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Thesis Title:

FINANCIAL INTEGRATION BETWEEN THE EMU AND THE WORLD: THE CHEER APPROACH

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ABSTRACT

The purchasing power parity (PPP) and the uncovered interest parity (UIP) hypotheses are among the most important but also controversial issues in international macroeconomics. On the one hand, the PPP hypothesis postulates that exchange rates adjust to price differentials; it simply advocates that the equilibrium exchange rate of two currencies should equalize their purchasing capacity. On the other hand, the UIP hypothesis states that the expected change in the exchange rate of two currencies equals the interest rate differential of the respective countries; considers international asset markets and asserts that the exchange rate adjust to interest rate differential.

An alternative approach that is different from traditional theories of equilibrium exchange rate is known as Capital-enhanced Equilibrium Exchange Rate (CHEER), which was implemented, among others, by Juselius (1991, 1995), Johansen and Juselius (1992), Özmen and Gökcan (2004) and Giannellis and Koukouritakis (2013) Koukouritakis (2013). CHEER is actually a combination of PPP and UIP hypotheses and enables the interactions among exchange rates, prices and interest rates. The CHEER approach captures the basic Casselian view of the PPP condition, which implies that an exchange rate may be away from its PPP-determined rate because of non-zero interest rate differentials. But, unlike the PPP condition, it also indicates that the interest rates can have a medium-run, or business cycle, effect. In other words, the long-term persistence in the real exchange rate is mirrored in the interest rate differential. (MacDonald, 2000).

The aim of this thesis is to investigate the validity of the CHEER approach using four exchange rates: euro against US dollar, euro against sterling pound, euro against Japanese yen and euro against Swiss franc by using monthly data from January 1999 to present. The validity of the CHEER approach for the exchange rates under consideration can be interpreted as evidence in favor of financial integration.

ΠΕΡΙΛΗΨΗ

Οι υποθέσεις περί ισοτιμίας της αγοραστικής δύναμης (PPP) και ακάλυπτης ισοτιμίας επιτοκίων (UIP) αποτελούν από τα πιο σημαντικά αλλά ταυτόχρονα αμφιλεγόμενα ζητήματα στη διεθνή μακροοικονομική. Από τη μία πλευρά, η PPP υποθέτει ότι οι συναλλαγματικές ισοτιμίες προσαρμόζονται στις διαφορές των τιμών και υποστηρίζει ότι η συναλλαγματική ισοτιμία ισορροπίας δύο νομισμάτων θα πρέπει να εξισώσει την ικανότητα της αγοράς τους. Από την άλλη πλευρά, η υπόθεση UIP αναφέρει ότι η αναμενόμενη αλλαγή της ισοτιμίας δύο νομισμάτων ισούται με τη διαφορά των επιτοκίων των αντίστοιχων χωρών, ισχυρίζεται ότι η συναλλαγματική ισοτιμία προσαρμόζεται στην διαφορά των επιτοκίων.

Μια εναλλακτική προσέγγιση, η οποία διαφέρει από τις παραδοσιακές θεωρίες συναλλαγματικών ισοτιμιών ισορροπίας είναι γνωστή ως Capital-Enhanced Equilibrium Exchange Rate (CHEER), η οποία τέθηκε σε εφαρμογή, μεταξύ άλλων, από Juselius (1991, 1995), Johansen και Juselius (1992), Ozmen και Gökcan (2004), Giannellis και Koukouritakis (2013) και Koukouritakis (2013). Το CHEER είναι στην πραγματικότητα ένας συνδυασμός των PPP και η UIP που επιτρέπει τις αλληλεπιδράσεις μεταξύ των συναλλαγματικών ισοτιμιών, των τιμών και των επιτοκίων.

Σκοπός αυτής της εργασίας είναι να διερευνήσει την εγκυρότητα της προσέγγισης CHEER για τέσσερις συναλλαγματικές ισοτιμίες: ευρώ έναντι του δολαρίου ΗΠΑ, του ευρώ έναντι της στερλίνας, ευρώ έναντι γιεν και του ευρώ έναντι του ελβετικού φράγκου, χρησιμοποιώντας μηνιαία στοιχεία από τον Ιανουάριο 1999 έως σήμερα. Η εγκυρότητα της προσέγγισης CHEER για τις συναλλαγματικές ισοτιμίες υπό εξέταση μπορεί να ερμηνευθεί ως απόδειξη υπέρ της χρηματοπιστωτικής ολοκλήρωσης.

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ABBREVIATIONS

ADF	Augmented Dickey Fuller
AIC	Akaike Information Criterion
BEER	Behavioral Equilibrium Exchange Rate
CHEER	Capital-enhanced Equilibrium Exchange Rate
DEER	Desired Equilibrium Exchange Rate
EMU	European Monetary Union
FEER	Fundamental Equilibrium Exchange Rate
FLMA	Flexible Price Monetary Approach
JMN	Johansen Mosconi and Nielsen test
KPSS	Kwiatkowski Phillips Schmidt Shin
NATREX	Natural Real Exchange Rate
PEER	Permanent Equilibrium Exchange Rate
PPP	Purchasing Power Parity
RID	Real Interest Differentials
SIC	Schwarz Information Criterion
SPMA	Sticky Price Monetary Approach
UIP	Uncovered Interest Parity
UK	United Kingdom
USA	United States of America
VECM	Vector Error Correction Model

CONTENTS

INTRODUCTION

Exchange rates are ubiquitous, as it seems like that whatever the subject under discussion, the answer turns out to revolve around exchange rates. This is much the case in the present environment of deregulation and globalization of financial markets. For this reason exchange rate fluctuations take a central place in the discussions over a simple planning of vacation of an individual to the outlook of an economy, the choices of economic policies and even stock markets. The exchange rate is important and can affect in plausible different ways the everyday life of an individual, a business, a country or the relationship between countries.

The history of exchange rate regime is reach. After World War II, economic policy focused on the reconstruction of world's economies. In this sense a policy system of fixed exchange rates introduced known as Bretton Woods system (1944-1968) (Copeland 2000, p. 29-30). Countries were expected to keep their exchange rates against the dollar within narrow margins, plus or minus 1%, and the United States assured convertibility of the dollar into gold at a fixed rate of $35 per ounce. Bretton Woods system served two purposes first to not only stabilize materially defined purchasing power parities and secondly to sustain socially defined inferences regarding cooperation (Widmaier 2014, p. 240). As a system was characterized by a significant expansion of international trade and investment as well as a notable macroeconomic performance, that combined low inflation rate than the floating exchange period that followed, a higher real per capita income growth comparing with the one existed before Bretton Woods and low interest rates. The expanded use of the dollar as an international currency, the great increase in the degree of economic interdependence among nations and comparative rigidity of parity rates that developed in actual practice led to the breakdown of Bretton Woods (1968-1973) (Garber 1991).

The breakdown of Bretton Woods system followed a floating rate era. This international monetary system is highly flexible in nature compared with Bretton Woods, as it can adapt to the different economic conditions and policy preferences of individual countries. Now, flexible exchange rates move quickly to reflect concerns about monetary policy credibility. The post-1973 period has been influenced by a significant number of technological innovations that have lowered communication and transportation costs, successive rounds of trade liberalization and the inclusion of former communist countries into the world trading and financial system. This period has been characterized by an intensification of economic globalization. The belief that floating exchange rates regime is better than fixed has been questioned especially after the formation of European Monetary Union (EMU), the rise of emerging market economies and the recent global economic crisis (James *et al*. 2012, p. 139).

Technological developments have made the interactions between countries easier. This interaction appears with a higher degree of capital movement and the increased openness to international trade. The current situation led countries more vulnerable to real monetary shocks. Moreover the degree of integration of financial markets around the world increased significantly after the 1980s. A key factor underlying this process has been the increased globalization of investments, seeking higher rates of return and the opportunity to diversify risk internationally (Agenor 2003, p.3). Financial integration can be defined as the market for a given set of financial instruments and services fully integrated if all potential market participants have the same relevant characteristics. These characteristics are described as followed; it is independent of the financial structures within regions, frictions in the process of intermediation can persist after financial integration is completed and definition of financial integration separates the two constituents of a financial market, namely the supply of and the demand for investment opportunities (Baele et al. 2004). Or as Brouwer (2005) stated financial market integration is the process through which financial markets in an economy become more closely integrated with those in other economies or with those in the rest of the world. As exchange rates interconnect two countries' currencies in a direct way, the investigation of financial integration can be identified as the tendency of the economies to meet their equilibrium point.

Exchange rate fluctuations tend to induce macroeconomic phenomena that are undesirable by affecting other macroeconomic variables, as for example the stability of interest rates and the level of inflation. For this reason the concern regarding exchange rates, interest rates and inflation is great. The macroeconomic structure, defined by the capital mobility and the speed of price adjustments, determines interest rates, exchange rates and inflation effects after a macroeconomic disturbance. Moreover policy makers influence the degree to which interest rates, exchange rates and inflation adjust to the disturbance that appear in the economy. Financial integration has been a matter of great concern over the last decades.

Since the breakdown of the Bretton Woods system of fixed exchange rates, forecasting currency values has become crucial for many purposes such as international comparisons of incomes, earnings and the costs of living by international agencies, the alignment of exchange rates by governments, and corporate financial decision making. Equilibrium exchange rate is important for policy makers and also for the reform of international monetary system. But even more today the fall of the euro’s external value, the appreciated value of sterling, US dollar, Swiss franc and the depreciation of the Japanese yen has renewed the interest in the equilibrium exchange rates. The question of which variables are the ones that determine the vale of exchange rate remains unsettled. There were various attempts to predict the future exchange rate, but even today there is no agreement on the classification of the models used for predicting the exchange rates. So over time a number of different methods have been developed in order to construct an equilibrium exchange rate, every model is followed by its own advantages and disadvantages. Although there is a plethora of different approaches there is no model that can be characterized as the best forecasting technique. As Verrier (1989) argued the method that a researcher chooses must depend on the time horizon selected or the purpose of his investigation.

The present thesis aims to investigate the validity of the CHEER approach for four exchange rates: euro against US dollar, euro against UK pound, euro against Japanese yen and euro against Swiss franc by using monthly data from January 1999 to present. The validity of the CHEER approach for the exchange rates under consideration is used as evidence in favor of financial integration. Financial integration can be examined under the veil of exchange rates as besides unanticipated disturbances; future exchange rate instability is not expected to be high if exchange rates are not significantly away from their equilibrium rates. On the other hand exchange rate misalignment from equilibrium could still be a case. This means that it is volatile in the future in its attempt to move close to its equilibrium rate. This volatility corresponds to short-run fluctuations of the exchange rate around its long-run trend (Giannelis & Koukouritakis 2011, p. 556).

The novelty of this thesis lies on the following issues. First, it uses the most recent data from the 1st of January 1999, (when the euro was first introduced), to the mid of 2015, in order to test the validity of CHEER approach for USA, UK, Japan and Switzerland. The European Monetary Union is used as a bench mark country. The motivation to study these countries arises from the fact that while these models have been tested for the UK, Latin American, Visegrad or Asian countries there is not a study focusing on the examination of CHEER for different countries around the world after the launch of euro. Moreover the results may also provide an important theoretical basis in the designing of financial stabilization policies; as far as these concepts play a major role in the choice between interest rates, inflation or exchange rate targeting in monetary targeting.

A key contribution of this study is to build on the existing literature by extending the scope of investigation into the USA, UK, Japan and Switzerland by using jointly PPP and UIP hypotheses as introduced by Juselius (1991), Johansen and Juselius (1992) (later named CHEER approach by MacDonald (2000)). CHEER approach as it is an alternative approach, different from traditional theories of equilibrium exchange rate that enables the interactions among exchange rates, prices and interest rates. Testing the PPP and UIP theorems has been prolific; the empirical validity of both concepts as models of exchange rate movements remains very controversial. The CHEER approach captures the basic Casselian view of the PPP condition, which implies that an exchange rate may be away from its PPP determined rate because of non-zero interest rate differentials. But, unlike the PPP condition, it also indicates that the interest rates can have a medium-run, or business cycle, effect. In other words, the long-term persistence in the real exchange rate is mirrored in the interest rate differential (MacDonald 2000, p. 18).

This thesis employs techniques that are valid in the presence of structural breaks, as the presence of structural breaks in the data is known to have significant effects on the properties and interpretation of standard unit root and cointegration tests. For this reason, it employs Augmented Dickey Fuller (ADF) and Kwiatkowski, Phillips, Schmidt and Shin (KPSS) tests in order to test for unit roots. The JMN cointegration test, which was introduced by Johansen, Mosconi and Nielsen (2000), is used for testing the CHEER approach in the presence of structural break in the data. The JMN cointegration test was used in order to establish an equilibrium relationship between the nominal euro exchange rate in relation to the currencies of the USA, UK, Japan and Switzerland and the fundamental variables that defined by CHEER model of exchange rate determination, prices and interest rates. As a default measure for prices was used the Harmonized Consumer Price Index (HCPI) for the EMU and the Consumer Price Index (CPI) for all four countries. For interest rates it was used by the 10-year government bond yields for all countries and the EMU as well.

In short, the empirical evidence of this thesis illustrates that the CHEER approach is not valid for any of the countries under examination. The evidence also shows that in each of the countries, namely the USA, UK, Japan, and Switzerland exist plausible economic relationships between the nominal exchange rate and each of the price and interest rate differentials.

The remainder of this thesis is organized as follows; Unit 1 presents a brief overview of some of the most popular equilibrium exchange rate determination models. It includes an overview of the following models; Purchasing Power Parity (PPP), Uncovered Interest Rate Parity (UIP), monetary approaches, portfolio balance model, fundamental equilibrium exchange rate (FEER), desired equilibrium exchange rate (DEER), natural real exchange rate (NATREX), behavioural equilibrium exchange rate (BEER), permanent equilibrium exchange rate approach (PEER) and capital enhanced equilibrium exchange rates (CHEER) approach and includes a section of how to choose the appropriate model for every research. Unit 2 is dedicated to an extensive discussion about CHEER approach, including a theoretical formulation of PPP and UIP as these two parities are fundamental for the formulation of the CHEER approach and explains how the two theories can be combined in a single equation framework known as CHEER approach which follows an empirical overview of studies that have been conducted in order to examine its validity in the past. Unit 3 outlines the unit root (ADF) and cointegration (JMN) tests in the presence of structural breaks, which are used in the subsequent analysis. Finally unit 4 presents the data that was used for the research and all the empirical results of the application of unit root and cointegration tests of the data.

1. EXCHANGE RATE DETERMINATION APPROACHES

The growth of international capital flows, and especially those that take place across national borders is considered to be one of the most important developments in international economics relations after World War II. These transactions are a dominant force on the determination of the demand of foreign currency. Exchange rate forecasting can have one of the following different forms; forecasting for event timing, forecasting event outcome or time series forecasting. Exchange rate forecasting can have the form of short-run, medium-run or long-run forecasting, with short-run being useful for short term exchange rate forecasting that it is useful for operations like money market investment and financing decisions, medium-run equilibrium is the exchange rate which is compatible with the economy being at internal and external balance and long-run required for foreign direct investment projects (Moosa 2000, p. 11). Over the years a number of different approaches on the exchange rate determination, involving short-run, medium-run and long-run approaches, have come to light making the literature in this field large and growing. In this section I discuss a variety of different approaches that have influenced the thinking of the exchange rate determination over the years.

1.1. PURCHASING POWER PARITY (PPP) AND UNCOVERED INTEREST PARITY (UIP)

1.1.1. Purchasing Power Parity (PPP)

There is plenty of empirical work in the literature regarding the estimation of equilibrium exchange rates and one of the most traditional theories is the so-called purchasing power parity (PPP), which is used in the long run as a baseline of equilibrium exchange rate. PPP is one of the most extensively researched, yet unresolved topics in international finance literature. But as one of the main theories for exchange rate determination, PPP is often a measure that economist turn to when they have to deal with the equilibrium of exchange rates.

The PPP hypothesis stems from the law of one price (LOOP) which indicates that the price of a product is the same in all locations in terms of a common currency

(Wallace 2013, p. 779). In other words, freely traded identical commodities should have the same price everywhere in the absence of transaction and transportation costs. The PPP was first introduced in a series of papers by Cassel (1916a, 1916b &1918). In his papers Cassel argued that in the short run, the nominal exchange rate prevailing in the foreign exchange market may deviate from that suggested by PPP and that in the short-run the extent of deviation from PPP might be thought of as an overvaluation or undervaluation of the home currency (Egert *et al.* 2006, p. 263-264). The PPP hypothesis postulates that exchange rates adjust to price differentials in open economies to restore international commodity market equilibrium (Ozmen & Goksan 2004, p. 779).

The PPP in its absolute form states that the nominal exchange rate between two currencies should equal the ratio of the respective price levels. Moreover it postulates that due to arbitrage activities in international goods market, we should expect the real exchange rate to return to a constant equilibrium value in the long run or prices across countries should be equalized. Absolute form of PPP is thus not useful for practical purposes. Instead, economists use the relative form of PPP which states that exchange rates should bear a constant proportionate relationship to the ratio of national price levels. The PPP entails a constant equilibrium real exchange rate. This means that domestic price inflation in the long run must be equal to price inflation abroad when adjusted for nominal exchange rate movements.

Although all of the recent literature on PPP has focused on its validity as a long run construct, since the work of Meese and Rogoff (1983) the validity of an exchange rate model has been judged by how well it performs in and out of sample forecasting context. Empirically proven the PPP may be a good approximation in the long run, but large deviations appear in the short run. The gradual realization that PPP is an unrealistic hypothesis in the short or medium run has been a natural corollary to the dissatisfaction that has emerged with the natural unemployment rate as anything other than a long-run hypothesis (Boughton 1988, p. 5).

1.1.2. Uncovered Interest Rate Parity (UIP)

The Uncovered Interest Rate Parity (UIP) equates the expected returns on domestic and foreign bonds and it is central to exchange rate determination in standard open economy models. The UIP holds only if securities that are similar except for currency of denomination are perfect substitutes, in which case their expected rates of return should be equal up to an additive constant. The UIP indicates that there should be no expected excess return in an efficient market and considers international asset markets, and asserts that exchange rates adjust to interest rate differentials (Ozmen & Gokcan 2004, p. 779). The UIP also states that interest rate differentials between two currencies reflect expectations on future exchange rate movements plus a constant risk premium.

The excess return of foreign bonds over home bonds consists of two components: the interest rate difference between the two countries and the exchange rate change over the investment period. It gives a rule by which the exchange rate can be calculated as an asset price from expected changes in its value over time. The UIP is intrinsically dynamic, because it is based on arbitrage of own rates of return over time (Lance 2004). So the UIP states that expected returns on interest-bearing securities will be equal, regardless of the currency of denomination, except possibly for an additive constant determined by differences in the characteristics of the securities (Boughton 1988, p. 5). Thus, equating expected returns across countries requires that, on average, the exchange rates of high interest rate countries depreciate and offset potential gains that arise from interest rate differentials. From a theoretical point of view, the UIP can be considered a cornerstone of international finance, and is a key assumption of most important exchange rate determination theories (Carriero 2006, p. 879).

This hypothesis is the source of the proposition that the exchange rate is the relative price of national moneys except in the trivial sense in which the proposition holds by definition in terms of money as the unit of account.

1.2. THE MONETARY APPROACH TO EXCHANGE RATE MODELLING

The monetary approach on the determination of exchange rate modelling is one of the eldest approaches, and it was the standard point of departure for the literature on exchange-rate determination. This approach is associated with PPP or with the LOOP. However it has clearly failed to provide an adequate explanation of the movements in exchange rates in the past. In monetary approach changes in the relative prices of goods are assumed to play a fairly minor supporting role, and exchange rates should be considered of as asset prices (MacDonald 1988). The common feature of asset-market models is that the exchange rate is viewed as equilibrating the net stock demands for financial assets denominated in different currencies. There are two competing classes of models concerned in the monetary approach of exchange rate determination; the monetary approach and the portfolio balance approach (MacDonald & Marsh 2010, p. 80).

1.2.1. The monetary approach

The popularity of this approach may be attributed to the compelling realism in our world of both its theoretical assumptions and its empirical implication. In the monetary approach non-money assets are assumed to be perfect substitutes. There is absence of substantial transaction costs, capital controls or any other impediments to the flow of capital between countries. As a result we assume that there is perfect capital mobility. In the monetary approach we can consider three different models; the flexible price monetary approach (FLMA), the sticky price monetary approach (SPMA) and a hybrid approach that is the combination of FLMA and SPMA, so-called real interest differentials (RID).

The FLMA, which was developed by Frenkel (1976) and Bilson (1978), explains the supposedly excessive exchange rate volatility in terms of magnified response of the current exchange rate to expected future excess money supplies. In the FLMA, prices are continuously flexible because they adjust immediately in the money market and so the exchange rate is always at what is effectively a PPP-defined equilibrium (MacDonald & Marsh 2010, p. 84). This model assumes that PPP holds continuously, implying that it is valid in the short-run and in the long-run as well (Moosa 2000, p. 110). The crucial assumptions are that domestic and foreign capital are perfect substitutes and the Fisher equation holds in both countries (Wilson 2009, p. 86). This approach is presented as a two country model with two monies, two bonds and a single homogenous traded good. The existence of one traded good implies PPP. In this approach the nominal exchange rate is driven by the relative excess supply of money. Also changes in output levels or interest rates have an effect on the exchange rate indirectly through the effect that they have on the demand for money. The FLMA model is considered to be a long-run equilibrium relationship, in which the nominal interest rates, via the Fisher condition, capture expected inflation (MacDonald & Marsh 2010, p. 81-82). In FLMA the level of the exchange rate is perfectly correlated with the level of the relative money supply, but nowadays the existence of secular inflation and its effect on money demand cannot be ignored (Frenkel 1993, p. 89). The model illustrates that the exchange rate is determined by the relative money supply and relative income. So, a rise in the domestic money supply relative to the foreign money supply lead to a proportional rise in the exchange rate and as it follows domestic currency depreciation (Moosa 2000, p. 111).

In 1976 Dornbusch developed a competing model of the monetary approach to exchange rates in order to overcome one of the major criticisms of the FLMA, the postulation that PPP holds in short-run. He relaxed the assumption of short run but he maintained the assumption that PPP holds in the long run. The SPMA that he proposed considered that prices are sticky in the short-run, because goods markets adjust more slowly to monetary shocks than financial markets (Moosa 2000, p. 115). In his paper he indicated that as domestic money supply decreases relative to domestic money demand, there would not be a matching drop in prices. In this case the domestic interest rate would rise with regard to foreign interest rates creating an inflow of foreign capital. Domestic currency would appreciate immediately. The result would be a negative relationship between the exchange rate and nominal interest rate.

Dornbusch (1976) stated that a sticky price model would mean that PPP would only hold true in the long run. The result of this restatement of the monetary model suggests that there will be a short-run overshooting of the nominal exchange rate. However, in the long run, one would expect prices to adjust as well as output in response to an increase in aggregate demand. Exchange rates would be affected accordingly (Wilson 2009).

The SPMA retains the monetary approach of one bond representation of financial markets but relaxes the monetarist model's one good representation of trade (Frenkel 1993, p. 89). The SPMA offers an explanation for excess exchange rate volatility in terms of asymmetric adjustment speeds between goods and asset markets. In SPMA there is a distinction between long-run and short-run equilibrium. The long-run is defined as in the FLMA, the short-run commodity prices are considered sticky and need time to adjust to their equilibrium values, while asset prices are continuously flexible and this asymmetry between goods and asset price adjustment is responsible for the overshooting result (MacDonald & Marsh 2010, p. 85).

RID combines all the good elements that each of the previous discussed approaches have in a manner which is econometrically attractive (MacDonald & Marsh 2010, p. 88). It was first introduced by Frankel who suggested that FLMA is realistic "when variation in the inflation differential is large" and the SPMA model is applicable "when variation in the inflation differential is small" (Frankel 1979, p. 610). His model supports a negative relationship between exchange rates and the nominal interest differential and a positive relationship between exchange rates and the expected long-run inflation differential (Wilson 2009, p. 87).

The fact that all three models are in the monetary tradition is reflected in the fact that they all feature a unit coefficient on the income elasticity. Monetary approaches to exchange rate determination imply that domestic and foreign assets are perfect substitutes, which the portfolio balance approach unequivocally deviates. The deviation arises from, among others, different risk attitudes towards foreign financial assets in relation to domestic financial assets; or there exists a risk premium on holding foreign financial assets relative to holding domestic financial assets. The key differences occur with respect to the two interest semi-elasticity's. In the FLMA there is a one-to-one relationship between inflation and interest rates and so there is no real interest rate effect. In the SPMA interest rates purely reflect liquidity effects and so there is no role for expected inflation differentials as given by long bond yields. Finally the RID combines both approaches within it and facilitates a role for both short and long interest rates.

1.2.2. The portfolio balance approach

The portfolio balance model was introduced as a natural extension of Tobin's (1969) financial market analysis from closed to open economy macroeconomics. It was introduced in order to remedy the deficiency of monetary models that were described above. This deficiency is related to the restrictiveness that money is the only asset available (Moosa 2000, p.118).In this sense the portfolio approach expands the monetary approach by including other financial assets. The main idea was that a floating exchange rate should be determined by some contemporary market clearing mechanism (Lance 2004, p. 212).

The portfolio balance model relaxes the assumption that financial assets are perfect substitutes and tells us that the ratio of domestic to foreign bonds is determined by their relative returns (Moosa 2000, p. 118). It postulates that the exchange rate is determined by the quantities of domestic money and domestic and foreign financial securities demanded and the quantities supplied. So, the portfolio-balance or asset-market approach to exchange-rate determination proposes that the exchange rate, as the domestic price of foreign currency, is determined as part of the financial market system that brings the demand for an asset in accordance with predetermined stock supplies (Ghi-Min & McDonald 1993, p. 75).

As in the monetary approach models, we assume capital mobility, in contrast to monetary approaches there is no requirement for PPP to hold, so goods do not have to be perfect substitutes. Also in contrast to the monetary approach, other financial assets are as important as domestic money. Investors allocate their bond portfolios between the two countries in proportions that are functions of the expected rates of return and in order to diversify the risk that comes from exchange rate variability; they balance their bond portfolios between domestic and foreign bonds in proportions that depend on the expected relative rate of return (Frankel 1993).

1.3. OTHER APPROACHES OF EQUILIBRIUM EXCHANGE RATE

1.3.1. Fundamental equilibrium exchange rate (FEER)

The literature on the fundamental equilibrium exchange rate (FEER) approach has grown since 1987 when Williamson popularized the idea and it includes real exchange rates when both the internal and external equilibrium are observed simultaneously. Unlike the simple PPP approach, the FEER approach allows the equilibrium exchange rate to move as fundamentals change. As an approach FEER aims to calculate exchange rates for a particular set of economic conditions, for this reason it abstracts from short-run cyclical conditions and temporary factors and concentrates on conditions and variables that are desirable outcomes that it is possible never to be realized (Clark & MacDonald 1998, p. 6). The FEER approach is based on the assumption that equilibrium real exchange rates can vary over time. It is calculated on the basis of an empirical model of macroeconomic variables that are influenced by the real exchange rate. FEER focuses on conditions or variables likely to persist over the medium-run that is why it can be characterized as a medium-run concept, as there is no need to be consistent with stock flow equilibrium (MacDonald 2000, p. 37), where the equilibrium real exchange rate is determined by stock and flow assets between countries as described by Faruqee (1995), Aglietta *et al.* (1998) ad Alberola *et al.* (1999, 2002).

The FEER approach indicates that the exchange rate is at its equilibrium value when it satisfies the condition of simultaneous internal and external balance (Koukouritakis 2013, p. 59). By defining as internal balance the level of output consistent with both full employment and a low and sustainable rate of inflation, or in other words that actual production equals the potential production level, so that price inflation is stable. While external balance is identified as a condition in terms of current account balance and states that the external balance is characterized as the sustainable desired net flow of resources between countries when they are in internal balance. Most of the time it is difficult to identify the level of potential output,so it is often assumed that the adjustment process assures internal balance when external balance is achieved.

The FEER is the rate that equates the current account at full employment with sustainable net capital flows. The FEER approach gives attention on the determinants of the current account, which is typically explained as a function of home and foreign aggregate output or demand and the real effective exchange rate.

Calculations of FEER require an empirical model of macroeconomic variables that are influenced by the real exchange rate. Some studies use a general macroeconomic model for one or more countries, whereas others use a partial model for the balance of payments. The partial approach seems to be more popular, partly because the mechanisms that determine FEER are more transparent, but also because model development and maintenance require fewer resources.

There is a number of disadvantages of the FEER approach, including the relative intractability, the use of normative assumptions, assumptions of what should happen to the economy, and the unclearness of whether the underlying exchange rate relationship is well-founded in a statistical point of view (MacDonald & Marsh 2010, p. 132).

1.3.2. Desired equilibrium exchange rate (DEER)

A similar approach to the FEER approach is the desired equilibrium exchange rate (DEER) approach presented by Bayoumi et al. (1994). Given its normative assumptions of what would be the level of internal and external balance, captured here especially by the size of targeted sustainable current account from the Central Bank, it has been suggested that the equilibrium real effective exchange rate derived from the FEER approach be called desirable. The DEER makes explicit the normative nature of the assumptions underlying macroeconomic balance, particularly external balance. As a close variant, the calculation of the DEER methodically follows that of the FEER, except that the estimates of the DEER are driven by the preference of policymakers regarding internal and external balance. In their work Bayoumi *et.al*. (1994) further claimed that the calculated medium-term DEER equilibrium exchange rate is consistent with, and necessary for achieving desired positions of internal and external balance. The authors also specified the medium-term horizon as the period needed for output to return to potential and for changes in competitiveness to be reflected in trade volumes, which would appear to be in the range of four to six years.

1.3.3. Natural real exchange rate (NATREX)

An alternative approach about exchange rate determination is the natural real exchange rate (NATREX), which is referred to in both medium-run and long-run periods. The NATREX was developed by Stein (1990, 1994) and is the rate that would prevail if speculative and cyclical factors could be removed while unemployment is at its natural rate; is consistent with simultaneous internal and external balance and equates the sustainable current account with saving and investment (Koukouritakis 2013). In contrast to the FEER approach, the NATREX approach distinguishes equilibrium real exchange rates at two horizons; in the medium run and long run depending on the considered stock variables of the model. The difference between the two horizons relates to the evolution of net foreign assets and the capital stock. In the medium run, the real exchange rate can be viewed at equilibrium when internal and external balances are achieved simultaneously, very much as in the FEER approach. As in the FEER approach speculative capital flows are excluded from the measure of the capital account, and moreover the sustainable capital account term is assumed equal to social saving less planned investment (MacDonald 2000, p. 46). As in the case of the FEER, the basic notion of the NATREX is close to the idea of the equilibrium exchange rate as introduced by Nurkse (1945).

1.3.4. Behavioural equilibrium exchange rate (BEER) and Permanent equilibrium exchange rate approach (PEER)

The behavioural equilibrium exchange rate (BEER) approach takes into account the possibility that the above mentioned macroeconomic variables may generate long swings and trend movements in the real exchange rate. BEER model emphasizes on variables that affect the relative prices of traded to non traded goods at home and in foreign countries, such as differing trends in productivity in traded goods sectors and asymmetric terms-of-trade shocks. It was first introduced by Clark and MacDonald (1998) as an approach of exchange rate determination. In contrast with FEER, DEER and NATREX approaches, BEER is more general in that it can in principle be used to explain the cyclical movements that occur in the real exchange rate (Clark & MacDonald 1998, p. 11), is a short-run concept which involves the direct econometric analysis of the exchange rate behaviour. The BEER approach does not actually rely on any theoretical model and the equilibrium rate is designated by the long-run behaviour of the macroeconomic variables (Giannellis & Koukouritakis 2011).

As an attempt to further extend the FEER approach, the BEER approach tries to explain the behaviour of the exchange rate by considering the origins of cyclical and temporary movements of the real exchange rate and also by taking the given values, not necessarily at the full employment values, of the fundamental determinants of the real exchange rate. But unlike the FEER approach, it does not consider macroeconomic balance and therefore uses the current values of economic fundamentals in defining the equilibrium real exchange rate. Furthermore this approach allows cross country differences in productivity growth and fiscal and monetary policies to contribute to persistent deviations from purchasing power parity.

This approach estimates the exchange rate misalignment in accordance with the deviations of the actual exchange rate from its estimated value, which is derived from the long-run relationship between the exchange rate and the macroeconomic fundamentals (Giannellis & Koukouritakis 2011). The key elements of the BEER approach are a set of long-term economic fundamentals and uncovered interest rate parity (UIP), which is assumed to determine the short-term behaviour of the exchange rate. BEER recognises the real determinants of real exchange rates and it takes as its starting point the proposition that real factors are a key explanation for the slow reversion to PPP observed in the data (MacDonald 2000, p. 20).

The BEER approach seems to illustrate some advantages if we compare it with FEER approach. It is highly tractable; it can be assessed in terms of how good a representation of the data generating process and it is amenable to the construction of simple counterfactual experiments (MacDonald & Marsh 2010, p. 133), which have the aim to analyze if the economy would be better if a different policy approach was followed. Another advantage of the BEER approach is that the exchange rate is a function of variables that have a direct effect on the exchange rate (Giannellis & Koukouritakis 2011). However, BEER does not distinguish between the long-term and short-term values of economic fundamentals.

The same authors proposed another model for the exchange rate determination, the permanent equilibrium exchange rate approach (PEER). PEER was developed as an extension of the BEER approach, and it is based on the consideration of the long-run levels of economic fundamentals. So in the PEER approach the exchange rate is a function only of those variables that have a persistent effect on it (Koukouritakis 2013). The PEER model is based on decomposing a real exchange rate into its permanent and transitory components, where the permanent component is then taken to be the measure of equilibrium (Egert *et al.* 2006, p. 278) and it is one way of calibrating a BEER (Clark & MacDonald 2000).

1.3.5. Capital-enhanced equilibrium exchange rate (CHEER)

A plethora of data is needed in order to implement one of the above approaches on exchange rate determination, data that may not be available for all countries (Koukouritakis 2013). Johansen and Juselius (1992) and Juselius (1995) propose an approach combining both international parities PPP and UIP, an approach that overcomes this problem of data availability, since it requires data that are available for the majority of the developing countries. By combining PPP and UIP this approach allows interactions among prices, interest rates and exchange rates and it is referred to as capital enhanced equilibrium exchange rates, or CHEER. “This approach captures the basic Casselian view of PPP, . . . , that an exchange rate may be away from its PPP determined rate because of non-zero interest differentials” (MacDonald 2000, p.18).

Table 1: Empirical approaches to estimating equilibrium exchange rates

	PPP (Purchasing Power Parity)	UIP (Uncovered Interest Parity)	Monetary Models	FEER (Fundamental Equilibrium Exchange Rate)	DEER (Desired Equilibrium Exchange Rate)	NATREX (Natural Real Exchange Rate)	BEER (Behavioural Equilibrium Exchange Rate)	PEER (Permanent Equilibrium Exchange Rate Approach)	CHEER (Capital-enhanced Equilibrium Exchange Rate)
Theoretical Assumptions	Constant Equilibrium Exchange Rate	The expected change in the exchange rate determined by interest differentials	PPP in long run (or short run) plus demand for money	Real exchange rate compatible with both internal and external balance. Flow not full stock equilibrium	As with FEERs, but the definition of external balance based on optimal policy	As with FEER, but with the assumption of portfolio balance	Real UIP with a risk premia and/or expected future movements in real exchange rates determined by fundamentals	As BEERs	PPP plus nominal UIP without risk premia
Relevant Time Hor Izon	Long Run	Short run	Short run	Medium run	Medium run	Long run	Short run	Medium / Long run	Medium/ Long run
Statistical Assumptions	Stationary	Stationarity (of change)	Non-stationary	Non- stationary	Non-stationary	Non-stationary	Non-stationary	Nonstationary (extract permanent component)	Stationary, with emphasis on speed of convergence
Dependent Variable	Real or nominal	Expected change in the real or nominal	Nominal	Real effective	Real effective	Real	Real	Real	Nominal
Estimation Method	Test for stationarity	Direct	Direct	Underlying Balance	Underlying Balance	Direct	Direct	Direct	Direct

Note: From Driver and Westaway (2004, p. 26)

1.4. HOW TO CHOOSE BETWEEN MODELS

Different attempts on measuring equilibrium exchange rates for a given time horizon may give different answers. As a result it is really important to choose the correct model each time. By examining the literature of exchange rate determination anyone can easily observe that different authors have used methods ranging from the purely statistical to the purely theoretical, with many options in between. Given the strengths and weaknesses of the different models, the selection of the model to be adopted should always be closely based on the scope of issues to be tackled, the main research question and the specific situation that the researcher wants to deal with.

In order to examine the financial integration between the EMU and the world, I chose the CHEER approach because of its characteristics. The determination of exchange rates has usually been analyzed either in the goods market by assuming adjustment to PPP or in the capital market by assuming market clearing based on UIP. The CHEER investigates the transmission effects jointly for the two markets (Ozmen & Goksan 2010, p. 783).

The CHEER approach allows the distinction between short-run and long-run effects, which is crucial in this empirical problem, since two different types of markets are involved. In the goods market arbitrage is costly, whereas it is much less so in the asset market. Consequently one can assume that exchange rates are affected by short-run fluctuations arising from highly volatile asset markets and by long-run effects from interrelated goods markets. The key idea of the model is that the exchange rate may be away from its equilibrium value due to non-zero interest rate differentials. In other words, while the PPP model may fail to explain long-run exchange rate movements, these may be explained by movements in interest rate differentials. Unlike the pure form of Casselian PPP, in which non-zero interest differentials only have a transitory impact on the real exchange rate, here the interest rates can have a medium-run, or business cycle, effect. The essential proposition of this approach is that the long-run persistence in the real exchange rate is mirrored in the interest differential (Egert *et al.* 2006, p. 283).

One more reason for choosing this model is because it gives more emphasis on understanding whole structures rather than isolated parameters or relations (Juselius 1995, p. 237).

In general, the CHEER approach has tended to suggest higher estimated speeds of convergence than is found for simple PPP estimates as was shown from the studies of Johansen and Juselius (1992), MacDonald and Marsh (1997), and Juselius and MacDonald (2000). Partly for this reason the approach has been successful in forecasting movements in bilateral exchange rates. Moreover CHEER has proved able to significantly out forecast a random walk even at horizons as short as two months. The implicit assumption behind the approach, however, is that in the very long run when interest rate differentials are zero, the real exchange rate will be constant, or in other words that PPP will hold (Driver & Westaway 2004).

Moreover the CHEER approach is a well founded measure of equilibrium that may be recovered from the vector, in the sense that the composite term is stationary and often degree one homogeneity restrictions can be imposed on the relative terms and the coefficients and the interest differential are consistent with a capital account interpretation. So while there may be factors that drive a wedge between prices and exchange rates, when these factors are held constant we would expect a change in exchange rates to be associated with a proportional, or homogeneous, change in prices. Furthermore, the need of mean-reversion of the adjustment term is often much faster than the unvaried PPP-based adjustment referred to the above and the out-of-sample exchange rate forecasts can be constructed which dominate a random walk at horizons as short as two months ahead. As a measure of the equilibrium exchange rate it is clearly a medium-run concept in the sense that it does not impose stock-flow consistency. This may be seen as a disadvantage of the approach for assessment purposes. However, it may, nevertheless, provide a useful measure of equilibrium in circumstances where data in net foreign asset positions are not available (MacDonald 2000, p.20).

The main advantage of this approach is that it is highly tractable and can be used to provide reasonable measures of equilibrium exchange rates for both developed and transition economies in the absence of the kind of data needed to implement some of the other approaches (Egert *et al.* 2006, p. 283).

Considering all the advantages that CHEER presents and because the approach requires only a limited menu of variables, and there is no need for a plethora of data in order to examine its validity, CHEER was suitable for my analysis.

2. THE CHEER APPROACH

A core stylized fact of the empirical exchange rate literature is that half-life deviations of equilibrium real exchange rates from levels implied by Purchasing Power Parity (PPP) are very persistent. Empirical efforts to explain this persistence typically proceed along two distinct paths, resorting either to the presence of real shocks such as productivity differentials that drive equilibrium exchange rates away from levels implied by PPP, or the presence of non-linearity's in the adjustment process around PPP. An alternative approach to explaining the persistence of real exchange rates is to combine PPP theories with that of the UIP condition. An approach to explaining the persistence in real exchange rates, and also in obtaining well-defined measures of the equilibrium exchange rate is the CHEER approach. The idea underlying this approach is that while PPP may explain long-run movements in real exchange rates, the real exchange rate may be away from equilibrium as a result of non-zero interest rate differentials. The approach focuses on the interaction between the real exchange rate and the capital account items. It ignores the relative output terms and net foreign assets. It does not regard non-zero interest differentials as having only a transitory impact on the real exchange rate. The essential proposition of this approach is that there is long term persistence in both the real exchange rate and the interest differential (MacDonald 2000).

2.1. THEORETICAL FOUNDATIONS OF PPP AND UIP HYPOTHESIS

2.1.1. THEORETICAL FOUNDATIONS OF PPP HYPOTHESIS

PPP is a theory that describes the relationship between prices and exchange rates. The principle of PPP states that over long periods of time exchange rate changes will tend to offset the differences in the inflation rate between two countries whose currencies comprise the exchange rate. The PPP hypothesis stems from the law of one price (LOOP) which states that, measured in a common currency, freely traded identical commodities should have the same price everywhere in the absence of transaction and transportation costs. PPP indicates that the nominal exchange rate is the domestic price level divided by the foreign price level. Mathematically, in its simplest and most strict form is expressed as:

$$p_t = e_t + p_t^* \qquad (2.1)$$

Where e is the log of the nominal exchange rate (domestic currency per unit of foreign currency), p and p* are the logs of the domestic and foreign prices, respectively. Thus, as prices rise relative to foreign prices the exchange rate will rise, so the domestic currency will depreciate and vice versa. PPP ignores any real determinant of the real exchange rate such as relative activity levels and net foreign asset positions, and the influence of capital flows on the exchange rate (MacDonald 2000).

Rearranging Equation (2.1) gives PPP:

$$e_t = p_t - p_t^* \qquad (2.2)$$

Traditionally, equation (2.2) is referred as the absolute PPP. Under absolute PPP the level of exchange rate will be determined to equalize levels of prices across countries. Note that absolute PPP assumes that the real exchange rate is constant.

Equation (2.2) can be obtained from the following functional form:

$$e_t = \gamma_0 + \gamma_1 p_t - \gamma_2 p_t^* \qquad (2.3)$$

Under the hypothesis that $\gamma_0 = 0$ and $\gamma_1 = \gamma_2 = 1$. Where γ_0, γ_1, γ_2 are constant coefficients that can be estimated. Equation (2.3) states that the exchange rate is a linear function of the price ration. In this case the symmetry and proportionality condition of the price coefficients holds. In practice, absolute PPP does not hold because of obstacles to international trade.

By relaxing the assumption of symmetry, that is that, the domestic and foreign prices are equal effects on the exchange rate, it derives the relative PPP. The relative

PPP relaxes the restriction that $\gamma_0 = 0$, and often defines the evolution of exchange rates in a growth rate form:

$$\Delta e_t = \Delta p_t - \Delta p_t^* \qquad (2.4)$$

Where Δ is the first difference operator. Under relative PPP, a currency with a higher inflation rate is expected to depreciate vis-à-vis a currency with a lower inflation rate. Equation (2.4) represents a weaker version of PPP that predicts that the exchange rate will adjust to offset inflation differentials between two countries over time. Thus, if most of the shocks affecting the exchange rate are monetary rather than real, then relative PPP will be able to explain a substantial portion of the exchange rate movement between two countries. This equation represents a comparative statics hypothesis on the relationship between the exchange rate and inflation differentials, stipulating that the rate of change of the exchange rate should be equal to the inflation differentials. Moreover, this equation shows that the country with the higher inflation rate should have a depreciating currency and vice versa.

The distinction between absolute and relative PPP is important because the existence of transportation costs and different price weights across countries means that there are no specific values for the vectors γ_1, γ_2 except that they are positive and negative (MacDonald and Marsh 2010, p. 51). Furthermore, while absolute PPP shows the relationship between exchange rates and prices at a particular point in time, relative PPP describes the movement of exchange rate from one level to another under the influences of changes in prices.

Tests for PPP refer to the investigation of time series properties of the real exchange rate q_t.

$$q_t = e_t - p_t + p_t^* \qquad (2.5)$$

Even if it does not hold exactly, the PPP model provides a benchmark to suggest the levels that exchange rates should achieve.

Dornbusch and Krugman (1976) noted: "Under the skin of any international economist lies a deep-seated belief in some variant of the PPP theory of the exchange rate”. Tests of the long-run variability of real exchange rates have been a convenient method for assessing departures from PPP. As Thygesen (1978) stated in cases where exchange-rate changes have been shown to conform to inflation differentials, so that real exchange rates have remained constant, a PPP based intervention rule has been proposed as the main criterion for managing exchange rates.

But even Cassel on his work was clear that his concept had limitations. The PPP exchange rate can be defined as the level of the nominal exchange rate such that the purchasing power of a unit of currency is exactly the same in the foreign economy as in the domestic economy, once it is converted into foreign currency at that rate (Taylor & Taylor 2004). By using this definition there is an easy way of investigating whether there may be discrepancies from PPP to compare the prices of similar or identical goods from the basket in the two countries.

The PPP theory at least in its absolute form may fail (an easy illustration of PPP failure is the Big Mac index that compares the prices of a Big Mac sandwich at MacDonald’s restaurants within different countries). This happens because it is costly to move goods across borders. As a result, transportation costs, government-imposed trade barriers, and taxes all limit the extent to which differences in prices across countries will result in the international movement of goods (Pakko & Pollard 2003, p. 16). The PPP theory was applied for short run and long run in the economy. The short run theory is not successful for holding PPP, but it seems that PPP holds in the long run. This delay occurs due to a number of reasons. Moreover, since some goods and services used in the indices are not traded, there could be price discrepancies between countries, relative price changes could lead to exchange rate changes even in the absence of an inflation differential and government intervention could lead to a disequilibrium exchange rate (Taylor & Taylor 2004, p. 137). In other words, the arbitrage opportunity occurs in the international market so that the trader buys goods at a lower price and sells them at a higher price.

PPP has been a controversial theory among economist during the years. Many attempts have been made to verify this theory empirically because of its decisive role both in theoretical macroeconomic models and in economic policy-making. In more traditional exchange rate models, under which trade flows were understood to be the fundamental determinant, PPP was considered a theory of exchange rate determination. Subsequently, in monetary and portfolio balance models, it has generally played a very important role as an equilibrium condition, although no specific hypotheses have been established regarding the direction of causality. In dynamic exchange rate models, it usually appears as a long-run equilibrium condition. Thus, the justifications behind PPP theory lie in goods market arbitrage and the neutrality of money.

2.1.2. THEORETICAL FOUNDATIONS OF UIP HYPOTHESIS

The UIP hypothesis states that one unit of currency should have the same return whether invested in the domestic or the foreign markets, in other words at equilibrium the rates of return on domestic and foreign assets expressed in the same currency are equal. This condition equalises the *ex-ante* risk-adjusted nominal rate of return on domestic and foreign currency assets. Ignoring transaction cost and liquidity constraints, the UIP gives an arbitrage mechanism that drives the exchange rate to a value that equalises the returns on holding both the domestic and foreign assets. The UIP relates interest rates of two countries to expected changes in exchange rates:

$$i_t = i_t^* + e_t^e - e_t \qquad (2.6)$$

The expected change in the nominal exchange rate is determined by the interest rate differential and any risk premium. Equation (2.6) says that the gross domestic return must be equal to the expected gross uncovered foreign return. More simplified:

$$i_t = i_t^* + \Delta e_t^e \qquad (2.7)$$

Where i_t and i_t^* are domestic and foreign nominal interest rates with maturity t+m respectively, where m is the term to maturity. In this case, equation (2.7) says that the exchange rate must change by a percentage that is equal to the interest rate differential. So the currency offering a lower interest rate must be expected to appreciate. The expected exchange rate change during t+m is presented by the following expression:

$$\Delta e_t^e \equiv E_t \Delta e_{t+m} \qquad (2.8)$$

Where E_t is the conditional expectations operator.

Assuming that expectations are formed rationally:

$$\Delta e_t^e = \Delta e_t + v_t \qquad (2.9)$$

Where v_t is a white noise error. Equations (2.7) and (2.9) give a rational expectations-cum-uncovered interest parity relationship:

$$i_t = i_t^* + \Delta e_t + v_t \qquad (2.10)$$

Which can be obtained from

$$i_t = \delta_1 i_t^* + \delta_2 \Delta e_t + \varepsilon_t \qquad (2.11)$$

Under $\delta_1 = \delta_2 = 1$ and ε_t is zero-mean stationary. Note that ε_t can also be defined as $v_t + u_t$, with u_t being a time-varying risk premium.

The UIP would hold if all investors were risk-neutral or if the underlying bonds were perfect substitutes. In this case, the expected exchange rate depreciation equals the current interest rate differential. The procedure is in fact a joint test for the rational expectations hypothesis and the risk neutrality. A rejection of the UIP condition means one or both of these hypotheses do not hold Taylor (1995).

The overall impression about the UIP is that its condition is more likely to hold in the long-run than, in the short-run. The deviation from the UIP condition in the short-run is the result of the exchange rate risk premium in the country, however, in the long-run the consistent results for the UIP condition are driven by the fact that, the exchange rates are determined by economic fundamentals (Chinn & Meredith 2005).

2.1.3. THE RELATIONSHIP BETWEEN PPP AND UIP

PPP and UIP are equilibrium conditions that identify the ideal level of exchange rate between a domestic and a foreign economy. The PPP condition holds when the exchange rate is such that the price of a local good is indifferent to the price of an identical foreign good, while the UIP condition holds when the exchange rate is such that the interest return on domestic currency is indifferent to the interest return on foreign currency deposits. On the one hand the PPP is more likely to hold over the long-run due to stickiness of prices over time, while UIP is a short-run equilibrium condition due to the lower level of friction in capital market interest rate determination.

Choy (2000) argued that the rejection of PPP and UIP, individually, by many studies may be due to a systematic relationship between the two conditions. PPP and UIP are interrelated in the following way; inflation determines time value of money. The higher the expected inflation, the less appealing to receive money in the future compared to today. High inflation can be tackled by increasing interest rates. Nevertheless, sometimes these forces can be in conflict highlighting the fact that PPP is derived from goods market and UIP from capital market.

2.2. THEORETICAL FORMULATION OF CHEER APPROACH

The CHEER approach captures the basic Casselian view of the PPP condition that an exchange rate may be away from its PPP-determined rate because of non-zero interest rate differentials. Cassel understood the possibility that the exchange rate might transitorily diverge from PPP, because of actual and expected inflation or deflation, new hindrances to trade and shifts in international movements of capital he viewed the deviations as minor. But, unlike the PPP condition, it indicates that the interest rates can have a medium-run, or business cycle, effect. Based on MacDonald (2000) and Egert *et al.* (2006), the model assumes perfect capital mobility and its starting point is the UIP condition. This condition is based on the proposition that if the expected returns on domestic and foreign equivalent securities are different, then the economic agents will borrow at a low rate and invest the proceeds at a high rate. This will take place until the domestic rate is equalized with the foreign one plus the expected rate of change in the exchange rate. By transforming equation (2.7), the UIP condition can be expressed in the following log-linear form:

$$\Delta e_{t+k}^{e} = i_t - i_t^{*} \quad (2.12)$$

If the expected exchange rate e_{t+k}^{e} in equation (2.12) is determined by the relative prices, which means that the PPP condition is valid, then equation (2.12) can be transformed in the following form:

$$i_t - i_t^{*} = \beta_1 (p_t - p_t^{*}) - e_t \qquad (2.13)$$

Where *p*, *p** denote the natural logarithms of the domestic and the foreign price indices, respectively. Since interest rate differentials are usually found in the empirical studies to be non-stationary, i.e. *I*(1), processes (Juselius & MacDonald, 2000), some combination of an appropriate interest rate differential and the real exchange rate may co integrate down to the following stationary process:

$$[\mathrm{e}_t + \beta_1 (p_t^{*} - p_t) + \beta_2 (i_t - i_t^{*})] \sim \mathrm{I}(0) \quad (2.14)$$

The intuition for this expression is as follows. For a period such as the recent float we know that there have been large current account imbalances and these have been driven in large measure by national savings imbalances, such as fiscal imbalances. The fact that real exchange rates have been so persistent, and therefore any adjustment of the current account to relative prices is painfully slow means that the current account imbalances have to be financed through the capital account of the balance of payment (MacDonald 2000, p.19).

In terms of cointegration, the CHEER approach involves exploiting the following vector:

$$\mathrm{y}_t = [\mathrm{e}_t, p_t, p_t^{*}, i_t, i_t^{*}] \qquad (2.15)$$

This vector can provide a satisfactory description of the covariance's in the basic data set. The order of integration of the process y, as well as the number of stationary relations and common trends can then be determined by analyzing the likelihood function. The stationarity and the nonstationarity hypotheses specified above can be formulated as restrictions on the parameters of the unrestricted model and tested using the likelihood ratio procedure. The statistical analysis of the likelihood function will thus provide a consistent framework for the determination of the time-series properties of the vectorial process y, and its individual components (Juselius 1995). Note here that even though the CHEER approach is a medium-run concept, since it does not impose stock-flow consistency, it still provides a useful measure of equilibrium in circumstances where data on net foreign asset positions and other fundamentals are not available, such as the countries investigated in the present paper.

2.3. CHEER: EMPIRICAL OVERVIEW

The CHEER approach was first introduced and developed by Johansen and Juselius (1992) and Juselius (1995). Johansen and Juselius (1992) investigated whether the PPP relation is stationary by itself, if the PPP relation with some combination of the two interest rates is stationary and whether there exists any linear combination between the prices and the exchange rates that is stationary. For this reason they applied the PPP and the UIP relation for the United Kingdom and the rest of the world. The empirical results seem to illustrate that the PPP relation is not stationary by itself, but it is for the interest rate differential. Moreover the hypothesis that the PPP relation with some combination of the two interest rates is stationary can indeed be accepted. The empirical results seem to illustrate that the movements in real PPP exchange rates are counteracted by the movements in the level of interest rates. This seems to indicate that the determination of prices, interest rates, and exchange rates should also be investigated in a balance-of-payments framework with interrelated movements in the current account and the capital account. Juselius (1995) uses an application of CHEER approach with data from Denmark and West Germany. The analysis shows that the empirical verification of the two fundamental parities as such is quite weak in terms of stationarity. When interaction between these two parities is allowed for, much more satisfactory results are obtained. Deviations from the PPP were found to be important for the long-run determination of the exchange rates and the interaction between the goods and the capital markets was found to be crucial for a full understanding of the movements of interest rates, prices, and exchange rates. Since then, the CHEER approach has become popular in the study of exchange rates.

Applying a cointegration relationship between nominal interest rate differentials, relative prices and the nominal exchange rate, MacDonald and Marsh (1997) successfully beat a random walk in forecasting bilateral exchange rates even at horizons as short as two months.

Caporale et al. (2001) investigates the German mark and Japanese yen to find evidence favourable to PPP and UIP with the aid of the cointegration approach. Concerning the effective nominal exchange rates, PPP is found to hold in both cases, whilst UIP holds for the Japanese yen, but not for the German mark, since no linear combination of exchange rates and prices that is stationary exists. PPP by itself is a stationary process; however, stationarity of the interest differential holds only in the case of the German mark, if the short-run interaction between asset and goods markets is taken into account. As for the bilateral rates, we find stronger evidence in favour of UIP; on the contrary, PPP does not seem to hold. The interest differential, instead, does not appear to be a stationary process, showing once more that both short- and long-run interactions between assets and goods markets are to be considered in order to draw valid inference.

Ozmen and Goksan (2004) used an application of the CHEER approach in Turkish data. The system that they analyzed contained Turkish and US inflation rates, interest rates, and exchange rate. The results suggest the existence of two stationary relationships. The first cointegration vector appears to explaining the long run evolution of Turkish interest rates whilst the second one representing the Turkish inflation rate equation. In addition the data appear to support the hypothesis that the system contains UIP and PPP relations. Although both PPP and UIP fail, cointegration relationship among prices, interest rates and exchange rate with dollar still exists. Consistent with the CHEER approach, the results further suggest that the deviations from PPP can be explained by the interest rates differentials while the deviations from UIP can be explained by the inflation rates differentials. The interaction between UIP and PPP has a crucial implication for an exchange rate targeting policy and an exchange rate based stabilization programme. These policies may not be sustainable if designed under a maintained hypothesis that the equilibrium exchange rate is determined only by commodity market clearing PPP condition. This is basically because, the adjustment of exchange rates to capital flows due to interest parities may lead to targeted exchange rates substantially diverging from the equilibrium rates for a financially open economy.

Rashid (2009) tests the validity of the CHEER approach for South Asian economies (Bangladesh, India, Pakistan and Sri Lanka). Even thought the hypothesis is strongly rejected when PPP is formulated in isolation, the results are robust to the CHEER approach of exchange rate determination and suggest that the deviations from PPP can be explained by the interest rates differentials while the deviations from both PPP and UIP can be explained by the variable used as proxy to measure the risk premium and capital market imperfections.

Keb1owski and Welfe (2010) investigated the concept of a steady-state level of the exchange rate is equated with the capital market equilibrium based on the CHEER approach by using Polish data. They extended the CHEER approach by including an independent credit default risk into their specification to take into account the decisions of financial investors. They used co integrated vector autoregressive (VAR) system and monthly data from Poland and the Euro area. Their results suggest that the sovereign credit risk is an important factor that determines the exchange rate along with the price and the interest rate differentials. They concluded that the zloty/euro exchange rate, three long-run relationships exist. They found that when inflation rates are taken into account, three long-run relationships exist among long and short-term interest rates for Poland and the euro zone, and the zloty/euro exchange rate. Two years later Keb1owski and Welfe (2012) augmented the CHEER approach with a sovereign credit default risk (as perceived by financial investors making their decisions) and continued their study on zloty and the euro. Four long-run relationships have been identified by the authors from whom two are connecting the term spreads with the inflation rates, one is characterizing the behaviour of the exchange rate and one is describing the inflation rate in Poland.

In his paper, Koukouritakis (2013) investigates the validity of the CHEER approach for the four new Visegrad EU countries; Czech Republic, Poland, Slovakia and Hungary by using unit root and cointegration tests in the presence of structural breaks in the data. The empirical analysis illustrated that the CHEER approach is empirically validated only for the Czech Republic, while for Poland and Slovakia there is evidence of plausible economic relationships between the nominal exchange rate and each of the price and interest rate differentials. In contrast, such a relationship cannot be identified for Hungary.

Giannellis and Koukouritakis (2013) found a long-run relationship for four Latin American countries (Brazil, Mexico, Uruguay and Venezuela) using the CHEER approach. Their empirical findings show evidence of a valid long-run relationship for each of the four nominal exchange rates. Their results do not provide strong evidence that inflation rate persistence in the four Latin America countries was directly related with exchange rate undervaluation, since it was present even in periods with overvalued home currency.

Adamek (2015) tested the calculated equilibrium exchange rate for Czech Republic and Hungary by using the CHEER approach. Adamek found significant relationship between the selected variables in both the Czech Republic and Hungary.

3. ECONOMETRIC METHODOLOGY

The use of unit root and cointegration tests is enormous and growing rapidly on macroeconomic modelling. This unit root revolution has a number of implications for macroeconomic theories as under a unit root hypothesis, random shocks have a permanent effect on the system. That means that the fluctuations are not transitory. As an idea the presence of unit roots goes against the prevailing view that business cycles are transitory fluctuations around a stable trend path. Testing for the order of integration is standard in applied econometric work. In order to test the potential of long run relation between macroeconomic variable, as the economic theory suggests it is important to first test the order of integration. This step is necessary if we want to set up an econometric model and do inference. Unit root tests are mainly a descriptive tool performed to classify series as stationary and non-stationary and cointegration can be described as particular kind of long-run equilibrium relationship. Moreover since the presence of structural breaks in the data are known to have significant effects on the properties and interpretation of standard unit root and cointegration tests we employ the discussion of both unit root and cointegration tests with structural breaks.

3.1. UNIT ROOT TESTS

The use of up-to-date econometric techniques has become more and more standard practice in empirical work in many fields of economics. Typical topics include unit root tests, cointegration.

It was the paper by Nelson and Plosser (1982) that sparked the huge surge in interest for unit root models among economists and gained even further popularity from the work of Perron (1989), which emphasized the importance of structural breaks when testing for unit root processes. Nelson and Plosser (1982) examined time series for some of the most important U.S. aggregate economic variables and concluded that almost all of them were better described as being integrated of order one rather than stable. Stationarity of a stochastic process requires that the variances and autocovariances are finite and independent of time (Verbeek 2004, p. 266). The implications of a unit-root process in macroeconomic time series are not trivial.

Unit root tests are coming into widespread use in macroeconomics. It is now commonplace to pre-test series to classify them as either trend-stationary or difference-stationary, and then impose that form in subsequent analysis. That subsequent analysis can include tests whose validity or form depends on the trend or difference stationarity of the series, estimation which imposes one or the other form, or direct reading of economic importance into the trend or difference stationarity of the series. There are many tests for determining whether a series is stationary or nonstationary.

Most economic time series are non-stationary. Whether a variable is stationary is important when we make the analysis for time series. If we use non-stationary variables to make a regression model, there might be a spurious regression. A spurious regression has a high R^2 and t-statistics that appear to be significant, but the results are without any economic meaning. Existence of a unit root indicates a variable is non-stationary, and therefore the variable has to be integrated of order one, denoted I (1) in order to be a stationary variable. If taking first difference does not produce a stationary variable, the variable will be integrated of order two. Two different unit root tests will be used which are ADF and KPSS tests.

3.1.1. AUGMENTED DICKEY-FULLER

The most popular one, and the one that I discuss, is the Augmented Dickey–Fuller test (ADF). Dickey and Fuller (1979, 1981) developed a procedure for testing whether a variable has a unit root or, equivalently, that the variable follows a random walk. Hamilton (1994, p. 528–529) describes the four different cases to which the ADF test can be applied. The ADF test procedure is based on the estimation of three equations or steps that are used to test the presence of: a unit-root with a constant and a trend, a unit-root with a constant and a simple unit-root process or the ADF test actually corresponds to three regression equations that differ from the presence of deterministic terms. The general strategy is that lagged differences, such as ΔY_{t-1}, ΔY_{t-2} *etc* are included in the regression, such that its error term corresponds to white noise (Verbeek 2004, p. 271). ADF test if a variable and follows a unit-root process.

The null hypothesis is that the variable contains a unit root, and the alternative is that the variable was generated by a stationary process. We assume the following model:

$$Y_t = \mu + \varphi_1 \mathrm{Y}_{t-1} + \varphi_2 \mathrm{Y}_{t-2} + ... + \varphi_p \mathrm{Y}_{t-p} + \varepsilon_t \quad (3.1)$$

If this is the process generating the data but an AR(1) model is fitted, say

$$Y_t = \mu + \varphi_1 \mathrm{Y}_{t-1} + v_t \quad (3.2)$$

v_t is an independently and identically distributed zero-mean error term. The main thrust of the unit root literature concentrates on whether the shocks have transitory or permanent effects. This can be tested by the ADF model, which is primarily concerned with the estimate of φ_1 of (3.2). Then:

$$v_t = \varphi_2 \mathrm{Y}_{t-2} + ... + \varphi_p \mathrm{Y}_{t-p} + \varepsilon_t \quad (3.3)$$

To illustrate how the DF test can be extended to autoregressive processes of order greater than 1, consider the simple AR (2) process below.

$$Y_t = \mu + \varphi_1 \mathrm{Y}_{t-1} + \varphi_2 \mathrm{Y}_{t-2} + \varepsilon_t \quad (3.4)$$

Equation (3.4) can be used to test the unit root hypothesis by testing $\varphi_1 + \varphi_2 = 1$ given $|\varphi_2| < 1$. This is conveniently done be rewriting (3.4) as:

$$Y_t = \mu + (\varphi_1 + \varphi_2)\mathrm{Y}_{t-1} - \varphi_2(\mathrm{Y}_{t-1} - \mathrm{Y}_{t-2}) + \varepsilon_t \quad (3.5)$$

And by subtracting Y_{t-1} from both sides gives:

$$\Delta Y_t = \mu + \beta \mathrm{Y}_{t-1} - \alpha_1 \Delta \mathrm{Y}_{t-1} + \varepsilon_t \quad (3.6)$$

Where the following have been defined

$\beta = \varphi_1 + \varphi_2 - 1$ and $\alpha_1 = -\varphi_2$

The coefficients in (3.6) can be consistently estimated by ordinary least squares and the estimate of the coefficient for Y_{t-1} provides a means for testing the null hypothesis

$\mathrm{H}_0 : \varphi_1 + \varphi_2 = 1$ or $\mathrm{H}_0 : \beta = 0$.

The resulting t -ratio

$$\text{ADF} = \frac{\hat{\beta}}{se(\hat{\beta})} \qquad (3.7)$$

In the spirit of the Dickey–Fuller procedure, one might add a time trend to the test regression. Depending on which variant is used, the resulting test statistic has to be compared with the critical values of the relative table. It would seem natural to assess the significance of the ADF statistic using the normal table. However, under H_0, Y_t is non-stationary, so conventional normal asymptotics are invalid. For this reason Dickey and Fuller (1979) introduced a table with critical values that are appropriate for this reason and MacKinnon (1991) extended them. If $|t|$ exceeds the critical values, we reject the null hypothesis, which also means that we do not reject the hypothesis of stationarity of the time-series. Non-rejection of the null hypothesis means that we do not reject the presence of a unit root and hence the nonstationarity of the time-series. More formally stated, a weakness of unit root tests in general is that they have low power discriminating between a unit root process and a borderline stationary process (Baltagi 2011, p. 380).

This procedure can easily be generalized to the testing of a single unit root in an $AR(p)$ process. Therefore to perform an Unit Root test on a AR(p) model the following regression should be estimated:

$$\Delta Y_t = \mu + \beta \mathrm{Y}_{t-1} - \sum_{j=1}^{p} a_j \Delta Y_{t-j} + \varepsilon_t \quad (3.8)$$

Or by including a trend:

$$\Delta Y_t = \mu + \beta Y_{t-1} + \delta t - \sum_{j=1}^{p} a_j \Delta Y_{t-j} + \varepsilon_t \quad (3.9)$$

In this case the standard Dickey-Fuller model has been augmented by ΔY_{t-j}, where j is the number of lags. The noconstant option removes the constant term μ from this regression and the trend option includes the time trend δt on (3.9). In the first case, the null hypothesis is that Y_t follows a random walk without drift, and (3.9) is fit without the constant term μ and the time trend δt. The second case has the same null hypothesis as the first, except that we include μ in the regression. In both cases, the population value of μ is zero under the null hypothesis. In the third case, we hypothesize that Y_t follows a unit root with drift, so that the population value of μ is nonzero; we do not include the time trend in the regression. Finally, in the fourth case, the null hypothesis is that Y_t follows a unit root with or without drift so that μ is unrestricted and we include a time trend in the regression.

We test the following null hypothesis, under certain restrictions that were described above:

$$\mathrm{H}_0 : \varphi_1 + \varphi_2 + ... + \varphi_p = 1 \quad \text{or} \qquad \mathrm{H}_0 : \beta = 0$$

Moreover if a time trend is included, the test procedure is the same, but different critical values are required. The ADF test has a different distribution when the time trend has been included, and a different table should be consulted.

Summarizing, this test is conducted by augmenting the equation by adding the lagged values of the dependent variable ΔY_t. The number of lagged difference terms to include is often determined empirically, the idea being to include enough terms so that the error term is serially uncorrelated. Deciding which case to use involves a combination of theory and visual inspection of the data. If economic theory favours a particular null hypothesis, the appropriate case can be chosen based on that.

In the case of exchange rates, the simplest way to describe its dynamics would be the following one:

$$e_t = \rho e_{t-1} + \varepsilon_t$$

Where ε_t are random innovations. Empirical investigations for the calculation of the autoregressive parameter ρ show that ρ lies systemically around 1 (Cheung et al., 2005).

The unit-root finding for real interest rates can be characterized as puzzling as it contradicts the consumption-based asset pricing models and also the Fisher effect (Lai 2008, p. 141). Interest rates generally have great difficulty rejecting unit-root dynamics (Daniels et al. 1996, Lee et al. 1998).

However one of the main points of criticism towards ADF is that it has low power, especially in small samples if the series is stationary but with the root close to the non-stationary boundary. This means that it will falsely suggest a non-stationary time series while it in reality is not.

3.1.2. AKAIKE AND SCHWARZ INFORMATION CRITERIA

As stated earlier, time series analysis involves both model identification and parameter estimation, and a selection criterion that balances model, fit, and model complexity must be used to arrive at a model. The Akaike information criterion (AIC) (Akaike 1974) and Schwarz information criterion (SIC) (Schwarz 1978) are two objective measures of a model's suitability, which take these considerations into account. They differ in terms of the penalty attached to increasing the model order.

Given $y_1,...,y_n$ the maximum value of the likelihood for the jth model under consideration is $M_j(y_1,...,y_n)$.

The Akaike procedure is to choose the model that minimizes:

$$\mathrm{AIC} = -2\ln M_j(y_1,...,y_n) + 2k_j$$

Where k_j is the number of free parameters in the model.

The Schwarz criterion is to choose the model that minimizes:

$$\text{SIC} = -2\ln M_j(y_1,...,y_n) + k_j \ln n$$

Therefore, if n ≥ 8, the Schwarz criterion will tend to favour models of lower dimension than those chosen by the AIC. This criterion concluded that the AIC would frequently choose higher order models for empirical data. Also, in forecasts for series when the AIC and SIC models differ, there is evidence that neither criterion has a clear edge in identifying models having small prediction set errors (Murphree & Koehler 1988, p. 187).

3.1.3. KWIATKOWSKI-PHILLIPS-SCHMIDT-SHIN

In order to circumvent the problem that unit root tests often have low power, Kwiatkowski, Phillips, Schmidt and Shin (1992) propose an alternative test where stationarity is the null hypothesis and the existence of a unit root is the alternative. The basic idea is that a time series is decomposed into the sum of a deterministic time trend, a random walk and a stationary error term. The null hypothesis specifies that the variance of the random walk component is zero. The test is actually a Lagrange multiplier test. First, run an auxiliary regression of Y_t upon an intercept and a time trend *t*. Next, save the Ordinary Least Squares OLS residuals ε_t and compute the partial sums

$$s_t = \sum_{s=1}^{t} \varepsilon_s \text{ for all } t \text{ .}$$

Then the test statistic is given by:

$$KPSS = \sum_{t=1}^{T} s_t^2 / \hat{\sigma}^2$$

Where $\hat{\sigma}^2$ is an estimator for the error variance.

KPSS test is used for testing the null hypothesis that an observable time series is stationary around a deterministic trend against the alternative of a unit root. The series is expressed as the sum of deterministic trend, random walk, and stationary error, and the test is a Lagrange Multiplier test of the hypothesis that the random walk has zero variance.

3.2. COINTEGRATION TEST WITH STRUCTURAL BREAKS

Structural breaks have been discussed intensively in the context of univariate autoregressive time series with a unit root. The empirical literature making use of unit root and cointegration tests has been growing over the last two decades. The application of those tests is challenging for many reasons including the treatment of deterministic terms (constant and trend) and structural breaks. Cointegration is a technique that has been used the last decades in order to illustrate a long-run economic relationship. The appeal of the cointegration analysis is that it provides an effective formal framework for estimating, testing and modelling long-run economic relationships from time-series data. Cointegration analysis allows nonstationary data to be used so that spurious results are avoided. It also provides applied econometricians an effective formal framework for testing and estimating long-run models from actual time-series data. Testing for cointegration is a test for the existence of the equilibrium relationship postulated.

Cointegration describes a long run linear combination of many series. Variables are co-integrated when a linear combination among them is stationary even though the variables are not stationary. However, a regression on non-stationary series will produce spurious correlation among the variables. If single variables in a model have different trend processes, they can not stay in a fixed long run relation to each other and there is no valid base for inference based on standard distributions. Therefore it is necessary to use stationary variables when we make regression among the variables. If cointegration is found among the variables, Vector Error Correction Model (VECM) will be applied. So the first step to test the cointegration is by determining the degree of integration in every variable by using the unit root test and then estimate the cointegration regression and test integration.

In what follows we assume that structural breaks occur at known break points. There is a vast literature on structural breaks and unit root tests. If a series is stationary around a deterministic trend with a structural break we are likely to accept the null of a unit root even if we include a trend in the ADF regression.

There is a similar loss of power in the unit root tests if the series present a shift in intercept. If the breaks are known the ADF test can be adjusted by including dummy variables in the ADF regression as in the case with unit root testing, structural breaks in the data can distort substantially standard inference procedures for cointegration. Thus, it is necessary to account for possible breaks in the data before inference on cointegration can be made. In the recent literature on cointegration in a VAR framework, there are two main approaches that test for cointegration in the presence of structural breaks. The models that have been suggested are: (A) ‘crash model’ with change in intercept but unaffected slope of the linear trend, (B) ‘changing growth model’ with no change in intercept but changing slope of trend function, and (C) where both intercept and slope are changed at the time of the break.

The most common method to test for the cointegration rank is the maximum likelihood cointegration test method developed by Johansen (1988, 1996). It is, however, the case that the inclusion of intervention dummies affects the distribution of cointegration tests. Johansen *et al.* (2000, henceforth called JMN) generalized the likelihood-based cointegration analysis developed by Johansen (1988, 1996) to the case where structural breaks exist at known points in time. It is associated with models A and C, in this way: JMN generalizes model C and allows for testing hypotheses corresponding to model A.

JMN takes trend breaks into account, but neglects the possibility of fractional cointegration. JMN extends the standard VECM with additional dummy variables in order to account for q exogenous breaks in the deterministic components of a vector-valued stochastic process. It extends the standard VECM with a number of additional dummy variables in order to account for *q* possible exogenous breaks in the levels and trends of the deterministic components of a vector-valued stochastic process. In JMN the entire transition period of the lag polynomial in a multivariate context is “wiped” out of the likelihood function by means of impulse dummies. JMN then derived the asymptotic distribution of the likelihood ratio (LR) or trace statistic for cointegration and obtain critical values or p-values, using the response surface method. To illustrate the JMN approach, consider briefly the simple case with only level shifts in the constant term μ of an observed *p*-dimensional time series y_t, $t = 1, 2, ..., T$ of possibly

$I(1)$ variables. JMN divide the sample observations into q sub-samples, according to the location of the break points, and assume the following VECM(k) for y_t conditional on the first k observations of each sub-sample $y_{T_{j-1}+1},...,y_{T_{j-1}+k}$:

$$\Delta y_t = \Pi y_{t-1} + \mu D_t + \sum_{i=1}^{k}\sum_{j=2}^{q} g_{ji} D_{j,\mathrm{t-i}} + \varepsilon_t \qquad \varepsilon_t \sim \mathrm{iidN}(0,\Omega) \quad (3.10)$$

Where $\mu = (\mu_1,...,\mu_q)$ and $D_t = (D_{1,t},...,D_{q,t})'$ of dimension (pxq) and (qx1) respectively, and the $D_{\mathrm{j},t}$'s are dummy variables, such that $D_{\mathrm{j},t} = 1$ for $T_{j-1} + k + 1 \le t \le T_j$ and $D_{\mathrm{j},t} = 0$ otherwise, for $j = 1,2,...,q$. provides a simple explanation of the specification of intervention dummies. The hypothesis of at most r co integrating relations $(0 \le r_0 \le p)$ among the components of y_t can be stated in terms of the reduced rank of the (pxp) matrix $\Pi = \alpha\beta'$, where α and β are matrices of dimension (pxr). Π embodies information on the long-run relationships between variables comprising the data set. As such it is the rank r of the matrix Π that indicates the number of co integrating vectors. If Π has a zero rank, then no stationarity linear combination can be identified and the variables y are non co integrated meaning that they can wander arbitrarily far from each other. If Π has a reduced rank r, $0 \le r \le n$, then it can be decomposed into two nxr matrices, α and β. α can be interpreted as a matrix of vector error correction parameters or short run adjustments, while β can be interpreted as the long-run relations. Under the null of cointegration, we restrict the trend to the co integrating relationships to exclude the possibility of quadratic trends in any time series. The cointegration hypothesis can then be tested by the likelihood ratio statistic:

$$LR_{JMN} = -T \sum_{i=r_0+1}^{p} \ln(1 - \hat{\lambda}_i) \quad (3.11)$$

Where the eigenvalues $\hat{\lambda}_j$'s can be obtained by solving the related eigenvalue problem, based on estimation of the VECM(k) in equation (3.10), under the restrictions that $\mu_j = a\rho_j'$, $j = 1,2,...,q$, where ρ_j is of dimension 1xr. These restrictions are required in order to eliminate a linear trend in the level of the process

y_t. (Johansen *et al.*, 2000, p. 218). The trace test, tests the null hypothesis of r co integrating vectors against the alternative hypothesis of n co integrating vectors. Johansen *et al* (2000) develop a maximum likelihood cointegration test method based on the squared sample canonical correlations, $\hat{\lambda}_i$, Δy_t. In addition, Johansen *et al.* (2000) show that the asymptotic distributions of the likelihood ratio test is well approximated by a Γ-distribution.

One of the advantages of this approach is the side effect that the transition period is dropped from the sample which may be useful if that period could not be easily modelled. Apart from that it avoids both of the following problems: The first step of the two-step (additional outlier) approach works well in finite samples only if there are no such dominant seasonal spikes. Including seasonal dummies in the first step would pose the problem that we could not test the significance of the break of the seasonal pattern, because the first step inference is infeasible due to strongly auto correlated residuals. The second problem that can be avoided by using JMN is that the innovational outlier approach that restricts the dynamic multipliers of the mean shift innovation to be equal to those of the regular stochastic innovations.

Cointegration modelling is applied in this analysis because it holds several intuitive implications that appropriate for this research. When the variables are co integrated, then in short-run, deviations from the long-run equilibrium will feed back on the changes in the dependent variable in order to force the movements towards the long-run equilibrium.

4. DATA AND EMPIRICAL RESULTS

4.1. DATA

In general, empirically validity of PPP and UIP is very sensitive to the choice of countries, and specific variables like exchange rate regime, and the use of price index and interest rates. For this study, the choice of the countries, the sample period and the variables may be justified in the following way. The study about the behaviour of the exchange rate and its responses to macroeconomic variables, particularly prices and interest rates, assume significance for all economies around the world since increased global trade and financial integration has been one of the major trends shaping the world economy over recent years. The wave of financial integration over recent decades, triggered by the gradual dismantling of Bretton Woods-inherited restrictions on international capital mobility and a decline in information processing and dissemination costs that has significantly affected all the economies.

For the purpose of my research I collected data for the USA, United Kingdom, Switzerland and Japan and I used the EMU as a bench mark country. Exchange rates, interest rates and consumer price indexes were obtained for the four countries and EMU. The sample is consisted of monthly observations that start from 1999:01 for all countries and EMU to latest 2015 observations depending on data availability for investigating the validity of CHEER. All exchange rates against the euro that have been used are average exchange rates and were obtained from Eurostat, with the sample including data for the Euro/U.S. Dollar, Euro/British Pound, Euro/Swiss franc and Euro/Japanese yen from 1999:01-2015:09. For prices I used the harmonized consumer price index (HCPI) for the EMU and the consumer price indexes (CPI) for all of the four countries which were obtained from the International Financial Statistics of the International Monetary Fund, all HCPI and CPI were form 1999:01-2015:08, with the exception of the Japanese that was from 1999:01-2015:07. Finally, the default measure of interest rates is the 10 year yield government bond, data for interest rates were obtained from Eurostat and covered the period between 1999:01-2015:09 for the Swiss and the British and 1999:01-2015:08 for the rest. The nominal exchange rates and price indices are expressed in natural logarithms, and all quoted interest rates are in percentages.

Figure 1: Exchange rate fluctuations

Euro/US dollar, Euro/UK pound, Euro/Japanese yen and Euro/Swiss franc denote the logarithm values of nominal monthly average exchange rates.

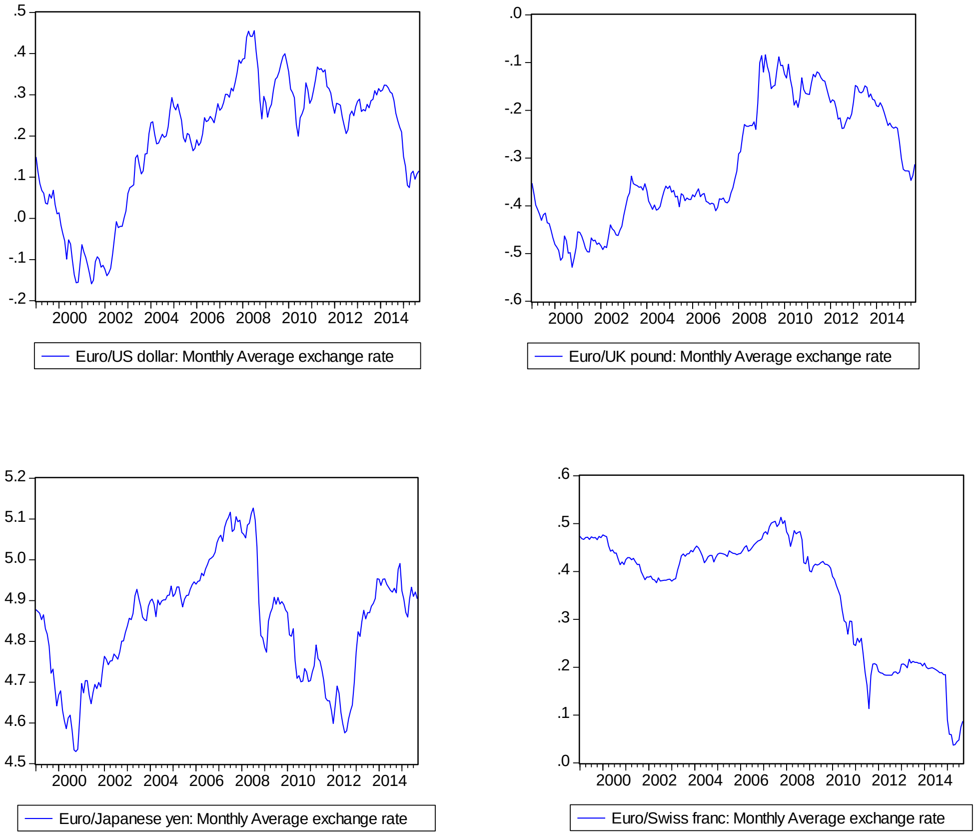
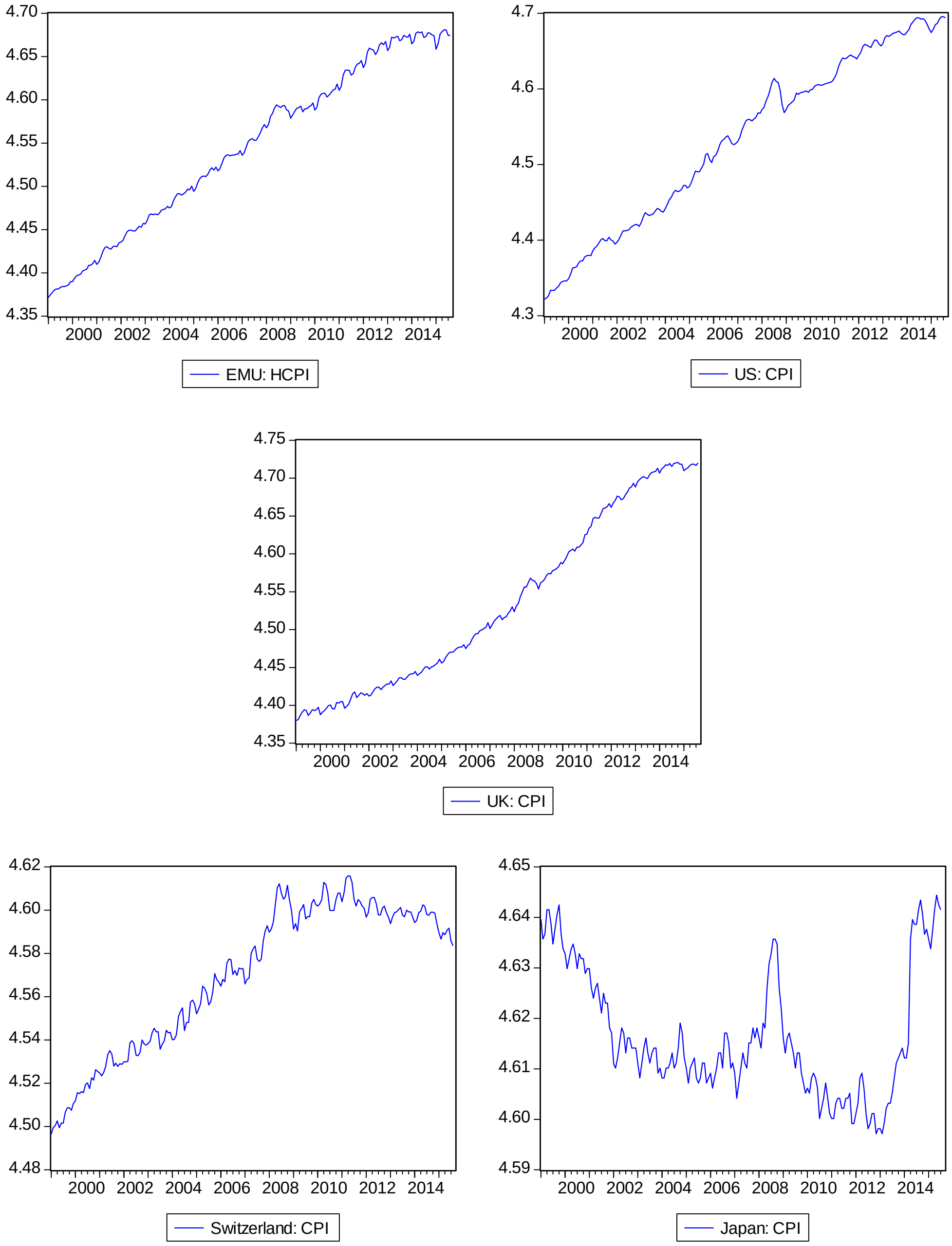


Figure 2: Interest rate fluctuations

For interest rates is used the 10 year government bond yield for each country.

Figure 3: Prices fluctuations

As a default measure for prices is used the HCPI for Euro Area and the CPI for all countries namely USA, UK, Japan and Switzerland. They are expressed in logarithms.



Both exchange rates and prices (HCPI for EMU and CPI for the US, UK, Japan and Switzerland) are in logarithms. The 10-year government bond yields that are used as a default measure for interest rates in this study seem to have the same trend. Since 1999 the 10-year government bond yields has the tendency to fall. Moreover since 1999 prices increased for all of the EMU, US, UK and Switzerland, while Japan followed a different road. Japanese CPI had a downward trend from 1999-2007, when it started an upward trend that continued until 2009. From 2009 there was a trend towards reducing the CPI that halted in 2012 when the Japanese CPI started to shoot up. Concerning the exchange rates, the first two years of the new currency of the EMU followed with an appreciation for currencies under examination (Swiss franc remained almost steady). The appreciation period followed by a depreciation period for the US, UK and Japan that continued since 2008. The years that followed the global economic crisis illustrate fluctuations of the exchange rates of the euro/US dollar and the euro/UK pound with times were there was an appreciation for either the US dollar or the UK pound against the euro, and others that there was depreciation, with a tendency of appreciation for both currencies. The Euro/Japanese yen relations characterizes by the appreciation of the Japanese yen against the euro from 2008-2012 and depreciative tendencies since 2012, while the Swiss franc appears to have appreciative tendencies against the euro since 2008.

4.2. UNIT ROOT TESTS

Before proceeding to the implementation of the CHEER approach for each of the four countries that were mentioned above and the EMU, each time series was first tested for a unit root. More specifically, the study tested whether all the said variables are integrated of order one, I (1). For this reason each time series was tested for a unit root using the ADF and the KPSS tests at the 1, 5 and 10 per cent level of significance.

ADF examines the null hypothesis of a unit root against stationary alternatives. Since the null hypothesis maintained is a nonstationary process, empirical failures to find stationarity may reflect the power of the test (Cheung & Lai 1995, p. 411). On the other hand KPSS tests the null hypothesis of stationarity against the alternative of a unit root (Kwiatkowski et al. 1992, p. 159). All the ADF and KPSS tests regressions are estimated, at levels for each country with a constant term. In conducting the ADF test, an issue that arises is the choice of the order of the auto regression used in the testing equation. In this case the Akaike Information Criterion and the Schwarz Information Criterion were used to select an appropriate lag length for the ADF tests in order to remove any manifest serial correlation. Table 2 presents the unit root results from the ADF test and Table 3 the KPSS that were conducted for levels.

According to Perron (1989, pp. 1361) 'most macroeconomic time series are not characterized by the presence of a unit root. Fluctuations are indeed stationary around a deterministic trend function. The only 'shocks' which have had persistent effects are the 1929 crash and the 1973 oil price shock'.

Table 2: Augmented Dickey Fuller Test Statistics at Levels

Country	**Variable**	**k Schwarz criterion**	**ADF Schwarz criterion**	**k Akaike info criterion**	**ADF Akaike info criterion**
USA	e	1	-1.53 (0.512)	1	-1.53 (0.512)
	i	1	-1.40 (0.581)	2	-1.24 (0.653)
	p	2	-1.46 (0.551)	8	-2.12 (0.234)
UK	e	1	-1.24 (0.656)	1	-1.24 (0.656)
	i	1	-1.02 (0.745)	6	-0.37 (0.910)
	p	13	-0.42 (0.900)	14	-0.123 (0.944)
Switzerland	e	0	0.40 (0.982)	0	0.08 (0.964)
	i	0	0.13 (0.967)	0	0.13 (0.967)
	p	12	-1.99 (0.289)	12	-1.99 (0.289)
Japan	e	1	-2.01 (0.283)	1	-2.01 (0.283)
	i	1	-1.94 (0.311)	1	-1.94 (0.3119)
	p	1	-1.99 (0.287)	12	**-2.73 (0.069)**
EMU	i*	1	-0.50 (0.886)	2	-0.23 (0.9309)
	p*	13	-1.76 (0.397)	14	-1.78 (0.386)

Note: All the test regressions contain a constant term. e represents the natural logarithm of the monthly average exchange rate of each country under examination currency against the euro, p the natural logarithm of the CPI for each country under examination, p* the natural logarithm of the HCPI of the EMU, i the 10-year government bond yields for the countries under concern while i* the 10-year government bond yields for the EMU. k represents the number of lags for Schwarz and Akaike info criteria. In the parenthesis are the p-values. Bold values indicate the rejection of unit root null hypothesis at the 10% level of significance. For 5% and 1% level of significance we fail to reject the null hypothesis of the ADF test.

Table 3: KPSS Test Statistics at Levels

Country	Variable	LM
USA	e	1.03
	i	1.49
	p	1.75
UK	e	1.31
	i	1.49
	p	1.73
Switzerland	e	1.24
	i	1.49
	p	1.59
Japan	e	**0.26**
	i	1.04
	p	**0.34**
EMU	i*	1.06
	p*	1.75

Note: This table presents the KPSS test results. The asymptotic critical values are for 0.01, 0.05 and 0.10 level of significance 0.739, 0.463, 0.347. The bold values indicate the fail of rejection of null hypothesis at the all levels.

The results that are presented on Table 2 depict that the null hypothesis of non-stationary cannot be rejected at 0.05 level of significance for all the said series at levels. The results of the KPSS test that are presented on Table 3 show that we reject the null hypothesis for all the variables at 5 per cent level of significance except for the exchange rate of the euro/Japanese yen and the Japanese prices where we fail to reject the null hypothesis. The time series data on exchange rates, prices and interest rates are found to be nonstationary time series. From the test of ADF and KPSS in first differences it could be said that the time series under examination are *I*(1) (Appendix 1).

4.3. COINTEGRATION TEST

The validity of the CHEER approach is tested by examining the cointegration results with structural breaks on the vector $\mathrm{y}_t = [\mathrm{e}_t, p_t, p_t^* i_t, i_t^*]$, which includes exchange rate, prices and interest rates. Given the non-stationarity of all variables for the countries under examination, the vector of exchange rates, interest rates and prices is viewed as a system of possibly co integrated variables. For this reason the number of cointegrating relationships was tested. The results are based on the JMN procedure.The JMN procedure was used in order to estimate the number of co integrating vectors and to derive a likelihood ratio test for the null hypothesis, that there are a given number of these relationships. In each case, the vector y_t contains the nominal exchange rate, prices and interest rates. The break was introduced exogenously in 2007:12, as the global financial crisis and had, of course, a significant impact on world's economies.

In the JMN procedure I estimated the VECM in equation (3.10) for each country and computed the LR_{JMN} test statistics and the corresponding response surface *p* values. The asymptotic distribution depends on the location of break date and other parameters as shown by Johansen *et al*. (2000). The critical values are found by response surface analysis in Johansen *et al*. (2000) and implemented in JMulTi. I tested the hypothesis of no cointegration. The likelihood ratio (LR) test is used to test the validity of the restrictions. Also, the Schwarz and Akaike criterion were used in order to select the optimal lag length, *k*, in the VECM for each of the four countries.

Table 4 reports the LR_{JMN} test statistics and the respective *p*-values, for each of the four countries.

Table 4: Cointegration Test with structural break

Country	$(p - r_0)$	LR	p-values	Optimal number of lags
United Kingdom	5	171.91***	0.000	13
	4	104.57***	0.000	
	3	58.08	0.610	
	2	32.69	0.145	
	1	13.14	0.278	
United States	5	147.09***	0.000	2
	4	90.15**	0.017	
	3	55.45*	0.099	
	2	24.68	0.535	
	1	7.68	0.774	
Japan	5	128.89**	0.003	1
	4	86.17**	0.036	
	3	54.81	0.111	
	2	27.49	0.368	
	1	8.00	0.744	
Switzerland	5	118.22**	0.023	1
	4	77.21	0.152	
	3	44.2	0.481	
	2	21.8	0.713	
	1	7.6	0.781	

Note: The value reported at the top of each column is for $r_0 = 0$, so that $p - r_0 = p$, where p = 5 (i.e. the dimension of the VECM). k denotes the estimated lag length in the VECM. *** denotes rejection of the null hypothesis at the 0.01, ** at the 0.05 and * at the 0.10 level of significance.

As shown in the table, the JMN test indicates two cointegrating vectors for the Euro Area/United States, the Euro Area/United Kingdom, the Euro Area/Japan and one cointegrating vector for the Euro Area/Switzerland case at 5 per cent level of significance. Based on arbitrage in the commodity and capital markets, the long-run economic theory posits the existence of two cointegrating vectors.

Pesaran and Smith (1999) argued that any empirical analysis contains the following; balancing consideration of purpose and statistical adequacy. Moreover the number of lags that is suggested is too low and an increase in the number of lags changes the results of the number of co integrating vectors. For the purpose of further analysis, I used economic theory for the Swiss case. So I assume that all countries under consideration have two cointegrating vectors. The evidence of two cointegrating relationships, as shown in Table 4, implies that the PPP and UIP conditions may hold for all sample countries. The first cointegrating vector has the highest eigenvalue, and is therefore the "most associated with the stationary part of the model" (Johansen & Juselius 1992, p 192). Having established a valid relationship, which can be interpreted as the long-run relationship, between the nominal exchange rate and the fundamentals, we estimate the corresponding VECMs.

4.4. TESTING THE STRUCTURE OF COINTEGRATING VECTORS

Based on the cointegration results of the previous section, we have established a valid relationship, which can be interpreted as the long-run relationship between exchange rates, prices and interest rates. Following the above, we estimate the corresponding VECMs, so the next step in our analysis is to examine the validity of the CHEER approach, by investigating the interrelations between the PPP and the UIP conditions. For this reason I employed the tests proposed by Johansen and Juselius (1992) and Juselius (1995). The building idea behind the CHEER approach is the long run persistence in both the real exchange rate and the interest rate differential. Actually, this implies that edthe PPP cannot alone explain exchange rate movements and that the interest rate differential has no transitory effects on the real exchange rate (Giannellis & Koukouritakis 2013, p. 207).

Johansen and Juselius (1992) and Juselius (1995) show that, for a q-dimensional system with r cointegration vectors, restrictions on the cointegration structure can be tested by formulating $\beta = [\mathrm{H}_1\Psi_1, ..., \mathrm{H}_r\Psi_r]$, where H_i are (pxq_i) design matrices and Ψ_i are $q_i x1$ vectors of q_i free parameters.

JMN derives the asymptotic distribution of the likelihood ratio (LR) or trace statistic for cointegration and obtain critical values or p-values. Firstly, I tested the LR test statistic as the hypothesis that the first cointegration vector describes the PPP condition with unrestricted interest rates, while the second co integrating vector describes the UIP condition with unrestricted prices. This means that the co integrating vectors are $\beta_1 = [1, -1, 1, \Psi_{11}, \Psi_{12}]$ and $\beta_2 = [1, \Psi_{21}, \Psi_{22}, -1, 1]$ while the respective design matrices have the following form:

$$H_1 = \begin{bmatrix} 1 & 0 & 0 \\ -1 & 0 & 0 \\ 1 & 0 & 0 \\ 0 & 1 & 0 \\ 0 & 0 & 1 \end{bmatrix} \qquad H_2 = \begin{bmatrix} 1 & 0 & 0 \\ 0 & 1 & 0 \\ 0 & 0 & 1 \\ -1 & 0 & 0 \\ 1 & 0 & 0 \end{bmatrix}$$

This LR test, which captures the proportionality and symmetry conditions, is distributed asymptotically as χ^2, with two degrees of freedom. If the above hypothesis cannot be rejected for a specific country, which means that the nominal exchange rate of this country is economically related with the interest rate and price differentials, I performed the following two LR tests. The hypothesis that the first vector includes only PPP and the second includes only UIP can also be tested. The restricted vectors are: $\beta_1 = [1, -1, 1, 0, 0]$ and $\beta_2 = [1, 0, 0, -1, 1]$, while the respective design matrices have the following form:

$$H_3 = \begin{bmatrix} 1 \\ -1 \\ 1 \\ 0 \\ 0 \end{bmatrix} \qquad H_4 = \begin{bmatrix} 1 \\ 0 \\ 0 \\ -1 \\ 1 \end{bmatrix}$$

This LR test is distributed asymptotically as χ^2, with six degrees of freedom. The other test refers to the hypothesis that the first vector describes the PPP condition with unitary coefficients and restricting interest rates to have equal and opposite signs, while the second co integrating vector the UIP condition with unitary coefficients and restricting prices to have equal and opposite signs. This test was performed since the adjustments in both asset and commodity markets may be interdependent in a financially open economy, and thus, the two parity conditions may be considered jointly. In this case, the co integrating vectors are $\beta_1 = [1, -1, 1, -\Psi_{11}, \Psi_{11}]$ and

$\beta_2 = [1, -\Psi_{21}, \Psi_{21}, -1, 1]$, while the respective design matrices have the following form:

$$H_5 = \begin{bmatrix} 1 & 0 \\ -1 & 0 \\ 1 & 0 \\ 0 & -1 \\ 0 & 1 \end{bmatrix} \qquad H_6 = \begin{bmatrix} 1 & 0 \\ 0 & -1 \\ 0 & 1 \\ -1 & 0 \\ 1 & 0 \end{bmatrix}$$

This LR test is distributed asymptotically as χ^2, with four degrees of freedom.

The results of these tests for the USA, UK, Japan and Switzerland are presented in Table 5. Based on the evidence of valid long-run co integrating relationships, I aim to estimate the equilibrium value of the examined exchange rates and the implied exchange rate misalignment. The evidence of two co integrating relationships, as shown in Table 5, implies that the PPP and UIP conditions may hold for all sample countries.

Table 5: LR Tests for the Structure of Co integrating Vectors

Country	**H1, H2** (PPP with unrestricted interest rates, UIP with unrestricted prices)	**H3, H4** (Only PPP, only UIP)	**H5, H6** (PPP with interest rates with equal and opposite signs, UIP with prices with equal and opposite signs)
USA	3.21 (0.201)	67.82*** (0.000)	34.65*** (0.000)
UK	2.24 (0.326)	22.48*** (0.001)	19.02*** (0.001)
Switzerland	5.69** (0.058)	41.95*** (0.000)	21.16*** (0.000)
Japan	4.60 (0.100)	33.82*** (0.000)	25.45*** (0.000)

Notes: All numbers are LR test statistics. *H*1, *H*2 are the design matrices for the null hypothesis that the first co integrating vector describes the PPP condition with unrestricted interest rates and the second co integrating vector describes the UIP condition with unrestricted prices. This LR test, which captures the proportionality and symmetry conditions, is distributed asymptotically as χ^2, with two degrees of freedom. *H*3, *H*4 are the design matrices for the null hypothesis that the first vector includes only the PPP condition, while the second vector includes only the UIP condition. This LR test is distributed asymptotically as χ^2, with six degrees of freedom. *H*5, *H*6 are the design matrices for the null hypothesis that the first vector describes the PPP condition, having restricted the two interest rates to have equal and opposite signs, while the second vector includes the UIP condition, having restricted the two prices to have equal and opposite signs. This LR test is distributed asymptotically as χ^2, with four degrees of freedom. Numbers in parentheses are *p* values. *** denotes rejection of the null hypothesis at the 0.01, and * at the 0,10 level of significance.

As shown in second column of table 5, the hypothesis that the first vector describes the PPP and the second vector describes the UIP, with proportionality and symmetry conditions cannot be rejected for any of the countries under examination at the 5 per cent level of significance. Since the design matrices H_1 and H_2 for the four countries under consideration could not be rejected for 5 per cent of significance, at first I tested if the first vector includes only the PPP condition and the second vector includes only the UIP condition, for this reason I used the restrictions defined by the design matrices H_3 and H_4, as described above. As shown in column 3 of Table 5, this hypothesis is strongly rejected in all four countries, at the 1, 5 and 10 per cent level of significance. Lastly, I performed the test that refers to the hypothesis that the two parity conditions are considered jointly, and I used the restrictions defined by the design matrices H_5 and H_6. As shown in column 4 of Table 5, this hypothesis is strongly rejected for all countries at 1, 5 and 10 per cent level of significance. These results indicate that the CHEER approach is not valid for any of the countries under examination. This means that for none of these countries the deviations from the PPP condition can be explained by the interest rate differential, while the deviations from the UIP condition can be explained by the price differential. The above results also indicate that in each country plausible economic relationships between the nominal exchange rate and each of the price and interest rate differentials.

The evidence shows that neither the PPP condition nor the UIP condition alone can be valid. This result is consistent with those of previous studies (Johansen & Juselius 1992; Juselius, 1995; MacDonald & Marsh, 1997; Juselius & MacDonald, 2000; Özmen and Gökcan 2004; Koukouritakis 2013; Giannellis & Koukouritakis 2013), whose evidence is in favour of the validity of the two parity conditions only when parities' interdependence is allowed.

Table 6: Structural Representation of the Co integrating Space: PPP and UIP Conditions

Country	s	P	p*	I	i*
USA	1	-1	1	-0.12 (0.038)	-0.11 (0.037)
	1	142.07 (16.180)	-221.29 (21.180)	-1	1
UK	1	-1	1	-5.28 (0.363)	2.50 (0.430)
	1	-21.72 (7.485)	36.35 (9.221)	-1	1
Switzerland	1	-1	1	-0.09 (0.020)	0.02 (0.015)
	1	-531.86	129.98 (53.907)	-1	1
Japan	1	-1	1	0.59 (0.123)	-0.03 (0.053)
	1	10.763 (13.242)	-110.21 (19.587)	-1	1

Note: For each country, the first line represents the vector that describes the PPP condition, while the second line represents the vector that describes the UIP condition. Standard errors are in the parentheses.

Table 6 presents a structural representation of the cointegration space, based on the restrictions defined by H_1 and H_2 for all four countries. Only in the case of USA the unrestricted interest rates have the same sing. In all the other cases unrestricted interest rates and prices present opposite signs.

CONCLUDING REMARKS

The increasing integration of the global capital market, brought about by the adoption of open capital accounts and facilitated by technological advances, has benefitted the world economy as a whole. It has also, at the same time, introduced new challenges for the overall macroeconomic management. The incidences of financial and currency crisis and the frequency with which they occur over the past decade are the reminders of the risks these challenges come with.

Under the present global economic environment, measuring the degree of misalignment and its fundamental determinants will increasingly be important elements for macroeconomic management of open economies. Needless to say, having the appropriate tools is imperative for meeting these mounting challenges.

In an open economy the determination of exchange rates is of crucial importance to an understanding of the links between the domestic and foreign economies. The transmission of foreign price inflation into the domestic economy has usually been analyzed either in the goods market by assuming adjustment to purchasing power parity or in the capital market by assuming market clearing based on uncovered interest rate parity.

The present study tested the validity of the CHEER approach. The empirical analysis has been performed relatively to the four bilateral cases; the EMU/USA, the EMU/UK, the EMU/Japan and the EMU/Switzerland. The ADF and KPSS tests were performed to check the time series properties of the variables and the JMN to investigate the existence of a cointegrating relation, in the presence of structural break in the data. The break is important as it represents the beginning of the global crisis in December 2007.

The cointegration test was used because it can capture the economic notion of long-run economic relation. The JMN cointegration test, results in the presence of a structural break show evidence of two cointegrating vectors for UK, Japan and USA and one for Switzerland. Each system contains one of the countries under examination and the EMU's interest rates, prices and the exchange rates. As economic theory posits that we should expect two cointegrating vectors in long run, I assumed that there are two cointegrating vectors for Switzerland too. Any linear combination of the stationary vectors is also a stationary vector and therefore a direct interpretation is not always interesting. The first cointegration vector appears explaining the long run evolution of interest rates, it contains the assumed PPP relation among the three variables, while the second one representing the inflation rate equation for each of the countries.

Although the hypothesis that the first cointegrating vector describes the PPP and the second vector describes the UIP, with proportionality and symmetry conditions cannot be rejected for none of the countries at 10 per cent of significance, it is rejected for Switzerland at 5 % of significance. The empirical results of the study for the USA, UK, Japan, Switzerland and the EMU as bench mark country show that the CHEER approach is not valid for any of these countries. The reason could be found according to the theory in differences that may appear on monetary targeting, regulation of the financial markets, foreign exchange intervention, different taxes and subsidies and even macroeconomic stability and business and political traditions differences between the EMU and each of these countries.

The empirical analysis also showed that the PPP and UIP hypotheses do not hold independently, an outcome that is consistent with previous empirical studies (Johansen & Juselius 1992; Juselius, 1995; MacDonald & Marsh, 1997; Juselius and MacDonald, 2000; Özmen and Gökcan 2004; Koukouritakis 2013; Giannellis & Koukouritakis 2013). That means that it is important to examine the equilibrium exchange rate determination by combining both parities.

Countries are able to choose among the full range of monetary regimes from fixed to floating and are able to organize their monetary and intervention policies as they see fit. The previous crisis showed that the absence of the control of global liquidity is a result of the uncoordinated decisions of the central banks issuing key currencies, that may lead to global asset bubbles or global deflation and moreover exchange rate volatility and misalignments may, at times, be excessive and require a credible commitment to resist them by modifying the policies of systemically important countries (James *et al.* 2012, p. 145).

More than thirty years of empirical research in international finance has attempted to resolve whether exchange rates are predictable. It would be overly simplistic to believe that all that drives exchange rates is goods prices and interest rates. The empirical evidence of this study and previous studies suggests that the PPP and UIP are at least a good first approximation or a starting point for the long-run exchange rate equilibrium determination. Although it is important to find what are the other main determinants of the long run exchange rate, in order to provide even better models. An economy's balance of debt, public debt, speculations, government's intervention or even its size could play a significant role on the improvement of exchange rate equilibrium determination.

Even though the world is still a closed economy, its countries and regions are becoming increasingly open and exchange rates are a key macroeconomic price in international economics. Exchange rate misalignment is perceived to be the culprit of both domestic and global economic ills, including inflationary pressures, trade imbalances, and misallocation of resources within an economy and across trading partners (Hinkle & Montiel 1999, p. 602). Therefore, investigating exchange rate misalignment would be vital in the formulation of an appropriate exchange rate policy and understanding of interrelations between countries.

There is a need to continue the research by using different default measures for both prices and interest rates and different data frequencies. Moreover it would be interesting to take under consideration the examination of other main structural breaks that may occurred during the last 15 years. Finally it would also be interesting the use of panel approach as opposed to country to country analysis when we approaching the exchange rate determination and compare the econometric results.

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APPENDICES

APPENDIX 1: UNIT ROOT TESTS IN FIRST DIFFERENCES

Table Appendix 1.1: Augmented Dickey Fuller test Statistics in First Differences

Country	variable	K Schwarz criterion	ADF Schwarz criterion	k Akaike info criterion	ADF Akaike info criterion
USA	S	0	**-10.30 (0.000)**	1	**-9.12 (0.000)**
	I	0	**-11.54 (0.000)**	6	**-6.92 (0.000)**
	P	1	**-9.16 (0.000)**	7	**-7.33 (0.000)**
UK	S	0	**-11.29 (0.000)**	0	**-11.29 (0.000)**
	I	0	**-10.33 (0.000)**	5	**-7.65 (0.000)**
	P	12	-2.23 (0.1931)	13	**-2.70 (0.075)**
Switzerland	S	0	**-12.02 (0.000)**	0	**-12.02 (0.000)**
	I	0	**-13.07 (0.000)**	0	**-13.07 (0.000)**
	P	11	**-2.78 (0.063)**	11	**-2.78 (0.063)**
Japan	S	0	**-10.15 (0.000)**	3	**-7.05 (0.000)**
	I	0	**-12.36 (0.000)**	0	**-12.36 (0.000)**
	P	0	**-11.47 (0.000)**	11	**- 2.58 (0.090)**
EMU	I*	0	**-10.93 (0.000)**	1	**-9.65 (0.000)**
	P*	12	-2.29 (0.174)	13	-2.55 (0.104)

Note: The test regressions contain a constant term. k represents the number of lags for Schwarz and Akaike info criteria. Bold values indicate the rejection of unit root null hypothesis at the 10% level of significance.

Table Appendix 1.2: KPSS test Statistics in First Differences

Country	Variable	LM
USA	s	0.16
	i	0.06
	p	0.16
UK	s	0.18
	i	0.11
	p	0.34
Switzerland	s	0.24
	i	0.18
	p	0.39
Japan	s	0.08
	i	0.07
	p	0.36
EMU	i*	0.27
	p*	0.38

Note: This table presents the KPSS test results in first differences. The asymptotic critical values are for 0.01, 0.05 and 0.10 level of significance 0.739, 0.463, 0.347. The bold values indicate the fail of rejection of null hypothesis at the all levels.

APPENDIX 2: COINTEGRATION TESTS

The following tables present the cointegration test result where it was used, just constant and constant with trend, and as a default measure for exchange rate was used either the end of period or the average exchange rate, while for the default measure of interest rate was used the 10-year government bond yields of Germany or EMU. For this reason there are presented eight different tables. Each table presents one of the cases.

The value reported at the top of each column is for $r_0 = 0$, so that p - r_0 = p, where p = 5 (i.e. the dimension of the VECM). k denotes the estimated lag length in the VECM. *** denotes rejection of the null hypothesis at the 0.01, ** at the 0.05 and * at the 0.10 level of significance.

Appendix Table 2.1: Cointegration Test- Constant with the use of Average Exchange rates and EMU 10-year government bond yield

Country	(p-r0)	LR	p-values	optimal number of lags Schwarz Criterion	LR	p-values	optimal number of lags Akaike Criterion
United Kingdom	5	122.63**	0.000	1	179.46***	0.000	13
	4	64.44**	0.006		101.2***	0.000	
	3	35.2	0.180		56.71***	0.000	
	2	20.78	0.156		32.31***	0.000	
	1	9.15	0.196		11.66	0.079	
United States	5	117.07***	0.000	2	128.18***	0.000	13
	4	76.33***	0.000		71.2***	0.000	
	3	42.67**	0.013		39.79***	0.041	
	2	17.26	0.419		21.3	0.131	
	1	3.57	0.820		9.71	0.162	
Japan	5	112.22***	0.000	1	103.80**	0.000	7
	4	65.51***	0.004		60.91**	0.024	
	3	33.58	0.272		36.99	0.108	
	2	15.47	0.598		20.08	0.196	
	1	4.25	0.735		6.42	0.450	
Switzerland	5	111.95***	0.000	1	171.01***	0.000	13
	4	58.27*	0.057		108.96***	0.000	
	3	35.27	0.178		59.68***	0.000	
	2	20.12	0.194		24.23	0.043	
	1	8.27	0.261		11.29	0.091	

Appendix Table 2.2: Cointegration Test with Constant with the use of Average

exchange rates and Germany's 10-year government bond yield as interest measure

Country	(p-r0)	LR	p-values	optimal number of lags Schwarz Criterion	LR	p-values	optimal number of lags Akaike Criterion
United Kingdom	5	117.29***	0.000	1	139.23***	0.000	13
	4	59.50**	0.038		87.06***	0.000	
	3	29.02	0.622		51.41***	0.000	
	2	16.43	0.501		25.56**	0.024	
	1	5.46	0.573		10.67	0.114	
United States	5	185.71***	0.000	1	147.61***	0.000	13
	4	105.39***	0.000		84.74***	0.000	
	3	60.69***	0.000		49.79***	0.000	
	2	30.63***	0.002		25.31**	0.027	
	1	7.26	0.357		9.05	0.202	
Japan	5	124.75***	0.000	1	114.83***	0.000	7
	4	73.15***	0.000		67.56***	0.001	
	3	35.17	0.183		36.33	0.132	
	2	16.18	0.526		17.82	0.367	
	1	4.14	0.748		7.4	0.342	
Switzerland	5	142.74***	0.000	1	134.76***	0.000	13
	4	91.01***	0.000		75.66***	0.000	
	3	44.44*	0.064		43.08**	0.011	
	2	22.73*	0.078		21.45	0.125	
	1	8.46	0.246		8.03	0.283	

Appendix Table 2.3: Cointegration Test with Constant with the use of end of

period exchange rates and EMU 10-year government bond yield

Country	(p-r0)	LR	p-values	optimal number of lags Schwarz Criterion	LR	p-values	optimal number of lags Akaike Criterion
United Kingdom	5	116.81***	0.000	1	176.31***	0.000	13
	4	61.43**	0.019		97.68***	0.000	
	3	35.08	0.186		54.97***	0.000	
	2	19.48	0.234		28.03***	0.007	
	1	7.75	0.308		11.91*	0.071	
United States	5	159.06***	0.000	1	124.51***	0.000	13
	4	86.73***	0.000		69.70***	0.000	
	3	42.29**	0.015		38.04*	0.076	
	2	18.36	0.320		21.44	0.125	
	1	4.43	0.710		9.62	0.167	
Japan	5	109.14***	0.000	1	102.69***	0.000	7
	4	61.83**	0.017		60.79**	0.025	
	3	35.44	0.170		38.48*	0.067	
	2	16.78	0.466		20.57	0.168	
	1	4.21	0.740		6.86	0.401	
Switzerland	5	108.00***	0.000	1	169.58***	0.000	13
	4	59.13**	0.043		105.32***	0.000	
	3	32.95	0.314		59.99***	0.000	
	2	18.52	0.307		25.52**	0.025	
	1	7.62	0.320		12.61*	0.054	

Appendix Table 2.4: Cointegration Test with Constant with the use of End of Period exchange rates and German 10-year government bond yield

Country	(p-r0)	LR	p-values	optimal number of lags Schwarz Criterion	LR	p-values	Optimal number of lags Akaike Criterion
United Kingdom	5	109.72***	0.000	1	135.98***	0.000	13
	4	55.49	0.123		88.31***	0.000	
	3	29.03	0.622		52.6***	0.000	
	2	16.08	0.536		23.25*	0.064	
	1	5.51	0.566		10.86	0.107	
United States	5	173.70***	0.000	1	139.92***	0.000	13
	4	96.45***	0.000		81.90***	0.000	
	3	51.31***	0.000		46.78***	0.002	
	2	28.00***	0.007		24.33**	0.041	
	1	6.56	0.434		8.59	0.236	
Japan	5	121.48***	0.000	1	111.60***	0.000	7
	4	70.05***	0.000		65.66***	0.004	
	3	35.58	0.164		36.67	0.119	
	2	18.51	0.309		17.69	0.379	
	1	4.2	0.741		7.8	0.303	
Switzerland	5	140.85***	0.000	1	133.11***	0.000	7
	4	92.59***	0.000		79.15***	0.000	
	3	45.99***	0.003		46.67***	0.002	
	2	21.43	0.126		24.31**	0.042	
	1	7.35	0.347		8.88	0.214	

Appendix Table 2.5: Cointegration Test with Constant and Trend with the use of

average exchange rates and Germany's 10-year government bond yield

Country	(p-r0)	LR	p-values	optimal number of lags Schwarz Criterion	LR	p-values	Optimal number of lags Akaike Criterion
United Kingdom	5	99.59	0.279	1	147.44***	0.000	13
	4	61.55	0.679		96.87***	0.004	
	3	37.58	0.783		60.19**	0.039	
	2	16.89	0.929		32.63	0.147	
	1	6.87	0.841		10.83	0.469	
United States	5	146.23***	0.000	2	171.76***	0.000	13
	4	91.28***	0.013		104.52***	0.000	
	3	53.12	0.149		66.11**	0.010	
	2	27.73	0.355		35.24*	0.083	
	1	12.63	0.315		17.42*	0.082	
Japan	5	135.24***	0.000	1	158.19***	0.000	13
	4	85.33**	0.042		103.83***	0.000	
	3	49.84	0.245		57.26*	0.071	
	2	23.48	0.610		33.02	0.135	
	1	9.75	0.574		13.2	0.274	
Switzerland	5	141.55***	0.000	1	206.51***	0.000	13
	4	92.71**	0.010		114.20***	0.000	
	3	56.4*	0.084		62.10**	0.026	
	2	31.24	0.193		28.49	0.315	
	1	11.88	0.376		11.35	0.421	

Appendix Table 2.6: Cointegration Test with Constant and Trend with the use of End of period exchange rates and EMU 10-year government bond yield

Country	(p-r0)	LR	p-values	optimal number of lags Schwarz Criterion	LR	p-values	Optimal number of lags Akaike Criterion
United Kingdom	5	108.54	0.101	1	167.28***	0.000	13
	4	75.18	0.198		102.87***	0.001	
	3	50.1	0.236		56.49*	0.082	
	2	25.04	0.513		30.49	0.223	
	1	9.19	0.629		12.58	0.319	
United States	5	152.90***	0.000	1	164.29***	0.000	13
	4	76.06	0.177		107.81***	0.000	
	3	44.12	0.485		58.35	0.057	
	2	24.66	0.536		29.27	0.276	
	1	6.42	0.875		10.04	0.545	
Japan	5	128.94***	0.003	1	163.46***	0.000	13
	4	83.69*	0.056		105.3***	0.000	
	3	53.5	0.139		57.73*	0.065	
	2	25.61	0.477		30.73	0.213	
	1	8.38	0.709		10.85	0.467	
Switzerland	5	115.78*	0.035	1	203.35***	0.000	13
	4	74.37	0.219		139.96***	0.000	
	3	44.97	0.445		87.43***	0.000	
	2	20.31	0.794		45.34***	0.005	
	1	7.95	0.749		19.67**	0.038	

Appendix Table 2.7: Cointegration Test with Constant and Trend with

the use of End of period exchange rates and Germany's 10-year government bond yield

Country	(p-r0)	LR	p-values	optimal number of lags Schwarz Criterion	LR	p-values	optimal number of lags Akaike Criterion
United Kingdom	5	91.01	0.547	1	147.89***	0.000	13
	4	61.5	0.681		99.54***	0.005	
	3	36.37	0.827		60.16**	0.040	
	2	17.16	0.922		32.44	0.153	
	1	7.29	0.808		10.3	0.520	
United States	5	146.62***	0.000	1	164.90***	0.000	13
	4	74.26	0.222		104.83***	0.000	
	3	46.63	0.371		65.5**	0.012	
	2	24.47	0.548		37.05*	0.054	
	1	8.34	0.713		17.37*	0.083	
Japan	5	136.17***	0.000	1	156.35***	0.000	13
	4	83.49*	0.058		100.77***	0.001	
	3	48.45	0.296		59.02*	0.050	
	2	22.95	0.643		33.92	0.112	
	1	10.39	0.511		14.72	0.183	
Switzerland	5	138.15***	0.000	1	209.01***	0.000	13
	4	89.35**	0.020		120.56***	0.000	
	3	54.13	0.125		61.54**	0.029	
	2	28.16	0.332		28.49	0.315	
	1	11.65	0.395		10.9	0.462	

APPENDIX 3: ADJUSTMENT VECTORS

Appendix Table 3.1: Adjustment Vectors

Country	s	p	p*	i	i*
	-0,047	0.001	0.005	0,517	0,074
USA	(0.013)	(0.002)	(0.002)	(0.125)	(0.098)
	-0,006	0.000	0.001	0,005	-0,018
	(0.001)	(0.000)	(0.000)	(0.016)	(0.012)
	-0,001	0.000	0.000	0,113	0,11
UK	(0.002)	(0.000)	(0.000)	(0.024)	(0.020)
	0,007	0.000	0.000	-0,399	-0,46
	(0.009)	(0.001)	(0.001)	(0.096)	(0.079)
	-0,048	-0,01	-0,017	0.817	0.141
Switzerland	(0.024)	(0.006)	(0.007)	(0.264)	(0.310)
	0.001	0.000	0.000	0.008	0.000
	(0.000)	(0.000)	(0.000)	(0.004)	(0.005)
	-0,038	0.001	0.001	-0,111	0,13
Japan	(0.010)	(0.001)	(0.001)	(0.037)	(0.063)
	-0,004	0.000	0.001	0.008	-0,016
	(0.002)	(0.000)	(0.000)	(0.009)	(0.015)

Notes: The table represents the adjustment vectors for H_1 and H_2. Standard Errors are in the parentheses.