. Hence, it is the optimal model out of 20 selected models.

Table 3. ARDL Bound Test for Cointegration

k	Calculated F-statistic	10% LB	10% UB	5% LB	5% UB	1% LB	1% UB
2	3.984517	2.63	3.35	3.1	3.87	4.13	5

Source: Author Computations Using Eviews 9

As seen in Table (03), the computed F-statistic = 3.98 is greater than the upper bound critical value 3.87 at the 5 percent level. The results over the period of 1999Q1 to 2019Q4 suggest that there is a long run relationship among the variables and the null hypothesis of no cointegration rejected.

6.4. Long-Run and Short-Run Relationship

The error correction model reflects the measurement of the short-term relationship, on the one hand, and the measurement of adjustment speed to rebalance the dynamic model on the other. As we can see in table (04) below, the adjustment coefficient or restoring force is statistically significant at 1% level, it is negative and it is between 0 and 1 in absolute value, which guarantees an error correction mechanism , and therefore the existence of a long-term relationship (cointegration) between variables.

Table 4. Equilibrium Correction Form of the ARDL(4, 3, 4) UIP Equation

Dependent Variable: D(RER)			
short-run Coefficients			
Variable	Coefficient	t-Statistic	Prob.
D(RER(-1))	0.209899**	2.030959	0.0463
D(RER(-2))	0.097811	0.930343	0.3556
D(RER(-3))	-0.286155***	-2.882092	0.0053
D(INT)	-1.735080	-1.626911	0.1085
D(INT(-1))	-2.444397*	-1.765088	0.0822
D(INT(-2))	2.998367***	2.853595	0.0058
D(MS)	-2.015234***	-11.565617	0.0000
D(MS(-1))	0.506154*	1.863547	0.0668
D(MS(-2))	0.516505*	1.955886	0.0547
D(MS(-3))	-0.821802***	-3.094096	0.0029
ECT(-1)	-0.117520***	-4.081976	0.0001
Long-run Coefficients			
INT	-5.725804**	-2.096643	0.0399
MS	-1.821930***	-4.880971	0.0000
C	1.911054***	14.297722	0.0000
R^2 =98.11%, Adj R^2 = 97.73%, S.E= 0.024497, SSR=0.039607, F-stat=263.5086, Prob(F-stat) =0.000000,DW=1.968771			
Notes: (*)Significant at the 10%; (**)Significant at the 5%; (***) Significant at the 1%.			

Source: Author Computations Using Eviews 9

As can be seen in table (04), the results of descriptive statistics indicate that R square indicates 98.11% variation in real Dollar/Euro exchange rates is explained by the independent variables of the study. Durbin Watson value is 1.96 which indicates that there is no problem of autocorrelation in the data. F statistics value is 263.5086 and Prob (F-stat) =0.000000 which indicates that the model is fit or the ARDL model is statistically significant at the 1% level of significance.

The results shown at the top of table (04) indicate the results for the short-term parameters. The first thing that can be observed is that the error correction coefficient (-0.117520) is negative and statistically significant at the 1 percent level of significance. This value denotes that about 11.75% of disequilibrium in the real Dollar-Euro exchange rate in the previous quarter is corrected and adjusted in the current quarter. In other words, the error correction term suggests that real Dollar-Euro exchange rate apparently converges to the equilibrium long-run level by roughly 11.75% adjustment speed on a quarterly basis via the changes in the real interest rates (INT) and the money aggregate differential (MS).

The coefficients of the ARDL short run showed that real Dollar-Euro exchange rate is positively and negatively influenced by its own values with 1 and 3 lags, respectively. As for the differences in real interest rates (INT), the results showed that there is a positive relationship between the real dollar-euro exchange rate (RER), and the difference in real interest rates (INT), and that the increase in the latter by 1 percent leads to an increase in the real dollar-euro exchange rate by about 2.99 percent (due to the slow price adjustments, the positive effect was achieved after three lags). In other words, the increase in real interest rates in the US by 1 percentage points over the real interest rates in the euro area led to a decrease in the value of the dollar against the euro by about 2.99%. This result clearly indicates that the no-arbitrage condition is met in the short horizon, and that investors in the euro area are indifferent to the rise in real interest rates in the US. This means that the uncovered interest rate parity (UIP) holds in the short horizon.

As for the long-term coefficients, they were contrary to what is expected for both the interest rate differential and the money supply differential. The negatively significant coefficient of the INT imply that the INT cause the UIP to deviate and make the parity worse. In other words, the UIP model isn't supported in the long-term because during the adjustment process, the real exchange rate is inversely dependent on the differential real interest rates. This result indicates that there are controls imposed on the transfer of capital. Governments sometimes restrict the import and export of money through taxes or outright bans. In our case, the non-depreciation of the dollar's exchange rate against the euro (UIP failed) can be justified through the restriction practiced by the US government on the flow of capital to and from the US, especially the exit of capital. On the other hand, the economic reality indicates that the flow of capital to the US often coincides with a strict fiscal policy to avoid overheating the American economy.

As for the money supply differential results revealed a negative relationship between the real dollar-euro exchange rate and money supply differential ,in the short and long term, and that an increase in the money supply by 1 percentage point increased the value of the dollar against the euro (or RER decrease) in the short and long term by about 2.01% and 1.82%, respectively. This result contradicts the theoretical proposition of the monetary model, which states that an increase in the money supply leads to a decrease in the value of the local currency against the foreign currency. This result can be justified by one of the following scenarios: (i) In a contractionary growth environment, an increase in the US money supply may support the dollar against the euro. An increase in the rate of money supply growth leads to a rise in domestic interest rates, which will encourage the flow of capital to the US. If there are some restrictions practiced on the exit of capital, the increase in the flow of capital leads to an increase in the demand for dollars, and then the dollar will rise. (ii) These results may be explained by the rapid movement of large sums of money from the euro zone towards the US. This is due to several possible reasons - loss of confidence in the euro area economy and / or its "euro" currency (and thus the valuation of European assets), and concerns about imposing capital controls, not to mention the economic shocks that hit the euro area, especially in the post-financial crisis period (2008). (iii) If the financial assets in the two blocks were almost perfect substitutes, this would reduce the elasticity of capital to interest rate changes. In this situation, the rise of the dollar is only due to the increase in domestic demand.

Table 5. Diagnostic Tests for the Estimated ARDL Model

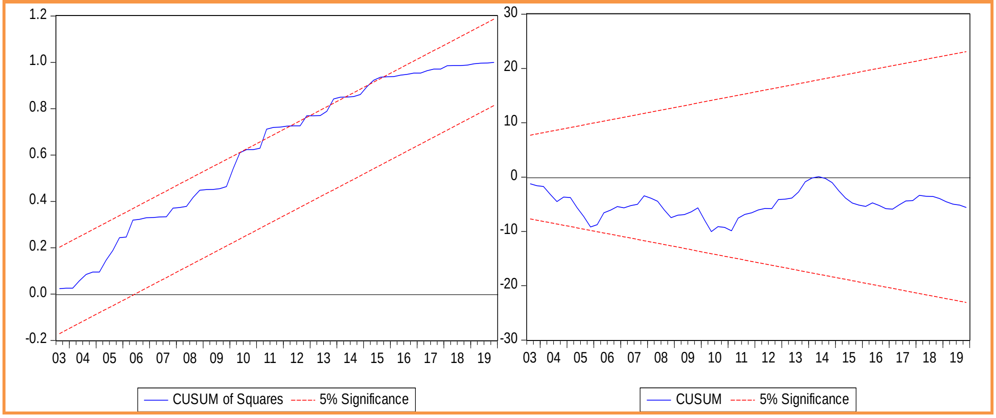
Test	Statistic	Value	Prob
Serial correlation	x^2- [1]:	0.058686	0.8278
Heteroscedasticity	x^2- [1]:	10.98782	0.6118
Misspecification	F-stat [1]:	0.244385	0.6227
Normality	Jarque-Bera stat	2.342551	0.309971

Source: Author Computations Using Eviews 9

Table (05) also provides the residual-based diagnostic tests. Based on the results of the Breusch-Godfrey Lagrange multiplier test for serial correlation at lag 1 and the Breusch-Pagan-Godfrey test for heteroscedasticity at lag 1, the null hypothesis cannot be rejected at 5% significant level. Therefore, we strongly conclude that there is no evidence of serial correlation and heteroscedasticity. The result based on the Ramsey's regression specification error test (RESET) test at lag 1 indicates that the functional form of the model is correct and well-specified, while the Jarque-Bera test indicates that the estimation errors are normally distributed. In addition, the plots of cumulative sum (CUSUM) and cumulative sum of squares (CUSUMSQ) in Figure (3) provide that the model parameters are stable as the CUSUM and CUSUMSQ lie within the 5% critical bounds.

Fig.3. Plots of CUSUM and CUSUMSQ Statistics

Plot of CUSUM test	*Plot of CUSUMSQ test*



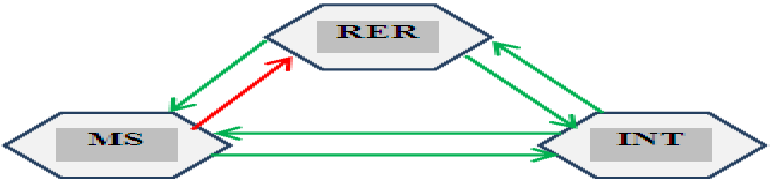
Source: Author Computations Using Eviews 9

6.5. Granger Causality Test Results

This part of the study presents the results of estimating the Granger causality test between variables. Basically, with the purpose of revealing the causal relationship between the real interest rate differential and the real dollar-euro exchange rate, and with the purpose of verifying the robustness of our previously reached results by estimating the ARDL model. The Granger causality test is based on an estimate of Eqs. 20 and 21.

Table 6. Results of the Granger Causality Test

Null Hypothesis	Obs	F-Statistic	Prob
INT does not Granger Cause RER	81	3.63312	0.0036
RER does not Granger Cause INT		4.29108	0.0011
MS does not Granger Cause RER	81	1.26763	0.2846
RER does not Granger Cause MS		2.80863	0.0172
INT does not Granger Cause MS	81	5.43272	0.0001
MS does not Granger Cause INT		2.45028	0.0338
Fig.4. Results of Granger Causality			



- The green arrow indicates a causal relationship between the two variables..
- The arrow indicates that there is no causal relationship between the two variables.

Source: Prepared by the Author

Table (06) describes the results of the Granger causality test. The results confirm the existence of bidirectional causality between all variables at 5% level of significance, except for the causality between the real dollar-euro exchange rate (RER) and the money aggregate differential (MS), which was in one direction (unidirectional causality) from the RER towards the MS. These results strongly support the theoretical proposal for the (UIP) theory in general, and in particular support the theory's credibility in explaining the short-term fluctuations in the dollar-euro exchange rate. Also, these results were consistent with the theoretical proposition of the interrelationships between the rest of the variables.

7.Conclusion

By measurement and analysis, this paper examined the reliability of the interest rate parity theory in explaining the fluctuations of the euro-dollar exchange rate using quarterly data ranging from the first quarter of 1999 to the fourth quarter of 2019. We initially analyzed the theoretical framework of the interest rate parity hypothesis and empirically test the validity of this hypothesis using autoregressive distributed lag (ARDL) bounds testing and Granger causality test.

Our analysis of the validity of the interest rate parity theory were based on an analysis of the evolution of the relationship between the real euro-dollar exchange rate and the real interest rate differential between the US and the euro area. The analysis proved that there is no general pattern in the history of the relationship between them, which indicates that there are some deviations from the interest rates parity condition in some sub-periods. As for the standard analysis, it was based on a set of technical procedures suitable for this purpose. To this end, we performed unit root tests (ADF and PP) to determine the order of integration of the time series used in this study, and it was found that the study variables are integrated of the same order I(1), accordingly, we implemented the ARDL model . The Bounds test for cointegration proved that there is a long-term relationship between the variables of the model, which was been confirmed by the significant and negative error correction coefficient. Estimates of the coefficients of the short and long-term relationships also showed that the theory of interest rate parity holds in the short term without the long term. This was been confirmed by the results of the Granger causality test, where it was found that there is a significant causal relationship from the interest rate differential towards the euro-dollar exchange rate. However, there appears to be some restriction on the free movement of capital between the US and the euro area that makes interest rate parity fail to explain the long-term fluctuations in the euro-dollar exchange rate.

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