RELATÓRIO SÍNTESE DE PROJETO DE PESQUISA

Mackpesquisa - Projeto Nº: 1618 - AJURP-FMP-347/2017

A DETERMINAÇÃO DA TAXA DE CÂMBIO DE LONGO PRAZO, UM ENFOQUE BASEADO EM PRODUTIVIDADES.

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Introdução

O projeto consistiu da produção de dois artigos sobre teorias de taxa de câmbio (que estão no final deste relatório em **ARTIGOS RESULTANTES DO PROJETO**)

O primeiro artigo examina o comportamento da taxa de câmbio no longo prazo sobre a perspectiva do modelo da paridade do poder de compra ou purchasing power parity theory (PPP) desenvolvido empiricamente por Cassel e o segundo artigo testa o modelo proposto por Basso oriundo do referencial clássico (Smith, Ricardo, Marx), que enfatiza preços e produtividades para determinar a taxa de câmbio.

Para testar os modelos, foram utilizadas as variáveis:

a) índice de preço ao consumidor (IPC)

b) índice de preço de valor agregado

c) índice de preços da produção bruta

A base de dados utilizada foi a EU KLEMS.

Examina-se o comportamento da taxa de câmbio para três países no período de 1977 a 2006, com frequência anual, utilizando os testes de cointegração de Johansen, os testes de raiz unitária de Dickey e Fuller e Phillips-Perron, os modelos de VAR (vetores autorregressivos) e VEC (vetores autorregressivos com correção de erro).

Foi feito um experimento em pseudo-tempo real, utilizando-se metade da amostra de dados para a modelagem e a outra para comparação das projeções dos modelos. Todas projeções foram testadas pelo Model-Confidence-Set, que escolheu os modelos mais eficientes.

Aceitando a argumentação de Milton Friedman que uma teoria econômica consistente precisa ser passível de realizar previsões testamos o poder preditivo das duas teorias.

Averígua-se que a PPP só foi corroborada para um índice de preço e para um par de países, sendo assim descartamos o segundo passo para esta teoria, qual seja, o poder preditivo. Na abordagem de Basso encontrou-se cointegração para cinco modelos do par de países Reino Unido - Estados Unidos, apresentando capacidade para prever a taxa de câmbio de longo prazo, não permitindo ainda generalizar o novo modelo para todos os pares de países.

O referencial teórico do projeto encontrava-se pronto quando o mesmo foi aprovado (fórmulas e equações a serem testadas).

A parte mais difícil foi preparar as bases de dados para os testes econométricos.

Vamos dar dois exemplos.

Para o teste das duas teorias (PPP e Produtividade) necessitamos de índices de preços coletados por um longo período de tempo (20 anos ou mais, porque as teorias testadas são teorias para o longo prazo).

Os índices disponibilizados pelo FMI (Fundo Monetário Internacional) não abrangiam todo o período de tempo necessário e tivemos que estimar índices de preços para os períodos nos quais não encontravam-se disponíveis.

O mesmo é válido para os índices de preços da EU-KLEMS.

A PPP precisa ser testada para bens transacionáveis com o exterior (exclui o setor de serviços não- transacionáveis; isto está mudando porque muitos serviços que eram não transacionáveis, como por exemplo transporte rodoviário na Europa, estão tornando-se transacionáveis com a queda das fronteiras (Mercado Comum Europeu). Precisamos agregar setores para encontrar um PIB para bens comercializáveis.

Tivemos dois resultados expressivos em termos de aceitação em congressos.

Os dois artigos são resultantes de minha aluna de doutorado, Helene Albuquerque Rebelo que está testando a paridade do poder de compra para países em desenvolvimento e o enfoque de produtividades para explicar a taxa de câmbio de longo prazo:

BASSO, L. F. C.; REBELO, H. A. ; HADAD JUNIOR, E. ; KIMURA, H. . The Focus of Productivity in Determining the Long-Term Exchange Rate. In: Eastern Economic Association, 2016, Washington DC. 42nd Annual Conference, 2016. v. 2016.

BASSO, LEONARDO FERNANDO CRUZ; REBELO, H. A. ; HADAD JUNIOR, E. . Purchasing Power Parity In Developing Countries. In: The 22nd International Academy and Business Conference, 2016, Londres. The 22nd Conference, 2016.

O resultado mais expressivo na minha opinião foi o artigo sobre paridade do poder de compra ter alcançado o "top ten" em sua área na SRRN, conforme mensagem abaixo (acreditamos que isto qualifica o paper para ser aceito em um periódico Qualis com boa classificação pela CAPES: B1) :

Dear Leonardo Cruz Basso:

Your paper, "PURCHASING POWER PARITY IN DEVELOPING COUNTRIES", was recently listed on SSRN's Top Ten download list for: ERN: International Trade (Topic).

As of 22 March 2017, your paper has been downloaded 20 times. You may view the abstract and download statistics at: https://ssrn.com/abstract=2911046.

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Thank you,
SSRN Management

A equipe do projeto foi composta de um número expressivo de alunos e professores que foram treinados na metodologia científica.

Alunos de graduação:

Ana Carolina Sacchi dos Santos

Danylo Irineu Palazzini

Ana Paula Rodrigues de Oliveira

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Flavio Luiz de Moraes Barboza

Um resultado expressivo deste projeto foi a aceitação de dois alunos para dar continuidade ao projeto na Universidade de Beira Interior (Portugal). Os doutorandos estão trabalhando com desenvolvimento e testes para teorias de câmbio. Os dois estão trabalhando na Universidade de Beira Interior (convênio com o Mackenzie para obtenção de dupla titulação). Helene Albuquerque Rebelo, que está trabalhando em 3 enfoques: produtividade do trabalho, enfoque Balassa- Samuelson e hipótese da paridade do poder de compra. Arthur Tornatore Siessere que está trabalhando com o enfoque keynesiano (margens) e o enfoque Balassa- Samuelson. **Uma grande vantagem do doutorado sanduiche em Portugal é que os dois estão trabalhando com o Professor João Leitão, que privilegia gestão e uma das vertentes do trabalho vai redundar em artigos com foco em gestão cambial. Isto seguramente vai enriquecer o currículo dos alunos.**

Os resultados preliminares do projeto (os dois artigos publicados em anais de congressos) permitiram que o Professor João leitão se dispusesse a orientar os dois (Helene Rebelo e Arthur Siessere). Mantivemos contato com o Professor Alan Freeman que nos aconselhou a submeter o artigo do enfoque da produtividade para o Cambridge Journal of Economics, um periódico com alta qualificação. Sugeriu que reduzíssemos o tamanho do artigo e solicitássemos melhorar a tradução utilizando um tradutor nativo na língua inglesa.

Pela relevância, incluo a mensagem do Professor Freeman:

RE: PAPER FOR YOUR COMMENTS

Alan Freeman <afreeman@iwgvt.org>

ter 30/08/2016 08:39

Para: LEONARDO FERNANDO CRUZ BASSO <leonardofernando.basso@mackenzie.br>;

Hello Leonardo and sorry for the delay.

I think there are four journals you might think of:

Cambridge Journal of Economics Capital and Class

Journal of Australian Political Economy

Review of Political Economy

CJE is the most respected but, of course, the most difficult.

In each case, I advise you to read carefully the instructions for authors. I think you will also need to attend to the English and to the length before you submit; it would be a pity to have an interesting article like this one rejected for secondary reasons.

Good luck

Alan

Por fim apresentamos links de sites de pesquisa internacionais onde inserimos os artigos para divulgação entre professores, pesquisadores e demais interessados.

SSRN:

Purchasing Power Paritiy in developing countries

https://papers.ssrn.com/sol3/papers.cfm?abstract_id=2911046

The Focus of Productivity in Determining the Long-Term Exchange Rate
https://papers.ssrn.com/sol3/papers.cfm?abstract_id=2498631

RESEARCH GATE:

Purchasing Power Paritiy in developing countries https://www.researchgate.net/publication/313465356_Purchasing_Power_Parity_in_Developing_Countries

The Focus of Productivity in Determining the Long-Term Exchange Rate
https://www.researchgate.net/publication/272679767_The_Focus_of_Productivity_in_Determining_the_Long-Term_Exchange_Rate

ARTIGOS RESULTANTES DO PROJETO

Purchasing Power Parity In Developing Countries

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Abstract

This article evaluates the long-term foreign exchange rate on the Purchasing Power Parity model in development. The tests were applied to seven countries in the Americas, eight countries in Africa, five in Asia, and five in the Middle East, using the United States as the reference country. To test the model, we used the consumer price index, the implicit GDP deflator, the wholesale price index, and the producer price index; the exchange rates were period-ending rates, for the period from 1965 to 2015, with annual frequency. We applied the Vector Error-Correction Model as a mechanism for correcting errors of the co-integration vectors, using STATA-14 software. Of the projections thereby produced, only four combinations corroborated the theory, therefore it is possible to say that we were unable to corroborate PPP.

Introduction

Exchange rate is one of the most important and longest-lasting macroeconomic variables in the economy, according to Soofi (1998) and Edwards (2006), because it affects inflation, exports, imports and economic activity of a country and between countries. Cassel (1916) says that the exchange rate between two countries is determined by the ratio between the general price levels in both countries.

Copeland (2005) says that one of the most widely studied long-term exchange rate models in the economy is Purchasing Power Parity (PPP), which shows ambiguous results, because in most of the tests, the theory is not corroborated. Dornbusch (1982) claims that PPP-oriented exchange rate policies have been widely adopted among developing countries as a way of assessing the foreign trade sector, although it is also applied in developed countries.

Aggarwal et al. (2000) evaluated PPP in real exchange rates between Japan and Indonesia, Korea, Malaysia, the Philippines, Singapore, Sri Lanka, Thailand, Germany, the US, and Australia. They considered the consumer price index (CPI) and producer price index (PPI) for the period from 1974 to 1997, using quarterly data. Aggarwal et al. (2000) concluded that PPP is maintained for Asian countries; however, the theory is not confirmed for non-Asian countries.

Endres; Chumrusphonlert (2004) evaluated PPP with average nominal exchange rates and CPI, using monthly data, for Hong Kong, Indonesia, Korea, Malaysia, Philippines, Singapore and Thailand, using Japan and the US as reference countries, for the period from 1973.1 to 2001.7, with the Philippines with data up to 2001.6; Malaysia with data up to 2001.4; Indonesia with data up to 2000.12 and Hong Kong with data up to 2001.6. Endres; Chumrusphonlert (2004) found evidence of PPP between Japan and Indonesia, Korea, Malaysia, Philippines and Thailand; and with the US as a reference, PPP is valid for all of the countries except Japan.

Baharumshaha; Tze-Haw; Fountas (2008), observing two sub-periods, from 1976.1 to 1997.6 and 1997.7 to 2002.9, studied PPP using nominal exchange rates and CPI, considering Japan and the US as reference countries, in order to assess parity with South Korea, Thailand, Indonesia, Malaysia, Singapore and the Philippines; no sufficient evidence was found to support PPP (BAHARUMSHAHA; TZE-HAW; FOUNTAS, 2008).

To test absolute PPP for the US, Japan, Canada, Mexico and the United Kingdom, Hong; Phillips (2010) used nominal exchange rates, with CPI, PPI and WPI (wholesale price index), with monthly frequency, from 1971.1 to 2004.12, except the PPI series for Mexico, which begins in January 1981. Applying the Augmented Dickey-Fuller (ADF) test, they found that US-Canada and US-Japan were not co-integrated for CPI and PPI, but are significant for US–Mexico and US–UK; with the KPSS test, there is a linear co-integration for the entire sample period (HONG; PHILLIPS, 2010).

Soofi (1998) analyzed PPP for several members of the Organization of Petroleum Exporting Countries, and the Geweke and Porter-Hudak (GPH) test results suggest that PPP models for Algeria, Ecuador, Saudi Arabia and Venezuela were co-integrated, but the ADF test shows the opposite (Soofi, 1998). Frenkel (1981) concluded that the exchange rate of the G-7 countries during 1970 did not support the forecast of the PPP theory. Liu (1992) tested PPP for nine countries in Latin America compared to the US, and concludes that the theory is corroborated in the cases studied. Xu (2003) tested PPP between the US and Canada, France, Germany, Italy, Japan, Korea, the Netherlands and UK, the first quarter of 1974 to the last quarter of 1997, using CPI, WPI and the traded goods price index (TPI), and rejected all of the hypotheses.

Theoretical reference

Purchasing Power Parity (PPP) was developed as an alternative to the gold standard using elements of the Quantity Theory of Money and considering the Law of One Price (LOOP) (CASSEL, 1918).

Cassel (1916), Dornbusch (1987), Batiz e Batiz (1994), Macdonald *et al.* (1992, 1994, 2007), Rogoff (1996), Sarno; Taylor (2001), Visser (2004), Moosa (2005) and Rossi (2013) argue that in the long term, the nominal exchange rate should reflect the relative prices of two currencies, because according to Cassel (1916, 1918, 1921, 1925a, 1928a, 1928b, 1930, 1932b, 1933, 1967), Houthakker (1978), Dornbusch (1987), Edwards (1989), Macdonald (1994, 2007), Rogoff (1996), Mccallum (1996), Famá e*t al.* (2001), Sarno; Taylor (2001), Xu (2003), Marçal e*t al.* (2003, 2011), Visser (2004), Copeland (2005), Felmingham (2007), Hong; Phillips (2010) and Rossi (2013), PPP shows that the price level in one country, converted into the currency of a second country by the nominal exchange rate, should be equal to the price level of the second country, for a unit of currency in the first country to have the same purchasing power as the second country, as follows:

$$e = P / P^* \quad (1)$$

$$P = e \, . P^* \quad (2)$$

Where $P$and P^* are the tradable goods price indices in different countries and and is the nominal exchange rate, which is the amount of local currency needed to buy a unit of foreign currency (DORNBUSCH, 1987 and BATIZ & BATIZ, 1994). However, when the nominal exchange rate is adjusted due to changes in price levels, Strauss (1996) says that the real exchange rate is obtained; for Batiz & Batiz (1994), this is an indicator of relative competitiveness between two or more countries, which compares the price of foreign goods in terms of domestic goods.

Hence, for Dornbusch (1987), Batiz & Batiz (1994), and Vasconcelos (2004), the real exchange rate (θ) between two countries can be formally represented by the nominal exchange rate adjusted by the ratio of relative prices:

$$\theta = \frac{e \cdot P*}{P} \tag{3}$$

$$\theta = \widehat{and} + \hat{P}^* - \hat{P} \tag{4}$$

In PPP, any change in the relative purchasing power between two currencies, which comes from an initial position of equilibrium, causes a fluctuation in the exchange rate (CASSEL, 1918, 1921, 1925a, 1928a; 1932b). Changes in domestic purchasing power of a currency have a greater influence on exchange rates than any other type of changes in the actual conditions in which international trade is developed (CASSEL, 1932b). In the Quantity Theory of Money, variations in the quantity of currency in circulation produce changes in the purchasing power of that currency, which reflect domestic prices and alter the exchange rate (CASSEL, 1967), although Keynes (1923), Angell (1926) Samuelson (1948), and Balassa (1964) say that there are channels of reciprocal causality between price index and exchange rate.

To empirically develop the PPP, Cassel (1918) distinguished the Absolute PPP (APPP) from the Relative PPP (RPPP); in the APPP, the nominal exchange rate of a country is determined by the relationship between the general price levels of two countries (CASSEL, 1916; HOUTHAKKER, 1978; SOOFI, 1998; MACDONALD, 1994, 2007; ROGOFF, 1996; SARNO; TAYLOR, 2001; PAPELL; PODRAN, 2003 and COPELAND, 2005).

Soofi (1998), MacDonald et al. (1992, 1994, 2007), and Batiz & Batiz (1994) state that in absolute PPP, the ratio of consumer goods prices to any country approaches the equilibrium exchange rate. Hence, when verifying the APPP and RPPP, Batiz & Batiz (1994) show that the real exchange rate (θ) will be constant and equal, reflecting identical competitive capabilities between the countries at any point in time.

Therefore, Edwards (1989), Soofi (1998), MacDonald (1994, 2007), Sarno; Taylor (2001), and Marcal (2003) show that at time *t*, the real exchange rate (θ)is:

$$\theta_t = and_t - p_t + p_t^* = 0 \tag{5}$$

Where and_t is the nominal exchange rate, p_t and p_t^* are the price levels of the country of origin and the foreign country and at time *t*. Thus, APPP supports the assertion that monetary factors, measured by the ratio of price level to the exchange rate at any moment t (MACDONALD, 1994, 2007). However, it is difficult to determine – according to MacDonald (1994, 2007), Rogoff (1996), and Sarno; Taylor (2001) – whether the same basket of goods is available in different countries, and it is more common to test the RPPP, as it sustains changes in the percentage of the exchange rate over a particular period, offsetting the difference in inflation rates in the countries evaluated in the same period of time.

Furthermore, the data necessary for APPP are collected sporadically (ROGOFF, 1996). MacDonald (1994, 2007) adds that in order to construct the APPP, general price levels of goods are used, but to test PPP, indices are used instead of levels. Accordingly, for Cassel (1921, 1925a, 1932b), Soofi (1998), Batiz & Batiz (1994), and Holland et al. (2008), the RPPP is:

$$\hat{P} = \hat{e} + \hat{P}^* \quad (6)$$

$$\hat{e} = \hat{P} - \hat{P}^* \quad (7)$$

MacDonald (1994, 2007) and Marcal (2003) mention that in RPPP there are two price indices (internal P or p and external P^*orp^*) composed of tradable goods and with a structure of weights and goods, demonstrated by the following equation:

$$\Delta e_t = \Delta p_t - \Delta p_t^* \quad (8)$$

where Δ represents the first difference operator. In MacDonald's view (1994, 2007), RPPP indicates that countries with relatively high inflation will experience a depreciation in the currency, so, compared to APPP, relative PPP is incontestable. Although absolute PPP often appears in theoretical models, only relative PPP can actually be tested (COPELAND, 2005).

In RPPP, the entire variation in the relation of purchasing powers between two currencies, starting from a position of equilibrium, will bring about a change in the exchange rate (MACDONALD, 1992, 1994, 2007 and BATIZ & BATIZ, 1994). Papell et al. (2003) and Copeland (2005), state that RPPP is emphasized by arbitration over time, because the exchange rate is adjusted to compensate for inflation differentials between countries.

Price Indices

As explained earlier by MacDonald (1994, 2007) and Sarno; Taylor (2001), the literature has focused on RPPP tests, considering that changes in relative price levels are balanced by changes in exchange rates.

Frenkel (1978), who tested the two versions of PPP, using different price indices, noted that for RPPP, indices are independent, but in APPP the type of measure of prices changed the findings for some of the exchange rates evaluated.

Thus, Cassel (1967) and Samuelson (1964) say that supply and demand in the economy of exchanging productivity factors exerts a key influence on prices, therefore it is important to evaluate the different price indices applicable to PPP.

The theoretical perspectives differ on the bases for price index: in the marginalist theory, prices seek to maximize profits; in Marxist theory they derive from the quantity of labor required to produce them; for Keynes (1923), prices are derived from applying margins on production costs; in the Sraffian theory, prices stem from a theory of surplus production, measured in terms of a standard commodity, without the need for value of labor theory.

Cassel (1928b) and Yeager (1958) believe that PPP refers to the domestic value of the currencies involved and the changes in the value thereof can only be measured by a general price index that represents the set of goods marketed in the country.

For Officer (1976), the prices of productivity factors substitute the prices of goods, as well as the unit cost of labor in industry and wage rate. According to Artus (1978), this is an advantage, because the price structure on the market of factors in a country tends to change more slowly than the price structure on the market of goods.

For Balassa (1964), Samuelson (1964) and Sarno; Taylor (2001), the index that is most widely used for PPP is the CPI, because it covers changes in competitiveness and includes a wide range of goods, in addition to periodic publication of reliable data in almost all countries, but Edwards (1989), Soofi (1998), Sarno; Taylor (2001), and Xu (2003) believe that CPI is a poor proxy because its calculation involves large amounts of non-tradeable goods and different baskets of goods in different countries, which leads to misleading empirical results (XU, 2003).

The most appropriate indices for Copeland (2005) are the Retail (or Consumer) Price Index (RPI, supplied by the CPI), which is based on a sample of prices at stores and other retail establishments, and the Wholesale (or Producer) Price Index (WPI, in some countries replaced by the PPI), which measures prices in transactions between companies.

Felmingham (2007) uses the ratio of the export price index to the import price index, and Edwards (1989) calculates the ratio of the CPI and WPI; however, Edwards himself (1989) and Xu (2003) stress that these are not entirely appropriate, since these three price indices use disparate weights between countries and the CPI retains large amount of non-tradable goods. Xu (2003), when comparing CPI, WPI and Traded Goods Price Index (TGPI), the latter seems to be a more appropriate price index for both PPP tests.

Edwards (1989) and Sarno; Taylor (2001) believe that the GDP deflator is a real aggregate production price index because it provides a good indicator of changes in the degree of productivity competitiveness, while the CPI and WPI are consumption price indices; however, Edwards (1989) asserts that the GDP deflator, for most developing countries, is only available on an annual basis.

For Angell (1922), Xu (2003) and Baharumshaha; Tze-haw; Fountas (2008), general price indices, especially the GDP deflator, can skew PPP, because the ratio of prices of tradable and non-tradable goods move in different ways over time, due to different growth rates of productivity when estimating long-term equilibrium exchange rate. However, Edwards (1989) and Sarno; Taylor (2001) state that none of these price indices are perfect and all of them have some advantages and disadvantages. Keynes (1923) and Frenkel (1978) show that PPP is a certainty if one is restricted to the use of tradable goods price index, thereby satisfying the LOOP. PPP is seen as an extension of the LOOP, and it is possible to use different price indices, according to Samuelson (1964), Edwards (1989), Soofi (1998) and Aggarwal; Montañes; Ponz (2000).

Thus, the most widely used general price indices used are the CPI or RPI, PPI or WPI, and the implicit deflator of the Gross Domestic Product (GDP), which are used in this research because according to Keynes (1923), Balassa (1964), Samuelson (1964), Frenkel (1978), Edwards (1989), Sarno; Taylor (2001) and Copeland (2005), these are the general price indices that are most widely used in the literature.

Method

The long-term stability between macroeconomic variables is estimated by techniques of econometric co-integration, and if the series are co-integrated, the linear constraints on the co-integrating vector are tested; if the constraints are appropriate, the error correction mechanism is valid and active. Asteriou; Hall (2007) assert that by combining series, it is possible to eliminate the non-stationarity, Engle; Granger (1987) and Johansen (1991) add that it is therefore possible to affirm that there is a stationarity transformation vector that eliminates the problem of spurious regressions.

The most widely used co-integration techniques, according to Gregory et al. (2004) are the Augmented Dickey Fuller (ADF) test (ENGLE; GRANGER, 1987), the $Z\alpha$, the trace test (TR), and the maximum eigenvalue or maximum likelihood (MAX) (JOHANSEN, 1988, 1991) and test of Reinsel and Ahn. Vector Error Correction Models (VECM) are used, which represent a part of the imbalance between the series of variables in a period, corrected in the following period (ENGLE; GRANGER, 1987).

Specific tests are required for using univariate and multivariate models, which identify non-random patterns in the time series variables of interest; if such tests and adjustments are not made, the results are inconsistent and useless for any analysis. For this study, we investigated the properties of Johansen (1988, 1990, 1991, 1995) for the maximum eigenvalue and trace test, assessing the existence of co-integration for situations empirically relevant to country pairs.

The co-integration of Johansen (1988) analyzes structural links between two or more variables, determining whether or not they have a long-term balance; if they are co-integrated, it is necessary to note the order of integration of each one, using the unit root test. First the existence of co-integration is tested for each pair of countries, then constraints are imposed on the co-integration vector, with chi-square distribution with degrees of freedom given by the number of constraints (JOHANSEN, 1988, 1990, 1991, 1995). We applied, in the co-integration relationship with proportionate constraint on the coefficients, β with values \ [1 -1] and number of lags equal to two, for the systems.

Database and variables

We observed the theory of RPPP for developing countries, considering the classification of the degree of economic and social development of the International Monetary Fund (IMF), testing the hypothesis of PPP for 25 countries: seven countries in the Americas (Brazil, Colombia, Costa Rica, Mexico, Panama, Peru, Uruguay); eight countries in Africa (Central African Republic, Congo Republic, Egypt, Morocco, South Africa, Trinidad and Tobago, Tunisia, and Zambia); five countries in Asia (India, Indonesia, Malaysia, Sri Lanka, Thailand), and five Middle Eastern countries (Iran Islamic Republic, Kuwait, Pakistan, Saudi Arabia, Turkey), using the US currency as a reference.

To test the PPP, four price indices were used for each of the 25 countries, namely the CPI, GDP deflator, WPI and PPI, since these are the price indices most frequently shown in the literature; in addition to the price indices, we used the period-end exchange rates of each of the 25 countries, producing 100 possible combinations. The selected developing countries are those with the longest time series collected in the data base of the IMF and the World Bank, from 1965 to 2015, with annual data.

Assessment of the results

Observing the pairs of countries, always the US and one of the 25 countries, we evaluated – in the first stage – the co-integration tests between the exchange rate and CPI; exchange rate and WPI; exchange rate and GDP deflator, and exchange rate and PPI.

In the series that were co-integrated, two series were used in one vector error-correction model (VECM) with linear constraints on β; in the ones in which there was evidence of error correction, the system of variables was classified as valid. Of the 100 possible combinations, only four had evidence of co-integration and valid linear constraints for the co-integration vector. The projected results, in Table 1 (APPENDIX A) were compared with observed values, with the following result:

For the consumer price index (CPI): the theory is corroborated for country pairs Sir Lanka – United States and Egypt – United States; For the implicit GDP deflator: only the Saudi Arabia – United States country pair confirms the theory; For the wholesale price index (WPI): only the Trinidad and Tobago – United States country pair corroborates the theory; For the producer price index (PPI): no two countries confirm the theory.

Conclusion

This paper aimed to verify whether relative PPP is maintained over time for 25 developing countries, having the United States as the reference country, with annual data from 1965 to 2015, using four price indices and period-end exchange rates.

We used co-integration tests to analyze whether or not the variables have a long-term equilibrium relationship, imposing constraints on the vectors, with chi-square distribution with degrees of freedom given by the number of constraints. In systems with significant results, a co-integration relationship was imposed, with proportionate constraint on the coefficients and number of lags equal to two.

The hypothesis was tested using the VECM, to examine the effects of individual shocks on the dynamics of the system, and adjustments were made in relation to the variance-covariance matrix of the residuals; regressions were made with the rolling regression process, taking the first half of the data as the sample space. A series was generated with the squared errors for each VECM projection, in STATA-14 software.

Of the 100 projections, the theory was not corroborated for any pair of countries with PPI; however, for the CPI, it was corroborated for two country pairs (Sir Lanka – United States, Egypt – United States); for the implicit GDP deflator, only one country pair was corroborated (Saudi Arabia – United States), and for WPI, one country pair (Trinidad and Tobago – United States) corroborates the theory. Ratifying the majority of published studies, PPP is not corroborated because the confirmed combinations are small countries with foreign trade flow that is too low to validate the proposed theory. Therefore, more studies are needed, that seek to explain why PPP is not corroborated or even to add variables to improve the explanatory power of the theory.

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APPENDIX A

Table 1 – Johansen Co-integration Tests

Johansen co-integration test

		exchange rate and CPI			GDP deflator exchange rate			Exchange rate and PPI			Exchange rate and WPI		
	Critical value 5%	Test statistic	Constraints on Beta Chi2(1)	Prob > Chi2	Test statistic	Constraints on Beta Chi2(1)	Prob > Chi2	Test statistic	Constraints on Beta Chi2(1)	Prob > Chi2	Test statistic	Constraints on Beta Chi2(1)	Prob > Chi2
BRAZIL													
H_0: r=0 vs H_1: re 1	15.41	13.7108			7.7021			7.8566			7.8567		
H_0: rd1 vs H_1: re2	3.46	4.5246			2.3017			2.2140			2.2140		
CENTRAL AFRICAN REPUBLIC													
H_0: r=0 vs H_1: re 1	15.41	9.0132			8.1144								
H_0: rd1 vs H_1: re2	3.46	2.3944			2.1388								
COLOMBIA													
H_0: r=0 vs H_1: re 1	15.41	9.1121			10.3578			9.9996			10.0010		
H_0: rd1 vs H_1: re2	3.46	1.9956			2.5498			1.9268			1.9286		
CONGO, REP.													
H_0: r=0 vs H_1: re 1	15.41				4.7052			10.8869			10.8869		
H_0: rd1 vs H_1: re2	3.46				0.4038			0.0797			0.0797		
COSTA RICA													
H_0: r=0 vs H_1: re 1	15.41	11.3652			11.5616			4.0381			4.0365		
H_0: rd1 vs H_1: re2	3.46	0.9325			0.0089			0.9158			0.9131		
EGYPT													
H_0: r=0 vs H_1: re 1	15.41	15.5834	6.195	0.013	14.3367			14.4465			14.4465		
H_0: rd1 vs H_1: re2	3.46	0.2368			1.5016			0.0255			0.0255		
INDIA													
H_0: r=0 vs H_1: re 1	15.41	2.7097			3.3789			7.3941			7.3850		
H_0: rd1 vs H_1: re2	3.46	0.5456			0.0533			0.2006			0.2000		
INDONESIA													
H_0: r=0 vs H_1: re 1	15.41	4.0420			4.2297			7.8645			7.8645		
H_0: rd1 vs H_1: re2	3.46	0.6309			0.6842			0.9613			0.9613		
IRAN, ISLAMIC REP.													
H_0: r=0 vs H_1: re 1	15.41	12.0355			9.3648			11.0203			11.0203		
H_0: rd1 vs H_1: re2	3.46	17934			0.5304			0.0454			0.0454		
KUWAIT													
H_0: r=0 vs H_1: re 1	15.41												
H_0: rd1 vs H_1: re2	3.46												
MALAYSIA													
H_0: r=0 vs H_1: re 1	15.41	7.1918			6.7746			5.5535			5.8993		
H_0: rd1 vs H_1: re2	3.46	2.5213			0.5922			0.7511			0.8807		
MEXICO													
H_0: r=0 vs H_1: re 1	15.41	17.9539	0.135	0.713	15.0849			36.6942	30.73	0.000	36.6945	30.730	0.000
H_0: rd1 vs H_1: re2	3.46	1.4644			0.7160			0.7763			0.7760		
MOROCCO													
H_0: r=0 vs H_1: re 1	15.41	16.3321	9.441	0.002									
H_0: rd1 vs H_1: re2	3.46	1.6400											
PAKISTAN													
H_0: r=0 vs H_1: re 1	15.41	3.4294			11.2161			5.2089			5.2086		
H_0: rd1 vs H_1: re2	3.46	0.0066			0.0001			0.1803			0.1799		
PANAMA													
H_0: r=0 vs H_1: re 1	15.41	2.3573			1.5236			1.3295			1.2197		
H_0: rd1 vs H_1: re2	3.46	0.0000			0.0000			0.0000			0.0000		
PERU													
H_0: r=0 vs H_1: re 1	15.41	14.9886			12.6319			36.3968	12.010	0.001	35.4008	11.550	0.001
H_0: rd1 vs H_1: re2	3.46	11475			14553			83327			81731		
SAUDI ARABIA													
H_0: r=0 vs H_1: re 1	15.41				19.0161	0.00113	0.973	14.0963			12.2860		
H_0: rd1 vs H_1: re2	3.46				2.2964			19011			0.8797		
SOUTH AFRICA													
H_0: r=0 vs H_1: re 1	15.41	14.7410			15.7808	4.346	0.037	13.3569			19.2961	6.603	0.010
H_0: rd1 vs H_1: re2	3.46	0.2399			0.0122			55559			54268		
SRI LANKA													
H_0: r=0 vs H_1: re 1	15.41	21.6667	0.854	0.355	17.3647	0.837	0.360	17.6840	5.316	0.021	17.6840	5.316	0.021
H_0: rd1 vs H_1: re2	3.46	1.2594			1.0944			1.1893			1.1893		
THAILAND													
H_0: r=0 vs H_1: re 1	15.41	12.7319			8.0429			6.1067			6.1126		
H_0: rd1 vs H_1: re2	3.46	0.6672			0.1947			0.0925			0.0930		
TRINIDAD AND TOBAGO													
H_0: r=0 vs H_1: re 1	15.41	4.2777			5.1095			31.7547	2.557	0.110	31.7547	2.557	0.110
H_0: rd1 vs H_1: re2	3.46	0.9446			0.5868			126601			12.6601		
TUNISIA													
H_0: r=0 vs H_1: re 1	15.41	13.4773			8.1165			15.1305			15.1305		
H_0: rd1 vs H_1: re2	3.46	0.0676			0.0060			0.1448			0.1448		
TURKEY													
H_0: r=0 vs H_1: re 1	15.41	11.1774			9.9082			10.1568			10.1551		

H_0: rd1 vs H_1: re2	3.46	15574			0.9985	44934	4.4942
URUGUAY							
H_0: r=0 vs H_1: re 1	15.41	9.9223			9.6734	8.6273	8.6295
H_0: rd1 vs H_1: re2	3.46	39258			42659	39671	3.9678
ZAMBIA							
H_0: r=0 vs H_1: re 1	15.41	21.5099	5.498	0.019	7.3517	13.1044	13.1044
H_0: rd1 vs H_1: re2	3.46	61696			0.3202	36976	3.6976

The focus of productivity in determining the long-term exchange rate

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Abstract

This article examines the behavior of the exchange rate over the long term from the perspective of the purchasing power parity theory (PPP) model developed empirically by Cassel and of the model proposed by Basso originating from the Marxist benchmark, which emphasizes prices and productivities to determine the exchange rate.

The consumer price index (IPC), value-added price index and gross producer price index (EU KLEMS database) were used to test the models.

The exchange rate behavior is examined for three countries over the 1977-2006 period, with annual frequency, using the causality tests of Granger and of Johansen, the Dickey-Fuller and Phillips-Perron unit root tests, the VAR (vector autoregression) and VEC (vector error correction) models and performing a projection with the Model Confidence Set.

Accepting the reasoning of Milton Friedman that a consistent economic theory needs to be capable of performing predictions, we tested the predictive power of the two theories. The most efficient projection models were chosen by the Model Confidence Set.

It is ascertained that PPP was only corroborated for one price index and for one pair of countries. Accordingly, we discarded the second step for this theory, namely, the predictive power. In Basso's approach cointegration was found for five models of the United Kingdom-United States country pair, showing the ability to predict the long-term

exchange rate, not yet allowing the new model to be generalized for all the pairs of countries.

Keywords: Purchasing power parity; Price indices; KLEMS; Basso model; Long-run exchange rate; Productivity approach.

1. Introduction

Exchange rate between the two countries is determined by the ratio between the general price levels in two countries (Cassel, 1916) or as the value of a country's currency in terms of currency of another country (Houthakker, 1978, Dornbusch, 1982 and Copeland, 2005).

Cassel (1928a), explains that the purchasing power parity (PPP) theory possesses remarkable stability, which can determine and classify all the other factors that may influence the exchange rate. Nevertheless, although it is the most traditional theory for determining long-term exchange rate, it exhibits conflicting results as far as corroboration is concerned, as the studies conducted show some cases in which the theory is rejected and others where it is proven.

Frenkel (1980) establishes during the 1970s that in the Mark/Pound; Franc/Pound; Dollar/Pound and Franc/Dollar pairs, the PPP results showed deviations, leading to the non-corroboration of the theory. Yoshikawa (1990) was of the opinion that PPP was not corroborated between Japan and the United States in the 1973-1987 period. Froot at al. (1994) claim that there does not appear to be long-term convergence to PPP, although new papers on the issue of the survivorship bias of the theory are valuable.

Rossi (1996), who used monthly data between Brazil and the United States, from January 1980 to July 1994, using PPP conditions, rejects it. Pedroni (2001), who also made monthly observations totaling 246 for data from June 1973 to November 1993 in 20 countries, did not corroborate PPP, explaining that the failure of the theory appears to be generalized in the post-Bretton Woods period.

Taylor (2002) tested PPP for a group of twenty countries over a period of more than 100 years, finding the validation of PPP in the long term, yet concluded the study with the observation that PPP deviations are always and everywhere a monetary phenomenon. With a similar result of non-corroboration of PPP, Xu (2003), examined nine countries for the period starting in the first quarter of 1974 and ending in the last quarter of 1997.

Obtaining a different conclusion, Papell et al. (2003) verified the validity of PPP for 16 countries and the non-ratification of the theory for 2 countries. Wadsley and Felmingham

(2007), who assessed Australian data for the 1985-2005 period, corroborated PPP in their studies.

Drine et al. (2007), who tested PPP for 80 countries, discovered that the theory is valid for the OECD countries (developed countries), but proved weak for the MENA countries (belonging to the Middle East and to North Africa) and was not corroborated for the countries from Africa, Asia, Latin America and Central/Eastern Europe. Other investigations by Drine et al. (2007) indicate, on one hand, that the nature of the exchange rate regime is not a condition for the validity of PPP and on the other, that PPP is more easily corroborated in countries with high inflation than in those of low inflation. Therefore, for developing countries the PPP theory is empirically rejected, confirming permanent deviations in PPP.

Simões and Marçal (2012), who studied the validity of PPP for Brazil and 21 of its business partners, for the 1957-2010 period, found evidence of the validity of the theory only for Uruguay; while for Colombia, Greece, Paraguay and Portugal, PPP was rejected and for the other business partners PPP presented inconclusive results, as the test results were conflicting.

2. Research Problem and Objectives

The purpose of the article is to investigate whether PPP remains steady in the long term and whether the theory drawn up by Basso (2008), of price indices associated with productivity, which has the Marxist theory as a point of reference, presents explanatory power for the long-term exchange rate.

The relative PPP was used in the survey as it employs price indices, whereas the absolute PPP adopts price levels, although Edwards (1989) and Sarno et al. (2001) point out that no price index is perfect and all have some advantages and disadvantages. Therefore, the consumer price index (IPC), the Gross Domestic Product (GDP) implicit price deflator, the gross value of production deflator and the value-added deflator were applied. Data referring to nonmarketable goods were eliminated for the study, since Keynes (1923), Frenkel (1978), Edwards (1989) and Sarno et al. (2001) assert that PPP is a certainty if restricted to the use of price indices of tradable goods.

Annual data were used in the study for the country pairs Japan – United Kingdom, United States - Japan and United States - United Kingdom, in the 1977-2006 period, as they exhibited the longest documented series with productivity data.

3- Why long run exchange rate?

Several criteria were used to classify the proposed theory as a long-term theory; the first criterion used was advocated by Milton Friedman, in which an economic theory – in order to be considered scientific – needs to provide forecasts.

The theories of interest rate differentials (covered and uncovered interest parity), purchasing power parity, money and output differentials (monetary models of exchange rate differentials), productivity differentials, net foreign assets fundamentals and portfolio balances meet this criterion. The most recent models known as agent-based models were left out of the classification.

The traditional criterion considered as short-term is the Keynesian criterion, which presumes fixed production capacity (Keynes, 1936). The change in production capacity – a long-term characteristic – is obtained by gross formation of fixed capital (investment, expenditure on new plants and equipment). In reality, the investments change the daily production capacity when one considers aggregate terms. Different companies from different sectors make non-synchronized investments, because they do not observe the periods of upswing in economic cycles, and alter the production capacities of sectors, companies, and countries. However, it is rather difficult to obtain monthly data for investments, so one might think of the long term as quarterly periods, because we found data available for the investment. It so happens that when one works with labor productivity, the data that are used are annual, as is the case with the database used for this study (KLEMS). Accordingly, the period used for testing the theory was annual, because there are data on productivity (mainly for labor productivity) and this is surely a period that characterizes the long term, because it clearly presents a change in production capacity. For a more rigorous (academic) stance, we could conduct empirical tests to verify the ratio of investment to gross domestic product that affects – with statistical significance – the production capacity of the economy (inventory of machinery and equipment).

A more pragmatic way to avoid pitfalls in order to operationalize the long-term Keynesian concept is to use the methodology of the articles that propose forecasts for the foreign exchange rate. This methodology depends on the predictor used, the forecast horizon, the time period of the model, the frequency of the selected variables, and the forecast evaluation method. The most important factors here are the forecast horizon, the frequency of the chosen variables, and the forecast period.

The existing literature on exchange rate forecasts indicates different frequencies for the data, including high-frequency data (daily interest rates or even variations of daily rates during a few seconds, called high-frequency rates), whereby interest rate differentials can be obtained daily, while productivity rates are obtained on an annual basis.

There is a trade-off between the frequency of the data and the sample size. High-frequency data involve large samples and are used for short-term forecasts. Low-frequency data (productivity rates) involve smaller samples and are used for long-term forecasts. **This is the criterion used to classify the theory presented in this study as a long-term forecast theory.**

It would be of interest to combine data with varying frequencies in the same econometric procedure, but there are still no appropriate econometric tools to test such models.

4.Literature Review

In 1918, Cassel was the first to empirically develop what he called Purchasing Power Parity (PPP) as an alternative to the gold standard, using elements of the quantity theory of money and considering the law of one price (LOOP). On that basis, Cassel (1916, 1918, 1921, 1925a, 1928a, 1928b, 1929, 1930, 1932b, 1933), Houthakker (1978), Dornbusch (1987), Edwards (1989), MacDonald (1994, 2007), Rogoff (1996), McCallum (1996), Famá et al. (2001), Sarno et al. (2001), Marçal et al. (2003, 2011), Visser (2004), Copeland (2005), Felmingham (2007) and Rossi (2013), explain that PPP shows that the price level in the country of origin, converted into the currency of the foreign country using the nominal exchange rate, must be equal to the price level of the foreign country. Hence a unit of currency in the country of origin using the nominal exchange rate as a converter will have the same purchasing power in the foreign country.
According to Batiz and Batiz (1994) and Dornbusch (1987) the law of one price is expressed by:

$$p_i = p_i^* + e \qquad (01)$$

In which: i is any given product; p represents the domestic price of the good, p^* the international price of the good, and e represents the nominal exchange rate.

Cassel (1916), Dornbusch (1987), Batiz and Batiz (1994), MacDonald et al. (1992, 1994, 2007), Rogoff (1996), Sarno et al. (2001), Visser (2004), Moosa (2005) and Rossi (2013) believe that in the long term the nominal exchange rate should reflect the relative prices of two currencies. Hence:

$$e = P / P^* \tag{02}$$

$$P = e . P^* \tag{03}$$

Accordingly, Dornbusch (1987), Batiz and Batiz (1994) and Vasconcelos (2004), clarify that the equation (01) represents a state of equilibrium, where the real exchange rate (θ) between two countries can be formally represented by the nominal exchange rate corrected by the ratio of relative prices:

$$\theta = \frac{e . P*}{P} \tag{04}$$

Due to the volatility of the exchange rate, PPP has been criticized on account of the causality relationship between price index and exchange rate, where Cassel (1921) argues that causality occurs in the price index to exchange rate direction, while Keynes (1923), Angell (1926), Samuelson (1948), Balassa (1964) and Frenkel (1980) advocate the existence of reciprocal causality.

When Cassel (1918) empirically developed the purchasing power parity, he distinguished between absolute PPP (APPP) and relative PPP (RPPP). From the viewpoint of Cassel (1916), Houthakker (1978), MacDonald (1994, 2007), Rogoff (1996), Sarno et al. (2001), Papell et al. (2003) and Copeland (2005), in APPP the nominal exchange rate (s) of a country is determined as a result of the relationship between the general price levels of the country of origin (p) and those of the foreign country (p^*); thus MacDonald (1994, 2007), Sarno et al. (2001) and Marçal (2003) demonstrate that at a given moment t the real exchange rate (q) should be equal to zero:

$$q_t = s_t - p_t + p_t^* = 0 \tag{05}$$

MacDonald (1994, 2007), Rogoff (1996) and Sarno et al. (2001) report that it is difficult to determine whether the same basket of goods is available in two different countries. Thus, it is more common to test relative PPP, as it holds that the percentage variation in the exchange rate over a period of time.

From the perspective of Batiz and Batiz (1994), relative PPP is expressed by:

$$\hat{P} = \hat{e} + \hat{P}^{*} \tag{06}$$

$$\hat{e} = \hat{P} - \hat{P}^{*} \tag{07}$$

According to MacDonald (1994, 2007) and Marçal (2003, 2011), in RPPP there are two price indices (P or internal p and P^{*} or external p^{*}), composed of tradable goods and with the same structure of weights and goods, demonstrated by the following equation:

$$\Delta e_t = \Delta p_t - \Delta p_t^{*} \tag{08}$$

Cassel (1933) and Frenkel (1978) believe that supply and demand in the exchange economy of productivity factors exerts a fundamental influence on prices, and that it is important to assess the different price indices applicable to PPP (Samuelson, 1964).

Therefore, according to Keynes (1923), Balassa (1964), Samuelson (1964), Frenkel (1978) Edwards (1989), Sarno et al. (2001) and Copeland (2005), the most commonly used general price indices are the consumer price index (IPC), the Gross Domestic Product (GDP) implicit price deflator, the gross value of production deflator and the value-added deflator, the latter two used by the Organization for Economic Cooperation and Development (OECD) and by the EU KLEMS base (capital, labor, energy, materials and service, supported financially by the European Commission, Directorate-General of Investigation).

Nevertheless, Edwards (1989) and Sarno et al. (2001) clarify that none of these indices is perfect and that they all have some advantages and disadvantages.

According to Angell (1922), general price index resources, especially the GDP deflator, can generate significant biases in PPP, because the ratio of prices of tradable goods and of non-tradable goods moves in a differentiated manner over time in several countries as a result of the distinct growth of productivity in these two industries, in the estimate of the long-term equilibrium exchange rate.

Complementing Angell's (1922) line of thought, Balassa (1964), Samuelson (1964) and Strauss (1996) explain that one of the causes of PPP violations and of constant movements in real exchange rates are the productivity differences between the spheres of tradable goods and of non-tradable goods. Since according to Balassa (1964), the international differentials of productivity between the tradable goods and non-tradable goods sectors constituted a factor that introduces permanent deviations between PPP and the equilibrium exchange rate, as the greater the difference in the productivity level in the tradable goods sector between two countries, the greater the international difference in the price level of non-tradable goods. The productivity differential between the industry that produces tradable goods and non-tradable goods also tends to affect the real exchange rate (Marçal, 2011).

Angell (1922), Samuelson (1964), Strauss (1996) and Marçal (2011), thus advise that to ensure equilibrium in the exchange rate and to abide by the law of one price, non-tradable goods are excluded.

In their analyses, Balassa (1964) and Samuelson (1964), refer to the service industry as non-tradable goods, with the exception of tourism, but the argument was put forward five decades ago; the current tests of the theory need to take into account the transformations caused by globalization, which altered the classification of tradable goods. The base used (EU KLEMS) presents a current classification of tradable and non-tradable goods.

The relevance of productivity in the value of a country's currency was considered by Cassel (1930) when contemplating that a particular country, when guided naturally not only by market prices, but also by the long-run level of salaries, is impacted by productivity, as there is a relationship between salaries and productivity; Consequently, productivity affects the international value of a country's currency. According to Houthakker (1978), in the international trade theory the labor factor (and not just capital) plays a central role. For this reason, productivity is an important factor for determining exchange rate.

The most important PPP model in the long term, which adds productivity, was developed by Balassa (1964) and Samuelson (1964), producing the Balassa-Samuelson Effect, where the price indices of all the countries are converted into dollars using predominant nominal exchange rates; as commodity prices tend to reflect the marginal unit costs of production, wealthy countries exhibit higher price levels than poor countries as they have higher costs.

Basso (2008), using the Marxist benchmark, specifically the currency value concept proposed by Hilferding in Basso (2008), came up with an alternative theory to determine exchange rate over a lengthy period of time, by incorporating price indices and labor productivity indices, as Basso (2008) regards the labor theory of value as essential to understand phenomena of the functioning of the capitalist system of production.

The value of money is obtained by dividing the GDP of a country by the number of hours worked used to produce it. Therefore:

Domestic GDP;

HT: hours of work spent to produce the national product;

Foreign GDP;

HT^*: hours of work spent to produce the foreign product;

(GDP/HT): value of the national currency;

(GDP^*/HT^*): value of the foreign currency;

E: nominal exchange rate having the dimension between two currencies;

$E(GDP^*/HT^*)$: value of the foreign currency expressed in national currency.

Hilferding (1982) in Basso (2008) observes that there is a variable, designated A, which levels the value of money between two countries; this, multiplied by the value of P^* expressed in the value of P, can be seen in (09) and (10):

$$\frac{GDP}{HT} = \frac{A\ .\ e\ .\ GDP^*}{HT^*} \tag{09}$$

$$P\ .\ \ Prod. = A\ .\ \ e\ .\ \ P^*\ .\ Prod.^* \tag{10}$$

An issue that merits elucidation according to Basso (2008) is the set of variables that explain A; assuming that A is equal to 1, the long-term exchange rate is expressed as:

$$P\ .\ Prod. = \ \ e\ .\ \ P^*\ .\ Prod.^* \tag{11}$$

$$e = \frac{P\ .\ Prod.}{P^*\ .\ Prod.^*} \tag{12}$$

Thus two interesting results are obtained (Basso, 2008):

a) The exchange rate is explained by prices, productivities and other relevant variables included in variable A (even if not yet identifiable) (Basso, 2008);

b) PPP will only be corroborated if productivities converge to the same value (Basso, 2008);

Basso (2008) contends that the adjustment that cannot be made in short-term productivity (constant installed capacity) can be made in prices, which makes it easier to justify the value attributed to A. Consequently, A disappears from the equation:

$$\frac{GDP}{HT} = \frac{e \, . \, GDP^*}{HT^*} \tag{13}$$

Due to the use of finished goods, GDP can be expressed by the multiplication of a price index (P) by a quantity index (Q) (Basso, 2008):

$$P.\frac{Q}{HT} = E \, . \, P^*.\frac{Q^*}{HT^*} \tag{14}$$

As explained previously, number of hours worked is equivalent to productivity, thus arriving at the demonstration of the theory proposed by Basso, where:

$$P \, . \, Prod. = E \, . \, P^* \, . \, Prod.^* \tag{15}$$

$$E = \frac{P \, . \, Prod.}{P^* \, . \, Prod.^*} \tag{16}$$

However, Basso (2008) explains that an alteration can be made in the equation, by incorporating a physical productivity index, defined by number of workers (NW) and average hours of work per worker (HWW):

$$HT = NT \, . HTT \tag{17}$$

Then:

$$P.\frac{Q}{NT \, .HTT} = E \, . P^*.\frac{Q^*}{NT \, .HTT^*} \tag{18}$$

Basso (2008) says that if Q/NT is a physical productivity index, we obtain:

$$P.Prod_{FIS} \cdot \frac{1}{HTT} = E \cdot P^{*}.Prod^{*}_{FIS} \cdot \frac{1}{HTT^{*}} \tag{19}$$

$$E = \frac{P}{P^{*}} \cdot \frac{Prod_{FIS}}{Prod^{*}_{FIS}} \cdot \frac{HTT^{*}}{HTT} \tag{20}$$

In arriving at this equation, Basso (2008) propounds that we should consider not only physical productivity, but also the evolution of the ratio between average hours of work per worker in the countries evaluated. Hence, Basso (2008) points out that in the same way as equation (16) contains a productivity index, it allows price index variations, and clarifies that the exchange rate is related to labor productivity and not to physical productivity, hence:

$$\hat{E} = \hat{P} + \widehat{Prod} - \hat{P}^{*} - \widehat{Prod}^{*} \tag{21}$$

$$\hat{E} = (\hat{P} - \hat{P}^{*}) + (\widehat{Prod} - \widehat{Prod}^{*}) \tag{22}$$

$$\hat{E} = \Delta E/E \,; \hat{P} = \Delta P/P \,; \widehat{Prod} = \Delta Prod/Prod \tag{23}$$

Basso’s focus considers other macroeconomic variables, hence equation (22) is a more sophisticated version of the theory, as it considers physical productivity and the evolution of the average number of hours of work per worker.

$$\hat{E} = (\hat{P} - \hat{P}^{*}) + (\widehat{Prod}_{FIS} - \widehat{Prod}^{*}{}_{FIS}) + (\widehat{HTT} - \widehat{HTT}^{*}) \tag{24}$$

Nevertheless, if it is assumed that hours worked per worker are equal between countries, equation (22) is reduced to:

$$\hat{E} = (\hat{P} - \hat{P}^{*}) + (\widehat{Prod}_{FIS} - \widehat{Prod}^{*}{}_{FIS}) \tag{25}$$

An additional advantage of Basso's approach (2008) is that it can be regarded as an estimator of future exchange rates, taking into account price movements and labor productivity. Although it is a simple version, it is the most robust as regards the theoretical benchmark, as it is fully based on the labor theory of value (Basso, 2008).

5. Methodology

The time series analysis requires specific tests to be usable in univariate and multivariate models. If such tests and adjustments in the series are not done, the results produced will be inconsistent and useless for any analysis.

a. Johansen's Cointegration Test and Unit Roots

The cointegration test proposed by Johansen (1988) enables the analysis of structural relations between variables, determining whether they have long-term equilibrium or not. To assess whether two or more variables are cointegrated, it is necessary to ascertain the order of integration of each variable individually, using the unit root test.
The main unit root tests used most often are the Augmented Dickey-Fuller (ADF) tests, as presented in Dickey and Fuller (1979), and the Phillips-Perron (PP) test developed by Phillips and Perron (1988). According to Marçal (1998), Dickey and Fuller developed tests to detect the unit root hypothesis against the alternative hypothesis of stationarity. The analysis variable y_t is estimated by ordinary least square regression:

$$\Delta y_t = \mu + \beta T_t + \rho y_{t-1} + \sum_{i=1}^{k} \delta_i \Delta y_{t-1} + \varepsilon_i \tag{25}$$

Where μ and βT_t are the deterministic components of the model, hence in the test:
a) The value of statistic t associated with coefficient ρ and that of statistic Φ_3 which tests whether $\rho=\beta=0$ are compared.
If the null hypothesis is rejected the test ends, but if the null hypothesis is accepted, the series presents a unit root or low power of the test due to the improper inclusion of a deterministic trend.

b) The deterministic trend is excluded from the regression. This is only valid if $\mu=0$. The statistic Φ_2 tests whether ($\rho=\beta=\mu=0$). If the null hypothesis is rejected, the test ends, and the hypothesis of existence of a unit root is accepted.

c) If the null hypothesis is accepted, the regression is run without the deterministic trend. The null hypothesis of existence of a unit root is tested by the result of statistic t associated with the parameter ρ and by statistic Φ_1 which tests whether $\rho=\mu=0$. If the null hypothesis is rejected, the procedure finishes.

d) If the null hypothesis is not rejected, this may be due to the lower power of the test, which can be improved by running the regression without the trend and the constant. Statistic t associated with ρ is evaluated. If the null hypothesis is rejected, it is concluded that the unit root is absent.

When two variables are integrated of order one, i.e., to make each one of them stationary, it is necessary to apply a first order difference, in this case it is said that each one of these variables is stationary difference. When two variables are integrated of order one, their linear combination is stationary, i.e., although they are both integrated of order one and their combination is integrated of order zero, they will be cointegrated, provided that the residues of the regression, involving these two variables, are stationary. When two variables are cointegrated they imply the existence of a long-term equilibrium between them.

An important issue in econometrics is the need for integration of short-term dynamics with long-term equilibriums. The short-term dynamic analysis is generally carried out with the elimination of the trend of the variables, usually performed with differentiation. This procedure, however, discards important information in long-term relations. Granger's cointegration (Granger, 1981), refined by Engle and Granger (1987), studies the integration dynamics of these two dynamics.

A time series is integrated of order 1, I(1) if Δy is a stationary series. The stationary series is called I(0). A random walk is a special case of series I(1) as if y_t is a random walk, Δy_t will be a random or white noise series.

If $y_t \sim I(1)$ and $\mu_t \sim I(0)$, added up they result in $Z_t = y_t + \mu_t \sim I(1)$. Let us assume that $y_t \sim I(1)$ and $x_t \sim I(1)$. y_t and x_t are cointegrated if there is a β, such that $y_t - \beta x_t$ is I(0). Accordingly, the regression equation $y_t = \beta x_t + \mu t$ makes sense because y_t and x_t do not move far apart over time.

If y_t and x_t are not cointegrated, i.e., y_t - $\beta x_t = \mu_t$ with I(1), they will move further and further apart over time and there is no equilibrium relationship between them. The relations that are obtained by regressing y_t in x_t are spurious.

Two or more variables are cointegrated when there is a long-term equilibrium relationship, presenting synchronized trajectories over time. According to Engle and Granger (Engle and Granger, 1987), the n variables of a vector x_t (n × 1), where $x_t = (x_{1t}, x_{2t}, ..., x_{nt})$, are cointegrated of order (d, b), xt ~ CI (d, b), when:

i) the variables have the same order of integration I(d);

ii) the series formed by the linear combination of the variables, $\beta_{xt} = \beta_1 x_{1t} + \beta_2 x_{2t} + ... + \beta_n x_{nt}$ has order of integration below that of the original variables – $\beta' x_t \sim I(d – b)$, with b > 0 and with β as the cointegration vector.

For integrated variables of order 1, d = 1, it follows that (d – b) = 0.

Johansen's method (1988) is used in this analysis where the presence of multiple cointegration vectors is verified by using a VECM model represented by the equation

$$X_t = A_1 x_{t-1} + A_2 x_{t-2} + ... + A_k x_{t-k} + \varepsilon_t \tag{26}$$

In which:

x_t = vector (n × 1), the n variables are integrated of the same order, and with k lags;

A_i = matrix of order parameters (n × n);

ε_t = erratic term, with $\varepsilon_t \sim$ i.i.d. (0, Ω) (Independent and identically distributed).

According to Enders (2004), under the Granger Representation Theorem, the equation (X) can be expressed by means of vector error correction (VEC) when $x_t \sim CI (1.1)$:

$$\Delta x_t = \prod x_{t-1} + \sum_{i=1}^{k-1} \Delta x_{t-1} + \varepsilon_t \tag{27}$$

And, $\prod = -\left(I - \sum_{i=1}^{k} A_i \right)$ e $\prod_i = -\sum_{j=i+1}^{k} A_j$ (28)

The matrix Π (n × n) can be represented by the product of two matrices Π = α β'. Matrix α is formed by the adjustment coefficients (their elements are the speed of adjustment of the variables to short-term disequilibrium) and matrix β has the cointegration parameters. The term $\beta' x_{t-1}$ is the error correction term.

$$\Pi = \alpha \beta' \tag{29}$$

In which α and β have dimension (n × r), while r is equal to the number of long-term relationships and n is the number of parameters to be estimated. The model is estimated by maximum likelihood, with assumptions based on the normality and nonexistence of autocorrelation of the random term, i.e., $\varepsilon t \sim N(0, \Omega)$ and $E[\varepsilon_t \varepsilon_s] = 0$ for $t \neq s$.
Hence it should be verified whether such conditions are observed. The rank of matrix Π is equal to the number of characteristic roots of Π different from zero, indicating the number of cointegration vectors.
If the matrix rank matrix is equal to:
i) zero, the matrix is null and the equation (11) is a VAR in the first difference; in this case there is no cointegration, as no stationary linear combination is observed between the variables of X_t;
ii) n, Π has full rank and the variables of x_t are stationary, not warranting a cointegration analysis;
iii) r, where 1 < r < n, there are r cointegration vectors.
Thus the verification of the number of cointegration vectors occurs through the analysis of the significance of the estimated characteristic roots of Π, which is performed by two statistics:
i) Trace statistic, λ trace that tests the null hypothesis of existence of no more than r cointegration vectors (equation 28);
ii) Maximum autovalue statistic, λ max, which tests the null hypothesis of r cointegration vectors, against the alternative hypothesis of r + 1 vectors (equation 14) (ENDERS, 2010).

$$\lambda_{trace}(r) = -T \sum \ln(1-\hat{\lambda}_i) \tag{30}$$

$$\lambda_{\max} = (r, r+1) = -T \ln(1-\hat{\lambda}_{r+1}) \tag{31}$$

$\hat{\lambda}_i$ It is equal to the number of estimated values of characteristic roots, obtained from the estimation of matrix Π and T equal to the number of observations.

b. Number of Lags

Variables within a VAR model are treated symmetrically and they are all treated as endogenous. VAR depends on the lags of all the variables and its number is arbitrary. The choice of the number of lags depends on until when these add information to the system. The greater the number of lags, the greater the number of parameters in the model and the lesser the number of degrees of freedom, yet a greater number of lags avoids the need for restrictions in the model.

The determination of the number of lags in VAR is performed by the information criteria of Akaike (AIC), Schwarz (BIC) and by the Likelihood Ratio (LR) test.

c. Vector Autoregression

The vector autoregression (VAR) system of SIMS (1980) proposes the symmetric treatment of variables when it is not possible to clearly determine when they are endogenous or exogenous. Be they two stochastic processes y_t and z_t:

$$y_t = a_{10} + a_{11}y_{t-1} + a_{12}z_{t-1} + \varepsilon_{1t} \tag{32}$$

$$z_t = a_{20} + a_{21}y_{t-1} + a_{22}z_{t-1} + \varepsilon_{2t} \tag{33}$$

In which:

$$\varepsilon_{1t} \sim I(0), \varepsilon_{2t} \sim I(0) \ e \ cov(\varepsilon_{1t}\varepsilon_{2t}) = 0 \tag{34}$$

And their matricial representation is in the form of:

$$\begin{bmatrix} y_t \\ z_t \end{bmatrix} = \begin{bmatrix} a_{10} \\ a_{20} \end{bmatrix} + \begin{bmatrix} a_{11} & a_{12} \\ a_{21} & a_{22} \end{bmatrix} \begin{bmatrix} y_{t-1} \\ z_{t-1} \end{bmatrix} + \begin{bmatrix} \varepsilon_{1t} \\ \varepsilon_{2t} \end{bmatrix} \tag{35}$$

Or in compact form:

$$x_t = A_0 + A_1 x_{t-1} + \varepsilon_t \tag{36}$$

In which:

$$x_t = \begin{bmatrix} y_t \\ z_t \end{bmatrix}, A_0 = \begin{bmatrix} a_{10} \\ a_{20} \end{bmatrix}, A_t = \begin{bmatrix} a_{11} & a_{12} \\ a_{21} & a_{22} \end{bmatrix}, \varepsilon_t = \begin{bmatrix} \varepsilon_{1t} \\ \varepsilon_{2t} \end{bmatrix} \tag{37}$$

For the generalization of the model, assuming that the processes are all stochastic x_{1t}, x_{2t}, …. x_{nt}, the representation becomes:

$$x_t = A_0 + A_1 x_{t-1} + A_2 x_{t-2} + \cdots + A_p x_{t-p} + \varepsilon_t \tag{38}$$

In which:

$$x_t = \begin{bmatrix} x_t \\ \cdots \\ x_{nt} \end{bmatrix}, A_0 = \begin{bmatrix} a_{10} \\ \cdots \\ a_{n0} \end{bmatrix}, A_i = \begin{bmatrix} a_{i,11} & \cdots & a_{i,1n} \\ \vdots & \ddots & \vdots \\ a_{i,n1} & \cdots & a_{i,nn} \end{bmatrix}, i = 1, \ldots p, \varepsilon_t = \begin{bmatrix} \varepsilon_{1t} \\ \cdots \\ \varepsilon_{nt} \end{bmatrix} \tag{39}$$

$$\varepsilon_{it} \sim I(0)\ e\ cov(\varepsilon_{it}\varepsilon_{st}) = 0 \tag{40}$$

d. Vector Autoregression with Error Correction

Assuming that $x_{1t} \sim I(1), x_{2t} \sim I(1), \ldots x_{nt} \sim I(1)$ and that they are cointegrated, it is possible to perform the representation:

$$\Delta x_t = \Pi_0 + \Pi x_{t-1} + \Pi_1 \Delta x_{t-1} + \Pi_2 \Delta x_{t-2} + \cdots + \Pi_p \Delta x_{t-p} + e_t \tag{41}$$

In which:

$$x_t = \begin{bmatrix} x_{1t} \\ \cdots \\ x_{nt} \end{bmatrix}, \Pi_0 = \begin{bmatrix} \pi_{10} \\ \cdots \\ \pi_{n0} \end{bmatrix}, A_i = \begin{bmatrix} \pi_{i,11} & \cdots & \pi_{i,1n} \\ \vdots & \ddots & \vdots \\ \pi_{i,n1} & \cdots & \pi_{i,nn} \end{bmatrix}, i = 1, \ldots p, e_t = \begin{bmatrix} e_{1t} \\ \cdots \\ e_{nt} \end{bmatrix} \tag{42}$$

and

$$\Pi_{nxn} = \begin{bmatrix} \pi_{11} & \cdots & \pi_{1n} \\ \vdots & \ddots & \vdots \\ \pi_{n1} & \cdots & \pi_{nn} \end{bmatrix} \quad (43)$$

Πx_t is the error correction mechanism and each line of this matrix represents a cointegration relationship, where there should be at least one and no more than n-1 cointegration relationships. Each line of Π is a cointegration vector, where there should be at least one and no more than n-1 cointegration vectors. The rank of Π determines the number of cointegration vectors.

e. *Model Confidence Set* (MCS)

The Model Confidence Set (MCS) is a model selection technique developed by Hansen, Lunde and Nason (Hansen, Lunde and Nason, 2011). It consists of a process of choice of models, M^*, which contains the best model(s) chosen from a collection of models, M^0, in which, "best model" is defined using criteria referring to the prediction quality.
The MCS estimates a set $\widehat{M^*}$ that contains the best models for a given descriptive level. In MCS the sets of data with the same information quality result in an $\widehat{M^*}$ with a single model, while data of lesser information quality result in more than one model, with similar prediction qualities, given a particular significance level.
MCS selects a model, using an equivalence test, δM and an elimination rule, eM. The equivalence test is applied to the set $M = M_0$.
If δM is rejected, then there is evidence that the models are not of minimum predictive quality, hence the rule δM is used to eliminate the models with poor predictive quality. The procedure is repeated until the equivalence test, δM, is accepted, then the model $\widehat{M^*}$ is selected for a set of the best models.
Using a descriptive level α in all the tests, the method ensures that:

$$lim_{n\to\infty}^{(M^* \complement M^*_{(1-\propto)})} \geq (1-\alpha) \quad (44)$$

When $\widehat{M^*}$ contains only one model, there is evidence that:

$$lim_{n\to\infty}^{(M^* = M^*_{(1-\propto)})} = 1 \quad (45)$$

MCS produces descriptive levels for each model that has been subject to the elimination rule. For each model i ∈ M^0, the descriptive level $\widehat{p_i}$ is the assurance that $i \in \widehat{M^*_{1-\alpha}}$, only if $\widehat{p_i} > \alpha$. Thus any model with low descriptive level is certainly not among the best models with information quality.

The MCS sequence is based on the following steps:

(i) $M = M_0$.

(ii) Test hypothesis $H_{0,}$ using δM at level of confidence α.

(iii) If $H_{0,}$ is accepted, then; $M*\hat{1}-\propto = M$, otherwise, the model is eliminated by rule eM.

(iv) The process is repeated for all the models, from step (ii).

6. Database

The data for the analysis correspond to the 1977-2006 time interval on an annual basis. For Japan (JP), the United Kingdom (UK) and the United States (US), they were extracted from the KLEMS database available at http://www.euklems.net/, Federal Reserve Saint Louis available at http://research.stlouisfed.org/fred2/ and from the International Monetary Fund available at www.imf.org.

The data extracted for Japan, the United States and the United Kingdom were:

Table (01) – United States data series

SERIES	DESCRIPTION
US_GDP_TI	GROSS OUTPUT AT CURRENT BASIC PRICES
US_H_EMP	TOTAL HOURS WORKED BY PERSONS ENGAGED
US_H_EMPE	TOTAL HOURS WORKED BY EMPLOYEES
US_DEFL_VA	GROSS VALUE ADDED, PRICE INDICES
US_GO_P	GROSS OUTPUT, PRICE INDEX
US_ER	NATIONAL CURRENCY PER U.S. DOLLAR, END OF PERIOD
US_CPI	CONSUMER PRICES, ALL ITEMS NORMAL

Source: Prepared by the authors

Table (02) – Japan data series

SERIES	DESCRIPTION
JP_GDP_TI	GROSS OUTPUT AT CURRENT BASIC PRICES
JP_H_EMP	TOTAL HOURS WORKED BY PERSONS ENGAGED
JP_H_EMPE	TOTAL HOURS WORKED BY EMPLOYEES

JP_DEFL_VA	GROSS VALUE ADDED, PRICE INDICES
JP_GO_P	GROSS OUTPUT, PRICE INDEX
JP_ER	NATIONAL CURRENCY PER U.S. DOLLAR, END OF PERIOD
JP_CPI	CONSUMER PRICES, ALL ITEMS NORMAL

Source: Prepared by the authors

Table (03) –United Kingdom data series

SERIES	DESCRIPTION
UK_GDP_TI	GROSS OUTPUT AT CURRENT BASIC PRICES
UK_H_EMP	TOTAL HOURS WORKED BY PERSONS ENGAGED
UK_H_EMPE	TOTAL HOURS WORKED BY EMPLOYEES
UK_DEFL_VA	GROSS VALUE ADDED, PRICE INDICES
UK_GO_P	GROSS OUTPUT, PRICE INDEX
UK_ER	NATIONAL CURRENCY PER U.S. DOLLAR, END OF PERIOD
UK_CPI	CONSUMER PRICES, ALL ITEMS NORMAL

Source: Prepared by the authors

The original data of the countries were used as a starting point to develop variables originating from logarithmic transformations, used in the evaluations of the pairs of countries Japan-United States, Japan-United Kingdom, United Kingdoms-United States (all nine variables are in first difference, to be stationary).

Table (04) – Variables created for Japan – United States

SERIES	DESCRIPTION
DJPUS_ER	DIFFERENCE BETWEEN THE EXCHANGE RATES
DJPUS_CPI	DIFFERENCE BETWEEN THE CONSUMER PRICE INDICES
DJPUS_DEFL_VA	DIFFERENCE BETWEEN THE VALUE-ADDED DEFLATORS
DJPUS_GO_P	DIFFERENCE BETWEEN THE TOTAL PRODUCTION DEFLATORS
DJPUS_PROD_EMP	DIFFERENCE BETWEEN THE ACTIVE LABOR PRODUCTIVITIES
DJPUS_PROD_EMPE	DIFFERENCE BETWEEN THE RELATED LABOR PRODUCTIVITIES

Source: Prepared by the authors

Table (05) – Variables created for Japan – United Kingdom

SERIES	DESCRIPTION
DJPUK_ER	DIFFERENCE BETWEEN THE EXCHANGE RATES
DJPUK_CPI	DIFFERENCE BETWEEN THE CONSUMER PRICE INDICES
DJPUK_DEFL_VA	DIFFERENCE BETWEEN THE VALUE-ADDED DEFLATORS
DJPUK_GO_P	DIFFERENCE BETWEEN THE TOTAL PRODUCTION DEFLATORS
DJPUK_PROD_EMP	DIFFERENCE BETWEEN THE ACTIVE LABOR PRODUCTIVITIES
DJPUK_PROD_EMPE	DIFFERENCE BETWEEN THE RELATED LABOR PRODUCTIVITIES

Source: Prepared by the authors

Table (06) – Variables created for the United Kingdom – United States

SERIES	DESCRIPTION
DUKUS_ER	DIFFERENCE BETWEEN THE EXCHANGE RATES
DUKUS_CPI	DIFFERENCE BETWEEN THE CONSUMER PRICE INDICES
DUKUS_DEFL_VA	DIFFERENCE BETWEEN THE VALUE-ADDED DEFLATORS
DUKUS_GO_P	DIFFERENCE BETWEEN THE TOTAL PRODUCTION DEFLATORS
DUKUS_PROD_EMP	DIFFERENCE BETWEEN THE ACTIVE LABOR PRODUCTIVITIES
DUKUS_PROD_EMPE	DIFFERENCE BETWEEN THE RELATED LABOR PRODUCTIVITIES

Source: Prepared by the authors

Each of the variables GDP_TI; H_EMP; H_EMPE; DEFL_VA; GO_P and CPI, was obtained from data from 96 economic sectors, aggregated in ten sectors and grouped in a final total value (see economic classification of EU KLEMS in Appendix A).

The CPI data that were available with base 100 in the year 2005 were converted to base 100 in the year 1995, making it compatible with the other deflators that had the year 1995 as base 100.

To test PPP, according to equation (08), the value-added price index (DEFL_VA), gross producer price index (GO_P) and consumer price index (CPI) are used to create specific variables.

The data were used to develop work variables for the Basso (2008) model, in which the total gross production (GDP_TI) was deflated by DEFL_VA, by GO_P and by CPI, thus creating deflated variables.

The variables were converted into US dollars using the end-of-period rate and then transformed into productivity, dividing them by hours worked by/from the total staff (H_EMPE) and by/from the total labor available (H_EMP).

The models were executed in the STATA-12 program and the MCS analyses were conducted in OXMETRICS-6.

7. Results of the tests with the variables

For relative PPP, the cointegration equations (see Appendix B) generated the following results:

In the pair of countries Japan – United States the exchange rate (JPUS_ER) does not cointegrate with any of the price indices used (JPUS_CPI, JPUS_DEFL_VA and JPUS_GO_P), showing that the purchasing power parity theory is not corroborated for Japan and the United States.

For the pair of countries Japan – United Kingdom the exchange rate (JPUK_ER) only exhibits cointegration with the gross production price index (JPUK _GO_P).
In the pair of countries United Kingdom – United States the exchange rate (UKUS_ER) does not cointegrate with UKUS_CPI, UKUS_DEFL_VA and UKUS_GO_P, hence there is no PPP model between the United Kingdom and the United States that can be explicable with these variables.

In the model proposed by Basso (2008):

Cointegration was found between all the systems of equations for:

a. Cointegration equations for each model

Table (07) – Number of cointegration equations

	MODEL	COINTEGRATION EQ.		
		JPUS	JPUK	USUK
1	Exchange rate diff., CPI diff., productivity emp. diff.	1	0	1
2	Exchange rate diff., CPI diff., productivity emp. diff.	1	1	1
3	Exchange rate diff., VA defl. diff., productivity emp. diff.	1	1	0
4	Exchange rate diff., VA defl. diff., productivity emp. diff.	1	0	0
5	Exchange rate diff., GDP defl. diff., productivity empe. diff.	1	1	1
6	Exchange rate diff., GDP defl. diff., productivity emp. diff.	1	1	1

Source: prepared by the authors

For the pair of countries Japan – United States (JPUS) the hypothesis of existence of a cointegration equation cannot be rejected for all the combinations of variables (1 to 6), at the level of 5%.
For the pair of countries Japan – United Kingdom (JPUK) there is no cointegration for the combinations of variables 1 and 4, and the hypothesis of existence of a cointegration equation cannot be rejected for the combinations of variables 2, 3, 5 and 6, at the level of 5%;
For the pair of countries United Kingdom – United States (UKUS) there is no cointegration for the combinations of variables 3 and 4, and the hypothesis of existence of a cointegration equation cannot be rejected for the combinations of variables 1, 2, 5 and 6, at the level of 5%;

b. Unit Root Tests

i. Dickey-Fuller Test

Table (08) – ADF Unit Root Test for Japan – United States

JAPAN - UNITED STATES SYSTEM						
	AT LEVEL		1st Difference		2nd Difference	
Variable	Statistics	p-value	Statistics	p-value	Statistics	p-value
JPUS_ER	-1,676	0.4436	-5,318	0.0000	-	-
JPUS_CPI	-0,631	0.8639	-3,863	0.0023	-	-
JPUS_PROD_EMPE	-1,794	0.3832	-5,243	0.0000	-	-
JPUS_PROD_EMP	-1,812	0.3747	-5,206	0.0000	-	-
JPUS_DEFL_VA	-1,273	0.6414	-2,526	0.1093	-6,307	0.0000
JPUS_GO_P	-1,692	0.4352	-4,757	0.0001	-	-

Source: prepared by the authors

The critical values for the Dickey-Fuller test are:

1% : -3.7230

5% : -2.9890

10% : -2.6250

Using the Dickey-Fuller test in the Japan-United States system, note that all the variables are stationary in first difference, with the exception of the variable JPUS_DEFL_VA (difference between the value-added deflators of Japan and the United States) which is stationary in second difference.

Table (09) – ADF Unit Root Test for Japan – United Kingdom

JAPAN - UNITED KINGDOM SYSTEM						
	AT LEVEL		1st Difference		2nd Difference	
Variable	Statistics	p-value	Statistics	p-value	Statistics	p-value
JPUK_ER	-1,844	0.3586	-4,409	0.0003	-	-
JPUK_CPI	-6,963	0.0000	-	-	-	-

JPUK_PROD_EMPE	-1,496	0.5353	-4,525	0.0002	-	-
JPUK_PROD_EMP	-1,531	0.5183	-4.53	0.0002	-	-
JPUK_DEFL_VA	-3,794	0.0030	-	-	-	-
JPUK_GO_P	-6,938	0.0000	-	-	-	-

Source: prepared by the authors

Using the Dickey-Fuller test in the Japan – United Kingdom system, note that the variables JPUK_CPI (difference between the CPIs of Japan and the United Kingdom), JPUK_DEFL_VA (difference between the value-added deflators of the two countries) and JPUK_GO_P (difference between the GDP deflators of the two countries) are stationary in level, and that the variables JPUK_ER (difference between the exchange rates of the two countries), JPUK_PROD_EMPE (difference between related personnel) and JPUK_EMP (difference between employed personnel) are stationary in first difference.

Table (10) – ADF Unit Roots Test for the United Kingdom – United States

UNITED KINGDOM - UNITED STATES SYSTEM						
	AT LEVEL		1st Difference		2nd Difference	
Variable	Statistics	p-value	Statistics	p-value	Statistics	p-value
UKUS_ER	-2.2344	0.1581	-4,956	0.0000	-	-
UKUS_CPI	-4,806	0.0001	-	-	-	-
UKUS_PROD_EMPE	-7,764	0.0000	-	-	-	-
UKUS_PROD_EMP	-7,044	0.0000	-	-	-	-
UKUS_DEFL_VA	-4,385	0.0003	-	-	-	-
UKUS_GO_P	-4,511	0.0002	-	-	-	-

Source: prepared by the authors

Employing the Dickey-Fuller test in the United Kingdom – United States system, note that the variable UKUS_ER (difference between the exchange rates) is stationary in first difference, while all the others are stationary in level.

ii. Phillips – Perron Test

The critical values for the Phillips-Perron test are:

1% : -3.7230

5% : -2.9890

10% : -2.6250

Table (11) – PP Unit Root Test for Japan – United States

JAPAN - UNITED STATES SYSTEM

	AT LEVEL		1st Difference		2nd Difference	
Variable	Statistics	p-value	Statistics	p-value	Statistics	p-value
JPUS_ER	-1,646	0.4589	-5,174	0.0000	-	-
JPUS_CPI	-0,607	0.8695	-4,042	0.0012	-	-
JPUS_PROD_EMPE	-1,799	0.3808	-5,258	0.0000	-	-
JPUS_PROD_EMP	-1,841	0.3603	-5,214	0.0000	-	-
JPUS_DEFL_VA	-1,035	0.7402	-2,733	0.0685	-6,353	0.0000
JPUS_GO_P	-1,579	0.4940	-4.76	0.0001	-	-

Source: prepared by the authors

Using the Phillips-Perron test in the Japan-United States system, note that all the variables are stationary in first difference, with the exception of the variable JPUS_DEFL_VA (difference between the value-added deflators) which is stationary in second difference.

Table (12) – PP Unit Root Test for Japan – United Kingdom

JAPAN - UNITED KINGDOM SYSTEM

	AT LEVEL		1st Difference		2nd Difference	
Variable	Statistics	p-value	Statistics	p-value	Statistics	p-value
JPUK_ER	-1,849	0.3566	-4,394	0.0003	-	-
JPUK_CPI	-6,207	0.0000	-	-	-	-
JPUK_PROD_EMPE	-1,486	0.5404	-4,487	0.0002	-	-
JPUK_PROD_EMP	-1,571	0.4981	-4,492	0.0002	-	-
JPUK_DEFL_VA	-3,248	0.0174	-	-	-	-
JPUK_GO_P	-7,583	0.0000	-3,677	0.0044	-	-

Source: prepared by the authors

For the Japan – United Kingdom system, using the Phillips – Perron test, note that the variables JPUK_CPI (difference between the CPIs of Japan and the United Kingdom), JPUK_DEFL_VA (difference between the value-added deflators of the two countries) and JPUK_GO_P (difference between the GDP deflators of the two countries) are stationary in level while the variables JPUK_ER (difference between the exchange rates of the two countries), JPUK_PROD_EMPE (difference in productivity of related personnel) and JPUK_EMP (difference in productivity of employed personnel) are stationary in first difference.

Table (13) – PP Unit Root Test for the United Kingdom – United States

UNITED KINGDOM - UNITED STATES SYSTEM						
	AT LEVEL		1st Difference		2nd Difference	
Variable	Statistics	p-value	Statistics	p-value	Statistics	p-value
UKUS_ER	-2,455	0.1269	-4,941	0.0000	-	-
UKUS_CPI	-3,915	0.0019	-4,883	0.0000	-	-
UKUS_PROD_EMPE	-7,351	0.0000	-2,304	0.1706	-	-
UKUS_PROD_EMP	-6,738	0.0000	-2,569	0.0996	-	-
UKUS_DEFL_VA	-4,957	0.0000	-3,802	0.0029	-	-
UKUS_GO_P	-5,157	0.0000	-3,995	0.0014	-	-

Source: prepared by the authors

In the United Kingdom – United States system we cannot reject the hypothesis that the series are stationary in first difference at the level of 5%.

c. Number of Lags

Table (14) – Number of lags Japan – United States

	JAPAN - UNITED STATES SYSTEM			
	VARIABLES			NUMBER OF LAGS
1	JPUS_ER	JPUS_CPI	JPUS_PROD_EMPE	2
2	JPUS_ER	JPUS_CPI	JPUS_PROD_EMP	2
3	JPUS_ER	JPUS_DEFL_VA	JPUS_PROD_EMPE	3

4	JPUS_ER	JPUS_DEFL_VA	JPUS_PROD_EMP	3
5	JPUS_ER	JPUS_GO_P	JPUS_PROD_EMPE	2
6	JPUS_ER	JPUS_GO_P	JPUS_PROD_EMP	2

Source: prepared by the authors

Table (15) – Number of lags Japan – United Kingdom

	JAPAN – UNITED KINGDOM SYSTEM			
	VARIABLES			NUMBER OF LAGS
1	JPUK_ER	JPUK_CPI	JPUK_PROD_EMPE	2
2	JPUK_ER	JPUK_CPI	JPUK_PROD_EMP	2
3	JPUK_ER	JPUK_DEFL_VA	JPUK_PROD_EMPE	3
4	JPUK_ER	JPUK_DEFL_VA	JPUK_PROD_EMP	3
5	JPUK_ER	JPUK_GO_P	JPUK_PROD_EMPE	4
6	JPUK_ER	JPUK_GO_P	JPUK_PROD_EMP	2

Source: prepared by the authors

Table (16) – Number of lags United Kingdom – United States

	UNITED KINGDOM - UNITED STATES SYSTEM			
	VARIABLES			NUMBER OF LAGS
1	UKUS_ER	UKUS_CPI	UKUS_PROD_EMPE	2
2	UKUS_ER	UKUS_CPI	UKUS_PROD_EMP	2
3	UKUS_ER	UKUS_DEFL_VA	UKUS_PROD_EMPE	3
4	UKUS_ER	UKUS_DEFL_VA	UKUS_PROD_EMP	3
5	UKUS_ER	UKUS_GO_P	UKUS_PROD_EMPE	2
6	UKUS_ER	UKUS_GO_P	UKUS_PROD_EMP	2

Source: prepared by the authors

8. Analysis of Results

VAR and VEC were used with the respective lags and variable adjustments for each combination of variables, with differentiations in the series for induction of stationarity.

Accordingly, 12 regressions (6 VAR and 6 VEC) were performed for each pair of countries.

The software programs used to produce the results were STATA-12, which executed the models, and OXMETRICS-6 for the model confidence set analysis, via MULCOM package.

The sample was halved and the VAR and VEC regressions were performed with the rolling regression system, projecting the values of half the sample until the end. The final analysis to decide on the usefulness of the models was performed with mean squared error and MCS. The systems that produced the results for analysis are those described in the tables (14, 15 and 16)

The projected results were used to generate the squared errors, which were analyzed by two criteria, the mean squared error, and MCS.

The analysis via the Model Confidence Set analysis indicated:

Japan – United Kingdom System: Inconclusive. No system had information quality that would qualify it as satisfactory for performing projections.

Japan – United States System: Inconclusive. No system had information quality that would qualify it as satisfactory for performing projections.

United Kingdom – United States System: Five projection systems were found that produce projections with the same information quality.

Table (17) – Systems and variables for the United Kingdom – United States (UKUS)

SYSTEM	VARIABLES
UKUS_VAR_5	DUKUS_ER UKUS_GO_P UKUS_PROD_EMPE
UKUS_VAR_6	DUKUS_ER UKUS_GO_P UKUS_PROD_EMP
UKUS_VEC_3	DUKUS_ER UKUS_DEFL_VA UKUS_PROD_EMPE
UKUS_VEC_4	DUKUS_ER UKUS_DEFL_VA UKUS_PROD_EMP
UKUS_VEC_5	DUKUS_ER UKUS_GO_P UKUS_PROD_EMPE

Source: prepared by the authors

The system UKUS_VAR_5 is composed of the variables:

Difference between the United Kingdom and United States exchange rates, in first difference (DUKUS_ER);

Difference between the United Kingdom and United States gross production deflators in level (UKUS_GO_P);

Difference between the United Kingdom and United States employed staff productivities, in level (UKUS_PROD_EMP).

The system UKUS_VAR_6 is composed of the variables:
Difference between the United Kingdom and United States exchange rates, in first difference (DUKUS_ER);
Difference between the United Kingdom and United States gross production deflators, in level (UKUS_GO_P);
Difference between the United Kingdom and United States related party productivities, in level (UKUS_PROD_EMPE).

The system UKUS_VEC_3 is composed of the variables:
Difference between the United Kingdom and United States exchange rates, in first difference (DUKUS_ER);
Difference between the United Kingdom and United States value-added deflators, in level (UKUS_DEFL_VA);
Difference between the United Kingdom and United States related party productivities, in level (UKUS_PROD_EMPE).

The system UKUS_VEC_4 is composed of the variables:
Difference between the United Kingdom and United States exchange rates, in first difference (DUKUS_ER);
Difference between the United Kingdom and United States value-added deflators, in level (UKUS_DEFL_VA);
Employed staff productivity (UKUS_PROD_EMP).

The system UKUS_VEC_5 is composed of the variables:
Difference between the United Kingdom and United States exchange rates, in first difference (DUKUS_ER);
Difference between the United Kingdom and United States gross production deflators, in level (UKUS_GO_P);
Difference between the United Kingdom and United States related party productivities, in level (UKUS_PROD_EMP).

9. Conclusion

The aim of this study was to verify whether PPP remains steady over time and whether the hypothesis submitted by BASSO (2008), claiming that the productivity differential can affect the exchange rate between two countries, has empirical support.

Information for Japan, the United Kingdom and the United States was used for the tests on annual bases, covering the 1977- 2006 period.

The unit root tests (Augmented Dickey-Fuller and Phillips-Perron) were applied to the variables for PPP and for the Basso model (2008), and variables were created with the necessary stationarity inductions. The hypotheses were tested using VAR (Vector Autoregression) and VEC (Vector Error Correction) regressions, adjusted with the appropriate lags, indicated by the AIC (Akaike), SBC (Schwarz Bayesian Criterion) and HQ (Hannan-Quinn) information criteria. The regressions were performed using the rolling regression process, having the first half of the data as a sample space.

For the pairs of countries in which PPP was applied, only the Japan – United Kingdom pair exhibited cointegration with a single price index (JPUK _GO_P).

The projections produced for the Basso model (2008) were used to generate series with the squared errors for each VAR and VEC projection, which were used for analysis with MCS. In MCS, the analyses for Japan – United States and Japan – United Kingdom do not contain any evidence that the selected variables have predictive power for the long-term exchange rate.

Evidence was found for the United Kingdom – United States system that supports the hypothesis proposed by BASSO (2008), in five regressions, UKUS_VAR_5; UKUS_VAR_6; UKUS_VEC_3; UKUS_VEC_4 and UKUS_VEC_5, out of a total of twelve, yet the same models did not exhibit predictive quality for the other pairs of countries, leading to the conclusion that the evidence found does not yet allow a generalizable theory for all the pairs of countries.

The next task consists of redoing the tests, improving the classification of tradable and non-tradable sectors and building sectorial variables deflated by sectoral price indices.

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APPENDIX A

EU KLEMS presents the following classification for the economic sectors, which can be integrated into sectors 1, 6, 14, 62, 67, 68, 72, 73, 80 and 94, where only sectors 1, 6, and 14 are of tradable goods and the others are classified as non-tradable.

	TOTAL INDUSTRIES
1	**AGRICULTURE, HUNTING, FORESTRY AND FISHING**
2	AGRICULTURE, HUNTING AND FORESTRY
3	Agriculture
4	Forestry
5	FISHING
6	**MINING AND QUARRYING**
7	MINING AND QUARRYING OF ENERGY PRODUCING MATERIALS
8	Mining of coal and lignite; extraction of peat
9	Extraction of crude petroleum and natural gas and services
10	Mining of uranium and thorium ores
11	MINING AND QUARRYING EXCEPT ENERGY PRODUCING MATERIALS
12	Mining of metal ores
13	Other mining and quarrying
14	**TOTAL MANUFACTURING**
15	FOOD , BEVERAGES AND TOBACCO
16	Food and beverages
17	Tobacco
18	TEXTILES, TEXTILE , LEATHER AND FOOTWEAR

19	Textiles and textile
20	Textiles
21	Wearing Apparel, Dressing And Dying Of Fur
22	Leather, leather and footwear
23	WOOD AND OF WOOD AND CORK
24	PULP, PAPER, PAPER , PRINTING AND PUBLISHING
25	Pulp, paper and paper
26	Printing, publishing and reproduction
27	Publishing
28	Printing and reproduction
29	CHEMICAL, RUBBER, PLASTICS AND FUEL
30	Coke, refined petroleum and nuclear fuel
31	Chemicals and chemical products
32	Pharmaceuticals
33	Chemicals excluding pharmaceuticals
34	Rubber and plastics
35	OTHER NON-METALLIC MINERAL
36	BASIC METALS AND FABRICATED METAL
37	Basic metals
38	Fabricated metal
39	MACHINERY, NEC
40	ELECTRICAL AND OPTICAL EQUIPMENT
41	Office, accounting and computing machinery
42	Electrical engineering
43	Electrical machinery and apparatus, nec
44	Insulated wire
45	Other electrical machinery and apparatus nec
46	Radio, television and communication equipment
47	Electronic valves and tubes
48	Telecommunication equipment
49	Radio and television receivers
50	Medical, precision and optical instruments
51	Scientific instruments
52	Other instruments
53	TRANSPORT EQUIPMENT
54	Motor vehicles, trailers and semi-trailers
55	Other transport equipment
56	Building and repairing of ships and boats
57	Aircraft and spacecraft
58	Railroad equipment and transport equipment nec
59	MANUFACTURING NEC; RECYCLING
60	Manufacturing nec
61	Recycling
62	**ELECTRICITY, GAS AND WATER SUPPLY**
63	ELECTRICITY AND GAS

64	Electricity supply
65	Gas supply
66	WATER SUPPLY
67	**CONSTRUCTION**
68	**WHOLESALE AND RETAIL TRADE**
69	Sale, maintenance and repair of motor vehicles and motorcycles; retail sale of fuel
70	Wholesale trade and commission trade, except of motor vehicles and motorcycles
71	Retail trade, except of motor vehicles and motorcycles; repair of household goods
72	**HOTELS AND RESTAURANTS**
73	**TRANSPORT AND STORAGE AND COMMUNICATION**
74	TRANSPORT AND STORAGE
75	Other Inland transport
76	Other Water transport
77	Other Air transport
78	Other Supporting and auxiliary transport activities; activities of travel agencies
79	POST AND TELECOMMUNICATIONS
80	**FINANCE, INSURANCE, REAL ESTATE AND BUSINESS SERVICES**
81	FINANCIAL INTERMEDIATION
82	Financial intermediation, except insurance and pension funding
83	Insurance and pension funding, except compulsory social security
84	Activities related to financial intermediation
85	REAL ESTATE, RENTING AND BUSINESS ACTIVITIES
86	Real estate activities
87	Renting of m&eq and other business activities
88	Renting of machinery and equipment
89	Computer and related activities
90	Research and development
91	Other business activities
92	Legal, technical and advertising
93	Other business activities, nec
94	**COMMUNITY SOCIAL AND PERSONAL SERVICES**
95	PUBLIC ADMIN AND DEFENSE; COMPULSORY SOCIAL SECURITY
96	EDUCATION
97	HEALTH AND SOCIAL WORK
98	OTHER COMMUNITY, SOCIAL AND PERSONAL SERVICES
99	Sewage and refuse disposal, sanitation and similar activities
100	Activities of membership organizations nec
101	Recreational, cultural and sporting activities
102	Media activities
103	Other recreational activities
104	Other service activities
105	PRIVATE HOUSEHOLDS WITH EMPLOYED PERSONS
106	EXTRA-TERRITORIAL ORGANIZATIONS AND BODIES

http://www.euklems.net/ e http://www.euklems.net/data/EUKLEMS_Growth_and_Productivity_Accounts_Part_I_Methodology.pdf

APPENDIX B

COINTEGRATION TESTS:

JAPAN – UNITED STATES SYSTEM

TEST BETWEEN jpus_er jpus_cpi

```
                       Johansen tests for cointegration
Trend: constant                                         Number of obs =      28
Sample:  1979 - 2006                                             Lags =       2
-------------------------------------------------------------------------------
                                                          5%
maximum                                      trace    critical
  rank    parms       LL       eigenvalue  statistic    value
    0      6       102.74471           .      12.9838*   15.41
    1      9       106.90992     0.25734       4.6534     3.76
    2      10      109.23661     0.15312
-------------------------------------------------------------------------------
```

TEST BETWEEN jpus_er jpus_defl_va

```
                       Johansen tests for cointegration
Trend: constant                                         Number of obs =      28
Sample:  1979 - 2006                                             Lags =       2
-------------------------------------------------------------------------------
                                                          5%
maximum                                      trace    critical
  rank    parms       LL       eigenvalue  statistic    value
    0      6       103.29587           .       8.2782*   15.41
    1      9       106.90317     0.22715       1.0636     3.76
    2      10      107.43495     0.03727
-------------------------------------------------------------------------------
```

TEST BETWEEN jpus_er jpus_go_p

```
                       Johansen tests for cointegration
Trend: constant                                         Number of obs =      28
Sample:  1979 - 2006                                             Lags =       2
-------------------------------------------------------------------------------
                                                          5%
maximum                                      trace    critical
  rank    parms       LL       eigenvalue  statistic    value
    0      6        110.1341           .      12.3459*   15.41
    1      9        116.2889     0.35572       0.0363     3.76
    2      10      116.30707     0.00130
-------------------------------------------------------------------------------
```

JAPAN – UNITED KINGDOM SYSTEM

TEST BETWEEN jpuk_er jpuk_cpi

```
                       Johansen tests for cointegration
Trend: constant                                         Number of obs =      28
Sample:  1979 - 2006                                             Lags =       2
-------------------------------------------------------------------------------
                                                          5%
maximum                                      trace    critical
  rank    parms       LL       eigenvalue  statistic    value
    0      6       100.62786           .      16.5252    15.41
    1      9       106.19914     0.32830       5.3827     3.76
    2      10      108.89046     0.17489
-------------------------------------------------------------------------------
```

TEST BETWEEN jpuk_er jpuk_defl_va

```
                       Johansen tests for cointegration
Trend: constant                                         Number of obs =      28
Sample:  1979 - 2006                                             Lags =       2
-------------------------------------------------------------------------------
                                                              5%
maximum                                      trace    critical
  rank    parms       LL       eigenvalue  statistic    value
    0      6       84.60487           .      19.5645    15.41
    1      9      92.322344     0.42377       4.1295     3.76
    2      10     94.387114     0.13712
-------------------------------------------------------------------------------
```

TEST BETWEEN jpuk_er jpuk_go_p

```
                       Johansen tests for cointegration
Trend: constant                                         Number of obs =      28
Sample:  1979 - 2006                                             Lags =       2
-------------------------------------------------------------------------------
                                                              5%
maximum                                      trace    critical
  rank    parms       LL       eigenvalue  statistic    value
    0      6      92.636459           .      23.1603    15.41
    1      9      102.70178     0.51274       3.0296*    3.76
    2      10     104.21658     0.10255
-------------------------------------------------------------------------------
```

UNITED KINGDOM – UNITED STATES SYSTEM

TESTE ENTRE ukus_er ukus_cpi

```
                       Johansen tests for cointegration
Trend: constant                                         Number of obs =      28
Sample:  1979 - 2006                                             Lags =       2
-------------------------------------------------------------------------------
                                                              5%
maximum                                      trace    critical
  rank    parms       LL       eigenvalue  statistic    value
    0      6      99.161212           .      11.9131*   15.41
    1      9      103.23362     0.25240       3.7683     3.76
    2      10     105.11777     0.12592
-------------------------------------------------------------------------------
```

TEST BETWEEN ukus_er ukus_defl_va

```
                       Johansen tests for cointegration
Trend: constant                                         Number of obs =      28
Sample:  1979 - 2006                                             Lags =       2
-------------------------------------------------------------------------------
                                                              5%
maximum                                      trace    critical
  rank    parms       LL       eigenvalue  statistic    value
    0      6      89.744121           .      19.7491    15.41
    1      9      97.037542     0.40605       5.1623     3.76
    2      10     99.618677     0.16837
-------------------------------------------------------------------------------
```

TEST BETWEEN ukus_er ukus_go_p

```
                       Johansen tests for cointegration
Trend: constant                                         Number of obs =      28
Sample:  1979 - 2006                                             Lags =       2
-------------------------------------------------------------------------------
                                                              5%
maximum                                      trace    critical
  rank    parms       LL       eigenvalue  statistic    value
    0      6      88.073884           .      18.8709    15.41
    1      9      93.997975     0.34502       7.0227     3.76
    2      10     97.509316     0.22183
-------------------------------------------------------------------------------
```

UNIT ROOTS:

JAPAN – UNITED STATES SYSTEM

```
.        dfuller jpus_er

Dickey-Fuller test for unit root                   Number of obs   =        29

                              ---------- Interpolated Dickey-Fuller ---------
                  Test         1% Critical       5% Critical      10% Critical
               Statistic           Value             Value             Value
------------------------------------------------------------------------------
 Z(t)             -1.676            -3.723            -2.989            -2.625
------------------------------------------------------------------------------
MacKinnon approximate p-value for Z(t) = 0.4436

.        pperron jpus_er

Phillips-Perron test for unit root                 Number of obs   =        29
                                                   Newey-West lags =         3

                              ---------- Interpolated Dickey-Fuller ---------
                  Test         1% Critical       5% Critical      10% Critical
               Statistic           Value             Value             Value
------------------------------------------------------------------------------
 Z(rho)           -3.319           -17.472           -12.628           -10.280
 Z(t)             -1.646            -3.723            -2.989            -2.625
------------------------------------------------------------------------------
MacKinnon approximate p-value for Z(t) = 0.4589

.        dfuller D.jpus_er

Dickey-Fuller test for unit root                   Number of obs   =        28

                              ---------- Interpolated Dickey-Fuller ---------
                  Test         1% Critical       5% Critical      10% Critical
               Statistic           Value             Value             Value
------------------------------------------------------------------------------
 Z(t)             -5.138            -3.730            -2.992            -2.626
------------------------------------------------------------------------------
MacKinnon approximate p-value for Z(t) = 0.0000

.        pperron D.jpus_er

Phillips-Perron test for unit root                 Number of obs   =        28
                                                   Newey-West lags =         3

                              ---------- Interpolated Dickey-Fuller ---------
                  Test         1% Critical       5% Critical      10% Critical
               Statistic           Value             Value             Value
------------------------------------------------------------------------------
 Z(rho)          -24.595           -17.404           -12.596           -10.260
 Z(t)             -5.174            -3.730            -2.992            -2.626
------------------------------------------------------------------------------
MacKinnon approximate p-value for Z(t) = 0.0000


.        dfuller jpus_cpi

Dickey-Fuller test for unit root                   Number of obs   =        29

                              ---------- Interpolated Dickey-Fuller ---------
                  Test         1% Critical       5% Critical      10% Critical
               Statistic           Value             Value             Value
------------------------------------------------------------------------------
 Z(t)             -0.631            -3.723            -2.989            -2.625
------------------------------------------------------------------------------
MacKinnon approximate p-value for Z(t) = 0.8639
```

```
.         pperron jpus_cpi

Phillips-Perron test for unit root                Number of obs   =        29
                                                  Newey-West lags =         3

                               ---------- Interpolated Dickey-Fuller ---------
                  Test         1% Critical       5% Critical      10% Critical
               Statistic           Value             Value             Value
------------------------------------------------------------------------------
 Z(rho)           -0.311           -17.472           -12.628           -10.280
 Z(t)             -0.607            -3.723            -2.989            -2.625
------------------------------------------------------------------------------
MacKinnon approximate p-value for Z(t) = 0.8695

.         dfuller D.jpus_cpi

Dickey-Fuller test for unit root                  Number of obs   =        28

                               ---------- Interpolated Dickey-Fuller ---------
                  Test         1% Critical       5% Critical      10% Critical
               Statistic           Value             Value             Value
------------------------------------------------------------------------------
 Z(t)             -3.863            -3.730            -2.992            -2.626
------------------------------------------------------------------------------
MacKinnon approximate p-value for Z(t) = 0.0023

.         pperron D.jpus_cpi

Phillips-Perron test for unit root                Number of obs   =        28
                                                  Newey-West lags =         3

                               ---------- Interpolated Dickey-Fuller ---------
                  Test         1% Critical       5% Critical      10% Critical
               Statistic           Value             Value             Value
------------------------------------------------------------------------------
 Z(rho)          -21.820           -17.404           -12.596           -10.260
 Z(t)             -4.042            -3.730            -2.992            -2.626
------------------------------------------------------------------------------
MacKinnon approximate p-value for Z(t) = 0.0012


.         dfuller jpus_defl_va

Dickey-Fuller test for unit root                  Number of obs   =        29

                               ---------- Interpolated Dickey-Fuller ---------
                  Test         1% Critical       5% Critical      10% Critical
               Statistic           Value             Value             Value
------------------------------------------------------------------------------
 Z(t)             -1.273            -3.723            -2.989            -2.625
------------------------------------------------------------------------------
MacKinnon approximate p-value for Z(t) = 0.6414

.         pperron jpus_defl_va

Phillips-Perron test for unit root                Number of obs   =        29
                                                  Newey-West lags =         3

                               ---------- Interpolated Dickey-Fuller ---------
                  Test         1% Critical       5% Critical      10% Critical
               Statistic           Value             Value             Value
------------------------------------------------------------------------------
 Z(rho)           -0.587           -17.472           -12.628           -10.280
 Z(t)             -1.035            -3.723            -2.989            -2.625
------------------------------------------------------------------------------
MacKinnon approximate p-value for Z(t) = 0.7402

.         dfuller D.jpus_defl_va

Dickey-Fuller test for unit root                  Number of obs   =        28
```

```
                              ---------- Interpolated Dickey-Fuller ---------
                  Test         1% Critical       5% Critical      10% Critical
               Statistic           Value             Value             Value
------------------------------------------------------------------------------
 Z(t)             -2.526            -3.730            -2.992            -2.626
------------------------------------------------------------------------------
MacKinnon approximate p-value for Z(t) = 0.1093


.         pperron D.jpus_defl_va

Phillips-Perron test for unit root                   Number of obs   =        28
                                                     Newey-West lags =         3

                              ---------- Interpolated Dickey-Fuller ---------
                  Test         1% Critical       5% Critical      10% Critical
               Statistic           Value             Value             Value
------------------------------------------------------------------------------
 Z(rho)          -13.337           -17.404           -12.596           -10.260
 Z(t)             -2.733            -3.730            -2.992            -2.626
------------------------------------------------------------------------------
MacKinnon approximate p-value for Z(t) = 0.0685


.         dfuller D2.jpus_defl_va

Dickey-Fuller test for unit root                     Number of obs   =        27

                              ---------- Interpolated Dickey-Fuller ---------
                  Test         1% Critical       5% Critical      10% Critical
               Statistic           Value             Value             Value
------------------------------------------------------------------------------
 Z(t)             -6.307            -3.736            -2.994            -2.628
------------------------------------------------------------------------------
MacKinnon approximate p-value for Z(t) = 0.0000


.         pperron D2.jpus_defl_va

Phillips-Perron test for unit root                   Number of obs   =        27
                                                     Newey-West lags =         2

                              ---------- Interpolated Dickey-Fuller ---------
                  Test         1% Critical       5% Critical      10% Critical
               Statistic           Value             Value             Value
------------------------------------------------------------------------------
 Z(rho)          -26.204           -17.336           -12.564           -10.240
 Z(t)             -6.353            -3.736            -2.994            -2.628
------------------------------------------------------------------------------
MacKinnon approximate p-value for Z(t) = 0.0000


.         dfuller jpus_go_p

Dickey-Fuller test for unit root                     Number of obs   =        29

                              ---------- Interpolated Dickey-Fuller ---------
                  Test         1% Critical       5% Critical      10% Critical
               Statistic           Value             Value             Value
------------------------------------------------------------------------------
 Z(t)             -1.692            -3.723            -2.989            -2.625
------------------------------------------------------------------------------
MacKinnon approximate p-value for Z(t) = 0.4352


.         pperron jpus_go_p

Phillips-Perron test for unit root                   Number of obs   =        29
                                                     Newey-West lags =         3

                              ---------- Interpolated Dickey-Fuller ---------
                  Test         1% Critical       5% Critical      10% Critical
               Statistic           Value             Value             Value
------------------------------------------------------------------------------
 Z(rho)           -0.605           -17.472           -12.628           -10.280
 Z(t)             -1.579            -3.723            -2.989            -2.625
```

```
------------------------------------------------------------------------------
MacKinnon approximate p-value for Z(t) = 0.4940

.        dfuller D.jpus_go_p

Dickey-Fuller test for unit root                   Number of obs   =        28

                               ---------- Interpolated Dickey-Fuller ---------
                  Test         1% Critical       5% Critical      10% Critical
               Statistic           Value             Value             Value
------------------------------------------------------------------------------
 Z(t)             -4.754            -3.730            -2.992            -2.626
------------------------------------------------------------------------------
MacKinnon approximate p-value for Z(t) = 0.0001

.        pperron D.jpus_go_p

Phillips-Perron test for unit root                 Number of obs   =        28
                                                   Newey-West lags =         3

                               ---------- Interpolated Dickey-Fuller ---------
                  Test         1% Critical       5% Critical      10% Critical
               Statistic           Value             Value             Value
------------------------------------------------------------------------------
 Z(rho)          -22.365           -17.404           -12.596           -10.260
 Z(t)             -4.760            -3.730            -2.992            -2.626
------------------------------------------------------------------------------
MacKinnon approximate p-value for Z(t) = 0.0001
```

JAPAN – UNITED KINGDOM SYSTEM

```
.        dfuller jpuk_er

Dickey-Fuller test for unit root                   Number of obs   =        29

                               ---------- Interpolated Dickey-Fuller ---------
                  Test         1% Critical       5% Critical      10% Critical
               Statistic           Value             Value             Value
------------------------------------------------------------------------------
 Z(t)             -1.844            -3.723            -2.989            -2.625
------------------------------------------------------------------------------
MacKinnon approximate p-value for Z(t) = 0.3586

.        pperron jpuk_er

Phillips-Perron test for unit root                 Number of obs   =        29
                                                   Newey-West lags =         3

                               ---------- Interpolated Dickey-Fuller ---------
                  Test         1% Critical       5% Critical      10% Critical
               Statistic           Value             Value             Value
------------------------------------------------------------------------------
 Z(rho)           -3.247           -17.472           -12.628           -10.280
 Z(t)             -1.849            -3.723            -2.989            -2.625
------------------------------------------------------------------------------
MacKinnon approximate p-value for Z(t) = 0.3566

.        dfuller D.jpuk_er

Dickey-Fuller test for unit root                   Number of obs   =        28

                               ---------- Interpolated Dickey-Fuller ---------
                  Test         1% Critical       5% Critical      10% Critical
               Statistic           Value             Value             Value
------------------------------------------------------------------------------
 Z(t)             -4.409            -3.730            -2.992            -2.626
------------------------------------------------------------------------------
MacKinnon approximate p-value for Z(t) = 0.0003

.        pperron D.jpuk_er
```

```
Phillips-Perron test for unit root                 Number of obs   =        28
                                                   Newey-West lags =         3

                               ---------- Interpolated Dickey-Fuller ---------
                  Test         1% Critical       5% Critical      10% Critical
               Statistic           Value             Value             Value
------------------------------------------------------------------------------
 Z(rho)          -23.900           -17.404           -12.596           -10.260
 Z(t)             -4.394            -3.730            -2.992            -2.626
------------------------------------------------------------------------------
MacKinnon approximate p-value for Z(t) = 0.0003


.         dfuller jpuk_cpi

Dickey-Fuller test for unit root                   Number of obs   =        29

                               ---------- Interpolated Dickey-Fuller ---------
                  Test         1% Critical       5% Critical      10% Critical
               Statistic           Value             Value             Value
------------------------------------------------------------------------------
 Z(t)             -6.963            -3.723            -2.989            -2.625
------------------------------------------------------------------------------
MacKinnon approximate p-value for Z(t) = 0.0000


.         pperron jpuk_cpi

Phillips-Perron test for unit root                 Number of obs   =        29
                                                   Newey-West lags =         3

                               ---------- Interpolated Dickey-Fuller ---------
                  Test         1% Critical       5% Critical      10% Critical
               Statistic           Value             Value             Value
------------------------------------------------------------------------------
 Z(rho)           -1.940           -17.472           -12.628           -10.280
 Z(t)             -6.207            -3.723            -2.989            -2.625
------------------------------------------------------------------------------
MacKinnon approximate p-value for Z(t) = 0.0000


.         dfuller jpuk_defl_va

Dickey-Fuller test for unit root                   Number of obs   =        29

                               ---------- Interpolated Dickey-Fuller ---------
                  Test         1% Critical       5% Critical      10% Critical
               Statistic           Value             Value             Value
------------------------------------------------------------------------------
 Z(t)             -3.794            -3.723            -2.989            -2.625
------------------------------------------------------------------------------
MacKinnon approximate p-value for Z(t) = 0.0030


.         pperron jpuk_defl_va

Phillips-Perron test for unit root                 Number of obs   =        29
                                                   Newey-West lags =         3

                               ---------- Interpolated Dickey-Fuller ---------
                  Test         1% Critical       5% Critical      10% Critical
               Statistic           Value             Value             Value
------------------------------------------------------------------------------
 Z(rho)           -1.544           -17.472           -12.628           -10.280
 Z(t)             -3.248            -3.723            -2.989            -2.625
------------------------------------------------------------------------------
MacKinnon approximate p-value for Z(t) = 0.0174


.         dfuller D.jpuk_defl_va

Dickey-Fuller test for unit root                   Number of obs   =        28

                               ---------- Interpolated Dickey-Fuller ---------
                  Test         1% Critical       5% Critical      10% Critical
               Statistic           Value             Value             Value
```

```
------------------------------------------------------------------------------
 Z(t)             -2.694            -3.730            -2.992            -2.626
------------------------------------------------------------------------------
MacKinnon approximate p-value for Z(t) = 0.0750

.         pperron D.jpuk_defl_va

Phillips-Perron test for unit root                 Number of obs   =        28
                                                   Newey-West lags =         3

                               ---------- Interpolated Dickey-Fuller ---------
                  Test         1% Critical       5% Critical      10% Critical
               Statistic           Value             Value             Value
------------------------------------------------------------------------------
 Z(rho)          -10.603           -17.404           -12.596           -10.260
 Z(t)             -2.563            -3.730            -2.992            -2.626
------------------------------------------------------------------------------
MacKinnon approximate p-value for Z(t) = 0.1008

.         dfuller D2.jpuk_defl_va

Dickey-Fuller test for unit root                   Number of obs   =        27

                               ---------- Interpolated Dickey-Fuller ---------
                  Test         1% Critical       5% Critical      10% Critical
               Statistic           Value             Value             Value
------------------------------------------------------------------------------
 Z(t)             -5.809            -3.736            -2.994            -2.628
------------------------------------------------------------------------------
MacKinnon approximate p-value for Z(t) = 0.0000

.         pperron D2.jpuk_defl_va

Phillips-Perron test for unit root                 Number of obs   =        27
                                                   Newey-West lags =         2

                               ---------- Interpolated Dickey-Fuller ---------
                  Test         1% Critical       5% Critical      10% Critical
               Statistic           Value             Value             Value
------------------------------------------------------------------------------
 Z(rho)          -24.709           -17.336           -12.564           -10.240
 Z(t)             -6.241            -3.736            -2.994            -2.628
------------------------------------------------------------------------------
MacKinnon approximate p-value for Z(t) = 0.0000

.         dfuller jpuk_go_p

Dickey-Fuller test for unit root                   Number of obs   =        29

                               ---------- Interpolated Dickey-Fuller ---------
                  Test         1% Critical       5% Critical      10% Critical
               Statistic           Value             Value             Value
------------------------------------------------------------------------------
 Z(t)             -6.938            -3.723            -2.989            -2.625
------------------------------------------------------------------------------
MacKinnon approximate p-value for Z(t) = 0.0000

.         pperron jpuk_go_p

Phillips-Perron test for unit root                 Number of obs   =        29
                                                   Newey-West lags =         3

                               ---------- Interpolated Dickey-Fuller ---------
                  Test         1% Critical       5% Critical      10% Critical
               Statistic           Value             Value             Value
------------------------------------------------------------------------------
 Z(rho)           -1.572           -17.472           -12.628           -10.280
 Z(t)             -7.583            -3.723            -2.989            -2.625
------------------------------------------------------------------------------
MacKinnon approximate p-value for Z(t) = 0.0000
```

UNITED KINGDOM – UNITED STATES SYSTEM

```
.         dfuller ukus_er

Dickey-Fuller test for unit root                   Number of obs   =        29

                               ---------- Interpolated Dickey-Fuller ---------
                  Test         1% Critical       5% Critical      10% Critical
               Statistic           Value             Value             Value
------------------------------------------------------------------------------
 Z(t)             -2.344            -3.723            -2.989            -2.625
------------------------------------------------------------------------------
MacKinnon approximate p-value for Z(t) = 0.1581

.         dfuller D.ukus_er

Dickey-Fuller test for unit root                   Number of obs   =        28

                               ---------- Interpolated Dickey-Fuller ---------
                  Test         1% Critical       5% Critical      10% Critical
               Statistic           Value             Value             Value
------------------------------------------------------------------------------
 Z(t)             -4.956            -3.730            -2.992            -2.626
------------------------------------------------------------------------------
MacKinnon approximate p-value for Z(t) = 0.0000

.         pperron ukus_er

Phillips-Perron test for unit root                 Number of obs   =        29
                                                   Newey-West lags =         3

                               ---------- Interpolated Dickey-Fuller ---------
                  Test         1% Critical       5% Critical      10% Critical
               Statistic           Value             Value             Value
------------------------------------------------------------------------------
 Z(rho)          -11.071           -17.472           -12.628           -10.280
 Z(t)             -2.455            -3.723            -2.989            -2.625
------------------------------------------------------------------------------
MacKinnon approximate p-value for Z(t) = 0.1269

.         pperron D.ukus_er

Phillips-Perron test for unit root                 Number of obs   =        28
                                                   Newey-West lags =         3

                               ---------- Interpolated Dickey-Fuller ---------
                  Test         1% Critical       5% Critical      10% Critical
               Statistic           Value             Value             Value
------------------------------------------------------------------------------
 Z(rho)          -26.170           -17.404           -12.596           -10.260
 Z(t)             -4.941            -3.730            -2.992            -2.626
------------------------------------------------------------------------------
MacKinnon approximate p-value for Z(t) = 0.0000

.         dfuller ukus_cpi

Dickey-Fuller test for unit root                   Number of obs   =        29

                               ---------- Interpolated Dickey-Fuller ---------
                  Test         1% Critical       5% Critical      10% Critical
               Statistic           Value             Value             Value
------------------------------------------------------------------------------
 Z(t)             -4.806            -3.723            -2.989            -2.625
------------------------------------------------------------------------------
MacKinnon approximate p-value for Z(t) = 0.0001

.         dfuller D.ukus_cpi

Dickey-Fuller test for unit root                   Number of obs   =        28

                               ---------- Interpolated Dickey-Fuller ---------
```

```
                 Test         1% Critical       5% Critical      10% Critical
              Statistic           Value             Value             Value
------------------------------------------------------------------------------
 Z(t)             -5.115           -3.730            -2.992            -2.626
------------------------------------------------------------------------------
MacKinnon approximate p-value for Z(t) = 0.0000


.         pperron ukus_cpi

Phillips-Perron test for unit root                 Number of obs   =        29
                                                   Newey-West lags =         3

                               ---------- Interpolated Dickey-Fuller ---------
                 Test         1% Critical       5% Critical      10% Critical
              Statistic           Value             Value             Value
------------------------------------------------------------------------------
 Z(rho)           -5.304          -17.472           -12.628           -10.280
 Z(t)             -3.915           -3.723            -2.989            -2.625
------------------------------------------------------------------------------
MacKinnon approximate p-value for Z(t) = 0.0019


.         pperron D.ukus_cpi

Phillips-Perron test for unit root                 Number of obs   =        28
                                                   Newey-West lags =         3

                               ---------- Interpolated Dickey-Fuller ---------
                 Test         1% Critical       5% Critical      10% Critical
              Statistic           Value             Value             Value
------------------------------------------------------------------------------
 Z(rho)          -21.071          -17.404           -12.596           -10.260
 Z(t)             -4.883           -3.730            -2.992            -2.626
------------------------------------------------------------------------------
MacKinnon approximate p-value for Z(t) = 0.0000


.         dfuller ukus_defl_va

Dickey-Fuller test for unit root                   Number of obs   =        29

                               ---------- Interpolated Dickey-Fuller ---------
                 Test         1% Critical       5% Critical      10% Critical
              Statistic           Value             Value             Value
------------------------------------------------------------------------------
 Z(t)             -4.385           -3.723            -2.989            -2.625
------------------------------------------------------------------------------
MacKinnon approximate p-value for Z(t) = 0.0003


.         pperron ukus_defl_va

Phillips-Perron test for unit root                 Number of obs   =        29
                                                   Newey-West lags =         3

                               ---------- Interpolated Dickey-Fuller ---------
                 Test         1% Critical       5% Critical      10% Critical
              Statistic           Value             Value             Value
------------------------------------------------------------------------------
 Z(rho)           -3.079          -17.472           -12.628           -10.280
 Z(t)             -4.957           -3.723            -2.989            -2.625
------------------------------------------------------------------------------
MacKinnon approximate p-value for Z(t) = 0.0000


.         dfuller D.ukus_defl_va

Dickey-Fuller test for unit root                   Number of obs   =        28

                               ---------- Interpolated Dickey-Fuller ---------
                 Test         1% Critical       5% Critical      10% Critical
              Statistic           Value             Value             Value
------------------------------------------------------------------------------
 Z(t)             -3.872           -3.730            -2.992            -2.626
------------------------------------------------------------------------------
MacKinnon approximate p-value for Z(t) = 0.0022
```

```
.        pperron D.ukus_defl_va

Phillips-Perron test for unit root                 Number of obs   =        28
                                                   Newey-West lags =         3

                               ---------- Interpolated Dickey-Fuller ---------
                  Test         1% Critical       5% Critical      10% Critical
               Statistic           Value             Value             Value
------------------------------------------------------------------------------
 Z(rho)          -18.350           -17.404           -12.596           -10.260
 Z(t)             -3.802            -3.730            -2.992            -2.626
------------------------------------------------------------------------------
MacKinnon approximate p-value for Z(t) = 0.0029

.        dfuller ukus_go_p

Dickey-Fuller test for unit root                   Number of obs   =        29

                               ---------- Interpolated Dickey-Fuller ---------
                  Test         1% Critical       5% Critical      10% Critical
               Statistic           Value             Value             Value
------------------------------------------------------------------------------
 Z(t)             -4.511            -3.723            -2.989            -2.625
------------------------------------------------------------------------------
MacKinnon approximate p-value for Z(t) = 0.0002

.        dfuller D.ukus_go_p

Dickey-Fuller test for unit root                   Number of obs   =        28

                               ---------- Interpolated Dickey-Fuller ---------
                  Test         1% Critical       5% Critical      10% Critical
               Statistic           Value             Value             Value
------------------------------------------------------------------------------
 Z(t)             -3.992            -3.730            -2.992            -2.626
------------------------------------------------------------------------------
MacKinnon approximate p-value for Z(t) = 0.0015

.        pperron ukus_go_p

Phillips-Perron test for unit root                 Number of obs   =        29
                                                   Newey-West lags =         3

                               ---------- Interpolated Dickey-Fuller ---------
                  Test         1% Critical       5% Critical      10% Critical
               Statistic           Value             Value             Value
------------------------------------------------------------------------------
 Z(rho)           -2.921           -17.472           -12.628           -10.280
 Z(t)             -5.157            -3.723            -2.989            -2.625
------------------------------------------------------------------------------
MacKinnon approximate p-value for Z(t) = 0.0000

.        pperron D.ukus_go_p

Phillips-Perron test for unit root                 Number of obs   =        28
                                                   Newey-West lags =         3

                               ---------- Interpolated Dickey-Fuller ---------
                  Test         1% Critical       5% Critical      10% Critical
               Statistic           Value             Value             Value
------------------------------------------------------------------------------
 Z(rho)          -20.513           -17.404           -12.596           -10.260
 Z(t)             -3.995            -3.730            -2.992            -2.626
------------------------------------------------------------------------------
MacKinnon approximate p-value for Z(t) = 0.0014
```

NUMBER OF LAGS:

JAPAN – UNITED STATES SYSTEM

LAGS WITH jpus_er jpus_cpi

Selection-order criteria
Sample: 1981 - 2006 Number of obs = 26

lag	LL	LR	df	p	FPE	AIC	HQIC	SBIC
0	17.0836				.001074	-1.16027	-1.13241	-1.0635
1	103.629	173.09	4	0.000	1.9e-06	-7.50995	-7.42635	-7.21962
2	118.956	30.654*	4	0.000	7.9e-07*	-8.38126*	-8.24192*	-7.89738*
3	122.243	6.5723	4	0.160	8.5e-07	-8.32635	-8.13128	-7.64892
4	123.951	3.417	4	0.491	1.1e-06	-8.15008	-7.89927	-7.27909

LAGS WITH jpus_er jpus_defl_va

Selection-order criteria
Sample: 1981 - 2006 Number of obs = 26

lag	LL	LR	df	p	FPE	AIC	HQIC	SBIC
0	13.377				.001429	-.875156	-.847287	-.778379
1	99.7654	172.78	4	0.000	2.5e-06	-7.21272	-7.12912	-6.92239
2	116.389	33.247	4	0.000	9.7e-07	-8.18375	-8.04441	-7.69987
3	123.079	13.381*	4	0.010	8.0e-07*	-8.3907*	-8.19562*	-7.71326*
4	123.607	1.0568	4	0.901	1.1e-06	-8.12365	-7.87284	-7.25266

LAGS WITH jpus_er jpus_go_p

Selection-order criteria
Sample: 1981 - 2006 Number of obs = 26

lag	LL	LR	df	p	FPE	AIC	HQIC	SBIC
0	16.2585				.001145	-1.09681	-1.06894	-1.00003
1	97.6203	162.72	4	0.000	3.0e-06	-7.04772	-6.96411	-6.75739
2	109.612	23.983*	4	0.000	1.6e-06*	-7.66244*	-7.5231*	-7.17855*
3	112.332	5.4404	4	0.245	1.8e-06	-7.56399	-7.36891	-6.88655
4	114.671	4.6774	4	0.322	2.1e-06	-7.4362	-7.18538	-6.56521

JAPAN – UNITED KINGDOM SYSTEM

LAGS WITH jpuk_er jpuk_cpi

Selection-order criteria
Sample: 1981 - 2006 Number of obs = 26

lag	LL	LR	df	p	FPE	AIC	HQIC	SBIC
0	18.6117				.000955	-1.27783	-1.24996	-1.18105
1	106.061	174.9*	4	0.000	1.6e-06*	-7.69703*	-7.61342*	-7.4067*
2	109.877	7.6308	4	0.106	1.6e-06	-7.68283	-7.54348	-7.19894
3	111.25	2.7461	4	0.601	2.0e-06	-7.48075	-7.28567	-6.80331
4	114.034	5.5686	4	0.234	2.3e-06	-7.38724	-7.13642	-6.51625

LAGS WITH jpuk_er jpuk_defl_va

Selection-order criteria
Sample: 1981 - 2006 Number of obs = 26

lag	LL	LR	df	p	FPE	AIC	HQIC	SBIC
0	5.50136				.002619	-.269335	-.241467	-.172559
1	99.5981	188.19*	4	0.000	2.6e-06*	-7.19986*	-7.11625*	-6.90953*

lag	LL	LR	df	p	FPE	AIC	HQIC	SBIC
2	102.626	6.0563	4	0.195	2.8e-06	-7.1251	-6.98576	-6.64121
3	106.601	7.9489	4	0.093	2.8e-06	-7.12313	-6.92805	-6.4457
4	110.461	7.7201	4	0.102	3.0e-06	-7.11237	-6.86155	-6.24138

LAGS jpuk_er jpuk_go_p

Selection-order criteria
Sample: 1981 - 2006 Number of obs = 26

lag	LL	LR	df	p	FPE	AIC	HQIC	SBIC
0	8.4319				.00209	-.494761	-.466893	-.397985
1	99.1904	181.52*	4	0.000	2.6e-06*	-7.16849*	-7.08489*	-6.87816*
2	101.176	3.9721	4	0.410	3.1e-06	-7.01357	-6.87423	-6.52969
3	103.436	4.5192	4	0.340	3.6e-06	-6.8797	-6.68462	-6.20226
4	104.193	1.5131	4	0.824	4.8e-06	-6.6302	-6.37939	-5.75921

UNITED KINGDOM – UNITED STATES SYSTEM

DEFASAGENS COM ukus_er ukus_cpi

Selection-order criteria
Sample: 1981 - 2006 Number of obs = 26

lag	LL	LR	df	p	FPE	AIC	HQIC	SBIC
0	57.4073				.000048	-4.2621	-4.23423	-4.16533
1	97.7522	80.69	4	0.000	3.0e-06	-7.05786	-6.97426	-6.76753*
2	103.836	12.167	4	0.016	2.5e-06	-7.21813	-7.07878*	-6.73424
3	107.867	8.0636	4	0.089	2.6e-06	-7.22057	-7.02549	-6.54313
4	113.219	10.703*	4	0.030	2.4e-06*	-7.32453*	-7.07371	-6.45354

LAGS WITH ukus_er ukus_defl_va

Selection-order criteria
Sample: 1981 - 2006 Number of obs = 26

lag	LL	LR	df	p	FPE	AIC	HQIC	SBIC
0	44.4853				.000131	-3.2681	-3.24023	-3.17132
1	97.9344	106.9	4	0.000	2.9e-06*	-7.07188*	-6.98828*	-6.78155*
2	98.9343	1.9996	4	0.736	3.7e-06	-6.8411	-6.70176	-6.35721
3	104.511	11.153*	4	0.025	3.3e-06	-6.96238	-6.7673	-6.28494
4	109.134	9.2453	4	0.055	3.3e-06	-7.01027	-6.75946	-6.13928

LAGS WITH ukus_er ukus_go_p

Selection-order criteria
Sample: 1981 - 2006 Number of obs = 26

lag	LL	LR	df	p	FPE	AIC	HQIC	SBIC
0	42.638				.00015	-3.126	-3.09813	-3.02922
1	94.2323	103.19	4	0.000	3.9e-06*	-6.7871*	-6.7035*	-6.49677*
2	94.7761	1.0877	4	0.896	5.1e-06	-6.52124	-6.3819	-6.03736
3	96.9656	4.3789	4	0.357	6.0e-06	-6.38197	-6.18689	-5.70453
4	102.466	11.001*	4	0.027	5.5e-06	-6.4974	-6.24658	-5.62641

Endogenous: ukus_er ukus_go_p
Exogenous: _cons