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

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Introdução

Este relatório é composto de duas seções.

A primeira onde apresentamos o artigo (em português) gerado com os principais resultados do projeto. Este artigo está sendo reduzido para ser submetido a congressos nacionais e internacionais. Na segunda seção apresentamos a tradução do artigo. Isto fez-se necessário por dois motivos.

O primeiro é que necessitávamos de uma versão em inglês para enviarmos à Universidade Ritsumeikan (Kyoto-Japão) para receber comentários dos pesquisadores japoneses que participam do projeto conjunto. O artigo foi enviado mas ainda não recebemos os comentários dos pesquisadores japoneses. O segundo motivo é que necessitamos submeter à versão em inglês para periódicos e congressos internacionais, o que vamos fazer no ano de 2015. A versão em inglês encontra-se disponível no site da SSRN (http://papers.ssrn.com/sol3/papers.cfm?abstract_id=2498631).

Como havíamos acordado com os japoneses, produzimos um artigo sobre determinação da taxa de câmbio no curto prazo, que foi realizado por um dos componentes do projeto Eli Hadad Junior e seu orientador, Emerson Fernandes Marçal. Este artigo também foi traduzido e enviado ao Japão. Encontra- se no site da SSRN (Is it Possible to Beat the Random Walk Model in Exchange Rate Forecasting? More Evidence for the Brazilian Casehttp://papers.ssrn.com/sol3/papers.cfm?abstract_id=2496615).

Seção I

O enfoque da produtividade para a determinação da taxa de câmbio de longo prazo

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Resumo

Este 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 do modelo proposto por Basso oriundo do referencial marxista, que enfatiza preços e produtividades para determinar a taxa de câmbio.

Para testar os modelos, foram utilizados índice de preço ao consumidor (IPC), o índice de preço de valor agregado e índice de preços da produção bruta (base de dados 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 causalidade de Granger e 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) e é feito projeção com *Model Confidence Set*.

Aceitando a argumentação de Milton Friedman que uma teoria econômica consistente precisa ser passível de realizar previsões testamos o poder preditivo das duas teorias. Os modelos mais eficientes de projeção foram escolhidos pelo *Model Confidence Set*.

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.

Palavras-chave: Paridade do poder de compra; Índices de preços; KLEMS; Modelo de Basso; Taxa de câmbio de longo prazo; Enfoque de produtividade.

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's model; Long-run exchange rate; Productivity approach.

1. Introdução

Taxa de câmbio entre os dois países é determinada pelo quociente entre os níveis gerais de preços em dois países (Cassel, 1916) ou como o valor de uma moeda de um país em termos de moeda de outro país (Houthakker, 1978, Dornbusch, 1982 e Copeland, 2005).

Cassel (1928a), explica que a paridade do poder de compra (PPC) ou *purchasing power parity theory (*PPP), possui uma estabilidade notável, que pode determinar e classificar todos os outros fatores que venham a influenciar a taxa de câmbio. Todavia, embora seja a mais tradicional teoria para determinar taxa de câmbio de longo prazo, apresenta resultados conflitantes no que concerne a corroboração, pois os estudos realizados mostram casos em que a teoria é rejeitada e em outros é comprovada.

Frenkel (1980) constata durante a década de 1970, que nos pares Marco/Libra; Franco/Libra; Dolar/Libra e Franco/Dolar, os resultados da PPP apresentaram desvios, levando a não corroboração da teoria. Para Yoshikawa (1990), a PPP não foi corroborada entre Japão e Estados Unidos, no período 1973 a 1987. Froot at al. (1994) afirmam que não parece haver convergência de longo prazo para a PPP, embora novos trabalhos sobre a questão do viés de sobrevivência da teoria sejam valiosos.

Rossi (1996), que utilizou dados mensais entre Brasil e Estados Unidos, de janeiro de 1980 a julho de 1994, usando condições de PPP, rejeita-a. Pedroni (2001), que também fez observações mensais, sendo 246 no total, para dados de junho 1973 a novembro de 1993, em 20 países não corroborou a PPP, explicando que o fracasso da teoria parece ser generalizado no período pós Bretton Woods.

Taylor (2002) testou a PPP, para um grupo de vinte países, em um período de mais de 100 anos, encontrando a validação da PPP no longo prazo, porém conclui o estudo com a observação de que os desvios da PPP são sempre e em toda parte um fenômeno monetário. Com resultado semelhante de não corroboração da PPP, Xu (2003), examinou nove países, para o período que começou no primeiro trimestre de 1974 e vai até o último trimestre de 1997.

Obtendo conclusão diferente, Papell et al. (2003) verificaram para 16 países a validade da PPP e para 2 países a não ratificação da teoria. Wadsley e Felmingham

(2007) que avaliaram dados australianos para o período de 1985 a 2005 corroboraram a PPP em seus estudos.

Drine et al. (2007) que testaram a PPP para 80 países descobriram que a teoria é válida para os países da OCDE (países desenvolvidos), mas apresentou-se fraca para os países do MENA (pertencentes ao oriente médio e norte da África) e não foi corroborada para os países da África, Ásia, América Latina e do centro e leste Europeu. Outras investigações de Drine et al. (2007) indicam, por um lado, que a natureza do regime cambial não condiciona a validade da PPP e do outro que a PPP é mais facilmente corroborada nos países com alta inflação relativamente aos de baixa inflação, assim para os países em desenvolvimento a teoria da PPP é empiricamente rejeitada, confirmando desvios permanentes da PPP.

Simões e Marçal (2012) que estudaram a validade a PPP para Brasil e 21 de seus parceiros comerciais, para o período de 1957 a 2010, encontraram evidências da validade da teoria apenas para o Uruguai; já para Colômbia, Grécia, Paraguai e Portugal a PPP foi rejeitada e para os demais parceiros comerciais a PPP apresentou resultados inconclusivos, uma vez que os resultados dos testes foram conflitantes.

2. Problema de Pesquisa e Objetivos

O propósito do artigo é investigar se PPP se mantém no longo prazo e se a teoria elaborada por Basso (2008), de índices de preços associados à produtividade, que tem como ponto de referência a teoria marxista, apresenta poder explicativo para a taxa de câmbio no longo prazo.

Na pesquisa foi utilizada a PPP relativa por empregar índices de preços, pois a PPP absoluta adota níveis de preço, embora Edwards (1989) e Sarno et al. (2001) lembrem que nenhum índice de preços é perfeito e todos eles apresentam algumas vantagens e desvantagens, assim sendo foi aplicado o índice de preços ao consumidor (IPC), o deflator implícito do Produto Interno Bruto (PIB), o deflator do valor bruto da produção e o deflator do valor adicionado. Para o estudo, foram eliminados os dados referentes a bens não comercializáveis, uma vez que Keynes (1923), Frenkel (1978), Edwards (1989) e Sarno et al. (2001), afirmam que a PPP é uma certeza caso se restrinja ao uso de índices de preços de bens transacionáveis.

No estudo utilizaram-se dados anuais para os pares Japão – Reino Unido, Estados Unidos - Japão e Estados Unidos - Reino Unido, no período de 1977 a 2006, por apresentarem as séries mais longas documentadas com dados de produtividade.

3. Revisão da Literatura

Em 1918, Cassel, foi o primeiro a desenvolver empiricamente o que ele denominou de *Purchasing Power Parity* (PPP) como alternativa para o padrão-ouro usando elementos da teoria quantitativa da moeda e considerando a *law of one price* (LOOP) ou lei do preço único. Com base nisso, 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) e Rossi (2013), explanam que PPP mostra que o nível de preços no país de origem, convertido para a moeda do país estrangeiro pela taxa de câmbio nominal, deve ser igual ao nível de preços do país estrangeiro, logo, uma unidade de moeda no país de origem utilizando como conversor a taxa de câmbio nominal terá o mesmo poder de compra no país estrangeiro.

Conforme Batiz e Batiz (1994) e Dornbusch (1987) a lei do preço único é expressa por:

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

Na qual: i é um produto qualquer; p representa o preço doméstico do bem, p^* o preço internacional do bem, e representa a taxa de câmbio nominal.

Cassel (1916), Dornbusch (1987), Batiz e Batiz (1994), MacDonald et al. (1992, 1994, 2007), Rogoff (1996), Sarno et al. (2001), Visser (2004), Moosa (2005) e Rossi (2013) acreditam que no longo prazo a taxa de câmbio nominal deve refletir os preços relativos de duas moedas, assim tem-se:

$$e = P \,/\, P^* \qquad (02)$$

$$P = e \, . P^* \qquad (03)$$

Assim sendo, Dornbusch (1987), Batiz e Batiz (1994) e Vasconcelos (2004), esclarecem que a equação (01) representa uma condição de equilíbrio, onde taxa de câmbio real (θ) entre dois países pode ser formalmente representada pela taxa de câmbio nominal corrigida pela razão dos preços relativos:

$$\theta = \frac{e\ .\ P*}{P} \qquad (04)$$

Devido à volatilidade da taxa de câmbio, surge uma das críticas feitas à PPP quanto à relação de causalidade entre índice de preços e taxa de câmbio, na qual Cassel (1921) defende a que causalidade ocorre no sentido índice de preços para a taxa de câmbio, todavia, Keynes (1923), Angell (1926), Samuelson (1948), Balassa (1964) e Frenkel (1980) defendem que existe causalidade recíproca.

Quando Cassel (1918) desenvolveu empiricamente a paridade do poder de compra, distinguiu a *absolute PPP* (APPP) ou PPP absoluta da *relative PPP* (RPPP) ou PPP relativa. Na visão de Cassel (1916), Houthakker (1978), MacDonald (1994, 2007), Rogoff (1996), Sarno et al. (2001), Papell et al. (2003) e Copeland (2005), na APPP a taxa de câmbio nominal (s) de um país é determinada em decorrência da relação entre os níveis gerais de preços do país de origem (p) e do país estrangeiro (p^*), assim, MacDonald (1994, 2007), Sarno et al. (2001) e Marçal (2003) demonstram que no instante *t* a taxa de câmbio real (q) deve ser igual à zero:

$$q_t = s_t - p_t + p_t^* = 0 \qquad (05)$$

MacDonald (1994, 2007), Rogoff (1996) e Sarno et al. (2001) informam que é difícil determinar, se a mesma cesta de bens está disponível em dois países diferentes, por isso, é mais comum se testar a PPP relativa, pois sustenta que a variação percentual da taxa de câmbio ao longo de um período de tempo.

Na perspectiva de Batiz e Batiz (1994) a PPP relativa é expressa por:

$$\hat{P} = \hat{e} + \hat{P}^* \qquad (06)$$

$$\hat{e} = \hat{P} - \hat{P}^* \qquad (07)$$

De acordo com MacDonald (1994, 2007) e Marçal (2003, 2011), na RPPP existem dois índices de preços (P ou p interno e P^* ou p^* externo), compostos por bens transacionáveis e com mesma estrutura de pesos e bens, demostrada pela seguinte equação:

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

Para Cassel (1933) e Frenkel (1978) a oferta e a demanda na economia de troca de fatores de produtividade exerce uma influência fundamental sobre os preços, sendo importante avaliar os diferentes índices de preço aplicáveis na PPP (Samuelson, 1964).

Assim sendo, conforme Keynes (1923), Balassa (1964), Samuelson (1964), Frenkel (1978) Edwards (1989), Sarno et al. (2001) e Copeland (2005), os índices gerais de preços mais utilizados são o índice de preços ao consumidor (IPC), o deflator implícito do Produto Interno Bruto (PIB), o deflator do valor bruto da produção e o deflator do valor adicionado, estes dois últimos são usados pela Organização para Cooperação e Desenvolvimento Econômico (OECD) e pela base EU KLEMS (Capital, trabalho, energia, material e serviço, suportada financeiramente pela Comissão Europeia, Direcção-Geral de Investigação)

Todavia, Edwards (1989) e Sarno et al. (2001), esclarecem que nenhum desses índices é perfeito e todos eles apresentam algumas vantagens e desvantagens.

Para Angell (1922), os recursos a índices gerais de preços, em especial o deflator do PIB, podem gerar vieses significativos na PPP, pois a razão dos preços de bens transacionáveis e de bens não transacionáveis move-se diferenciadamente ao longo do tempo em diversos países como resultado do crescimento distinto da produtividade nestes dois setores, na estimativa da taxa de câmbio de equilíbrio de longo prazo.

Complementando o pensamento de Angell (1922), Balassa (1964), Samuelson (1964) e Strauss (1996) explicam que uma das causas de violações da PPP e dos movimentos constantes nas taxas de câmbio reais são as diferenças de produtividade entre os âmbitos de bens transacionáveis e de bens não transacionáveis. Uma vez que de acordo com Balassa (1964), os diferenciais internacionais de produtividade entre os setores de bens comercializáveis e bens não comercializáveis constituiriam um fator que introduz desvios permanentes entre a PPP e a taxa de câmbio de equilíbrio, pois quanto maior a diferença no nível de produtividade no setor de bens transacionáveis entre dois países, maior a diferença internacional no nível de preços de bens não transacionáveis.

O diferencial de produtividade entre o setor que produz bens transacionáveis e os bens não comercializáveis tende também a afetar a taxa de câmbio real (Marçal, 2011).

Angell (1922), Samuelson (1964), Strauss (1996) e Marçal (2011), logo advertem que para existir equilíbrio na taxa de câmbio e respeitar a lei do preço único, bens não transacionáveis são excluídos.

Em suas analises, Balassa (1964) e Samuelson (1964), referem-se ao setor de serviços como bens não comercializáveis, a exceção de turismo, mas a argumentação foi feita cinco décadas atrás; os testes atuais da teoria precisam levar em consideração as transformações ocasionadas pela globalização que alterou a classificação de bens transacionáveis. A base utilizada (EU KLEMS) apresenta uma classificação atual de bens transacionáveis e não transacionáveis.

A relevância da produtividade no valor da moeda de um país foi considerada por Cassel (1930) ao ponderar que, um determinado país quando guiado naturalmente não apenas pelos preços de comercialização, mas também pelo nível dos salários no longo prazo é impactado pela produtividade, pois existe uma relação entre salários e produtividade; consequentemente a produtividade afeta o valor internacional da moeda de um país. Para Houthakker (1978), na teoria do comércio internacional o fator trabalho (e não somente o capital) tem um papel central, por isso, produtividade é um fator importante para determinar taxa de câmbio.

O modelo mais importante da PPP no longo prazo, que agrega produtividade, foi desenvolvido por Balassa (1964) e Samuelson (1964), dando origem ao Efeito Balassa-Samuelson, onde os índices de preços de todos os países são convertidos para dólares a taxas de câmbio nominais predominantes; como os preços dos bens tendem a refletir os custos unitários marginais de produção os países ricos apresentam níveis de preços mais elevados do que os países pobres por terem custos mais elevados.

Basso (2008), utilizando o referencial marxista, especificamente o conceito do valor da moeda proposto por Hilferding *apud* Basso (2008), elaborou uma teoria alternativa para determinar taxa de câmbio em um longo período de tempo, ao incorporar índices de preços e índices de produtividade do trabalho, visto que para Basso (2008) a teoria do valor trabalho é fundamental para a compreensão de fenômenos do funcionamento do sistema capitalista de produção.

O valor da moeda é obtido através da divisão do PIB de um país pelo montante de horas trabalhadas utilizadas para produzi-lo. Assim:

PIB nacional;

HT: horas de trabalho dispendidas para produzir o produto nacional;

PIB^* estrangeiro;

HT^*: horas de trabalho despendidas para produzir o produto estrangeiro;

(PIB/HT): valor da moeda nacional;

(PIB^*/HT^*): valor da moeda estrangeira;

E: taxa de câmbio nominal possuindo a dimensão entre duas moedas;

$E(PIB^*/HT^*)$: valor da moeda estrangeira expresso em moeda nacional.

Hilferding (1982) *apud* Basso (2008) observa que existe uma variável, denominada A, que iguala o valor da moeda entre dois países; esta, multiplicada pelo valor de P^* expressa no valor de P, pode ser vista em (09) e (10):

$$\frac{PIB}{HT} = \frac{A \,.\, e \,.\, PIB^*}{HT^*} \quad (09)$$

$$P \,.\, Prod. = A.e.P^* .Prod.^* \quad (10)$$

Uma questão que merece elucidação segundo Basso (2008) é o conjunto de variáveis que explicam A; assumindo que A seja igual a 1, a taxa de câmbio de longo prazo é expressa como:

$$P \,.Prod. = e.P^* .Prod.^* \quad (11)$$

$$e = \frac{P \,.\, Prod.}{P^* \,.\, Prod.^*} \quad (12)$$

Desta forma, têm-se dois resultados interessantes (Basso, 2008):

a) A taxa de câmbio é explicada por preços, produtividades e outras variáveis relevantes incluídas na variável A (mesmo que ainda não identificáveis) (Basso, 2008);

b) A PPP só será corroborada se ocorrer uma convergência das produtividades para um mesmo valor (Basso, 2008);

Basso (2008) argumenta que o ajuste que não pode ser feito na produtividade no curto prazo (capacidade instalada constante) pode ser feito nos preços, o que torna mais fácil de justificar o valor atribuído a A. Por conseguinte, o A desaparece da equação:

$$\frac{PIB}{HT} = \frac{e \,.\, PIB^*}{HT^*} \quad (13)$$

Em decorrência do uso de bens finais, o PIB pode ser expresso pela multiplicação de um índice de preços (P) por um índice de quantidade (Q) (Basso, 2008):

$$P.\frac{Q}{HT} = E\,.\,P^*.\frac{Q^*}{HT^*} \quad (14)$$

Como explicado anteriormente, quantidade por horas trabalhada equivale à produtividade, chegando assim à demonstração da teoria proposta por Basso, tem-se:

$$P\,.\,Prod. = E.P^*\,.Prod.^* \quad (15)$$

$$E = \frac{P\,.\,Prod.}{P^*\,.\,Prod.^*} \quad (16)$$

Contudo Basso (2008) explana que uma alteração pode ser feita na equação, ao incorporar um índice de produtividade física, definido por número de trabalhadores (NT) e média de horas de trabalho por trabalhador (HTT):

$$HT = NT.HTT \quad (17)$$

Logo tem-se:

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

Basso (2008) diz que se Q/NT é um índice de produtividade física, obtém-se:

$$P.Prod_{FIS}\,.\frac{1}{HTT} = E\,.\,P^*.Prod^*_{FIS}\,.\frac{1}{HTT^*} \quad (19)$$

$$E = \frac{P}{P^*}\,.\,\frac{Prod_{FIS}}{Prod^*_{FIS}}\,.\,\frac{HTT^*}{HTT} \quad (20)$$

Ao chegar a esta equação, Basso (2008) expõe que não se deve considerar apena a produtividade física, mas também a evolução da razão entre horas médias de trabalho por trabalhador nos países avaliados. Assim, Basso (2008) ressalva que da mesma forma que a equação (16) comporta índice de produtividade, ela admite variações de índices de preços e esclarece que a taxa de câmbio está relacionada à produtividade do trabalho e não a produtividade física, logo:

$$\hat{E} = \hat{P} + \widehat{Prod} - \hat{P}^* - \widehat{Prod}^* \quad (21)$$

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

$$\hat{E} = \Delta E/E\,; \hat{P} = \Delta P/P\,;\ \widehat{Prod} = \Delta Prod/Prod \quad (23)$$

O enfoque de Basso considera outras variáveis macroeconômicas, assim a equação (22) é uma versão mais sofisticada da teoria, pois considera produtividade física e a evolução do número médio de horas de trabalho por trabalhador.

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

Todavia, caso se assuma que horas trabalhadas por trabalhador são iguais entre os países, a equação (22) reduz-se para:

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

Uma vantagem adicional da abordagem de Basso (2008) é que pode ser considerada como um estimador das taxas de câmbio futuras, levando em consideração os movimentos dos preços e da produtividade do trabalho, embora seja uma versão simples é a mais robusta no que concerne ao referencial teórico, pois está totalmente embasada na teoria do valor trabalho (Basso, 2008).

4. Metodologia

A análise de séries de tempo requer testes específicos para poderem ser utilizadas em modelos univariados e multivariados. Caso tais testes e ajustes nas séries não sejam feitos, serão produzidos resultados inconsistentes e inúteis para qualquer análise.

4.1. Testes de Cointegração de Johansen e Raízes Unitárias

O teste de cointegração propostos por Johansen (1988) possibilita a análise de relações estruturais entre variáveis, determinando se elas possuem ou não um equilíbrio de longo prazo. Para avaliar se duas ou mais variáveis são cointegradas, é necessário constatar a ordem de integração de cada variável individualmente, para isso, é utilizado o teste de raiz unitária.

Dentre os principais testes de raízes unitárias, os mais utilizados são os testes Dickey-Fuller Aumentado (ADF), conforme apresentado em Dickey e Fuller (1979), o teste Phillips-Perron (PP) desenvolvido por Phillips e Perron (1988). Segundo Marçal (1998), Dickey e Fuller desenvolveram testes para detectar a hipótese de raiz unitária contra a hipótese alternativa de estacionariedade. A variável de análise y_t é estimada pela regressão de mínimos quadrados ordinários:

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

Onde μ e βT_t são os componentes determinísticos do modelo, assim no teste:

a) Compara-se o valor da estatística t associado ao coeficiente ρ e da estatística Φ_3 que testa se $\rho=\beta=0$.

Se a hipótese nula for rejeitada o teste se encerra, mas caso a hipótese nula seja aceita, a série apresenta uma raiz unitária ou ao baixo poder do teste pela inclusão indevida de uma tendência determinista.

b) Exclui-se a tendência determinista da regressão, sendo somente válida se $\mu=0$. A estatística Φ_2 testa se ($\rho=\beta=\mu=0$). Se a hipótese nula for rejeitada, o teste termina aceitando-se a hipótese de existência de uma raiz unitária.

c) Caso a hipótese nula seja aceita, roda-se a regressão sem a tendência determinista. Testa-se a hipótese nula de existência de raiz unitária pelo resultado da estatística t associada ao parâmetro ρ e pela estatística Φ_1 que testa se $\rho=\mu=0$. Se a hipótese nula for rejeitada, o procedimento termina.

d) Caso a hipótese nula não seja rejeitada, isso pode ser, devido ao baixo poder do teste, que pode ser melhorado ao rodar-se a regressão sem a tendência e a constante. Avalia-se a estatística t associada a ρ. Caso a hipótese nula seja rejeitada, conclui-se pela ausência de raiz unitária.

Quando duas variáveis são integradas de primeira ordem, ou seja, para tornar cada uma delas estacionária, é necessária a aplicação de uma diferença de ordem um, nesse caso, diz-se que cada uma dessas variáveis é diferença estacionária. Quando duas variáveis são integradas de ordem um, sua combinação linear for estacionária, isto é, apesar de serem ambas integradas de ordem um e a sua combinação for integrada de ordem zero, elas serão cointegradas, desde que os resíduos da regressão, envolvendo essas duas variáveis, sejam estacionários. Quando duas variáveis são cointegradas implicam na existência de um equilíbrio de longo prazo entre elas.

Uma questão importante na econometria é a necessidade de integração de dinâmicas de curto prazo com equilíbrios de longo prazo. A análise de dinâmica de curto prazo geralmente é feita com a eliminação da tendência das variáveis, geralmente feita com a diferenciação. Este procedimento, no entanto, descarta informações importantes nas relações de longo prazo. A cointegração de Granger (Granger, 1981), aprimorada por Engle e Granger (1987) estuda as dinâmicas de integração destas duas dinâmicas.

Uma série de tempo é integrada de ordem 1, I(1) se Δy for uma série estacionária. A série é estacionária é chamada de I(0). Um passeio aleatório é um caso especial de série I(1) pois se y_t for um passeio aleatório, Δy_t será uma série aleatória ou ruído branco.

Se $y_t \sim I(1)$ e $\mu_t \sim I(0)$, elas somadas resultam em $Z_t = y_t + \mu_t \sim I(1)$. Vamos supor que $y_t \sim I(1)$ e $x_t \sim I(1)$. y_t e x_t são cointegradas se existir um β, tal que $y_t - \beta x_t$ seja I(0). Desta forma, a equação de regressão $y_t = \beta x_t + \mu t$ faz sentido porque y_t e x_t não se distanciam muito ao longo do tempo.

Se y_t e x_t não forem cointegradas, isto é $y_t - \beta x_t = \mu_t$ sendo I(1), elas ficarão cada vez mais longe entre si, ao longo do tempo e não há relação de equilíbrio entre elas. As relações que obtem-se ao regredir y_t em x_t é espúria.

Duas ou mais variáveis são cointegradas quando existe uma relação de equilíbrio de longo prazo, apresentando trajetórias sincronizadas ao longo do tempo. De acordo com Engle e Granger (Engle e Granger, 1987), as n variáveis de um vetor x_t (n × 1), onde $x_t = (x_{1t}, x_{2t}, ..., x_{nt})$, são cointegradas de ordem (d, b), xt ~ CI (d, b), quando:

i) as variáveis tem a mesma ordem de integração I(d);

ii) a série formada pela combinação linear das variáveis, $\beta_{xt} = \beta_1 x_{1t} + \beta_2 x_{2t} + ... + \beta_n x_{nt}$ tem ordem de integração inferior à das variáveis originais – $\beta' x_t \sim I(d - b)$, com b > 0 e sendo β o vetor de cointegração.

Para variáveis integradas de ordem 1, d = 1, tem-se que (d – b) = 0.

Nesta análise é utilizado o método de Johansen (1988), onde verifica-se a presença de múltiplos vetores de cointegração ao utilizar um modelo VECM representado pela equação

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

Na qual:

x_t = vetor (n × 1), As n variáveis são integradas de mesma ordem, e com k defasagens;

A_i = matriz de parâmetros de ordem (n × n);

ε_t = termo errático, com $\varepsilon_t \sim$ i.i.d. (0, Ω) (Independentes e identicamente distribuídos).

Segundo Enders (2004), pelo Teorema da Representação de Granger, a equação (X) pode ser expressa por meio de um vetor de correção de erros (VEC) quando $x_t \sim CI$ (1,1):

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

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

A matriz Π (n × n) pode ser representada pelo produto de duas matrizes Π = α β’. A matriz α é formada pelos coeficientes de ajustamento (seus elementos são a velocidade de ajustamento das variáveis a desequilíbrios no curto prazo) e a matriz β possui os parâmetros de cointegração. O termo $\beta' x_{t-1}$ é o termo de correção de erros.

$$\Pi = \alpha\beta' \qquad (29)$$

Em que α e β possuem dimensão (n × r), sendo r igual ao número de relações de longo-prazo e n o número de parâmetros a ser estimado. O modelo é estimado por máxima verossimilhança, havendo pressupostos baseados na normalidade e inexistência de autocorrelação do termo aleatório, ou seja, $\varepsilon t \sim N(0, \Omega)$ e $E[\varepsilon_t \varepsilon_s] = 0$ para $t \neq s$.

Assim, deve-se verificar se tais condições são obedecidas. O posto da matriz Π é igual ao número de raízes características de Π diferentes de zero, indicando o número de vetores de cointegração.

Caso o posto da matriz seja igual a:

i) zero, a matriz é nula e a equação (11) é um VAR na primeira diferença, neste caso, não existe cointegração, pois não se verifica combinação linear estacionária entre as variáveis de X_t;

ii) n, Π tem posto completo e as variáveis de x_t são estacionárias, não cabendo análise de cointegração;

iii) r, sendo 1 < r < n, existem r vetores de cointegração.

Assim, a verificação do número de vetores de cointegração ocorre mediante a análise da significância das raízes características estimadas de Π, sendo esta realizada por duas estatísticas:

i) Estatística do traço, λ traço que testa a hipótese nula de existência de no máximo, r vetores de cointegração (equação 28);

ii) Estatística do máximo autovalor, λ max, a qual testa a hipótese nula de r vetores de cointegração, contra a hipótese alternativa de r + 1 vetores (equação 14) (ENDERS, 2010).

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

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

$\hat{\lambda}_i$ É igual ao número de valores estimados de raízes características, obtido a partir da estimação da matriz Π e T igual ao número de observações.

4.2. Número de Defasagens

Dentro de um modelo VAR, as variáveis são tratadas simetricamente e todas são tratadas como endógenas. O VAR depende das defasagens de todas as variáveis e seu número é arbitrário. A escolha do número de defasagens depende de até quando estas adicionam informação ao sistema.

Quanto maior o número de defasagens, maior o número de parâmetros no modelo e menor o número de graus de liberdade, entretanto um maior número de defasagens evita a necessidade de restrições no modelo.

A determinação do número de defasagens no VAR é feita pelos critérios de informação de Akaike (AIC), Schwarz (BIC) e pelo teste de Razão de Verossimilhança (LR).

4.3. Vetores Autorregressivos

O sistema de vetores autorregressivos (VAR) de SIMS (1980) propõe que variáveis devem ser tratadas simetricamente quando não é possível de se determinar claramente quando são endógenas ou exógenas. Sejam dois processos estocásticos y_t e z_t:

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

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

Nas quais:

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

E a sua representação matricial tem a forma:

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

Ou de forma compacta:

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

Na qual:

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

Para a generalização do modelo, assumindo-se que os processos são todos estocásticos x_{1t}, x_{2t}, ... x_{nt}, a representação se torna:

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

Na qual:

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

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

4.4. Vetores Autorregressivos com Correção de Erros

Supondo que $x_{1t} \sim I(1), x_{2t} \sim I(1), \ldots x_{nt} \sim I(1)$ e que sejam cointegrados, pode-se fazer a representação:

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

Na qual:

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

e

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

Πx_t é o mecanismo de correção de erros e cada linha desta matriz representa uma relação de cointegração, nela deverá existir pelo menos uma e no máximo n-1 relações de cointegração. Cada linha de Π é um vetor de cointegração, onde deverá existir pelo menos um e no máximo n-1 vetores de cointegração. O posto de Π determina o número de vetores de cointegração.

4.5. *Model Confidence Set* (MCS)

O *Model Confidence Set* (MCS) é uma técnica de seleção de modelos, desenvolvida por Hansen, Lunde e Nason (Hansen, Lunde e Nason, 2011). Trata-se de um processo de escolha de modelos M^*, que contenha o melhor (ou os melhores) modelo(s) escolhidos de uma coleção de modelos M^0, no qual, "melhor modelo" é definido a partir de critérios referentes à qualidade da previsão.

O MCS estima um conjunto $\widehat{M^*}$, que contém os melhores modelos para um dado nível descritivo. Nele, os conjuntos de dados com a mesma qualidade de informação resultam em um $\widehat{M^*}$ com um único modelo, enquanto que, dados com menor qualidade de informação resultam em mais de um modelo, com qualidades de previsões semelhantes, dado um determinado grau de significância.

O MCS seleciona um modelo, utilizando um teste de equivalência δM e uma regra de eliminação eM. O teste de equivalência é aplicado para o conjunto $M = M_0$.

Se δM é rejeitado, então existem evidências de que os modelos não apresentam qualidade preditiva mínima e então a regra eM é utilizada para eliminar os modelos com baixa qualidade preditiva. O procedimento é repetido até que o teste de equivalência δM seja aceito e então o modelo $\widehat{M^*}$ é selecionado para um conjunto dos melhores modelos.

Utilizando um nível descritivo α em todos os testes, o método assegura que:

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

Quando $\widehat{M^*}$ contém apenas um modelo, tem-se a evidência de que:

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

O MCS produz níveis descritivos para cada modelo que passou pela regra de eliminação. Para cada modelo i ∈ M^0, o nível descritivo $\widehat{p_i}$ é a garantia de que $i \in \widehat{M^*_{1-\alpha}}$, somente se $\widehat{p_i} > \alpha$. Assim, qualquer modelo com baixo nível descritivo, certamente não está entre os melhores modelos com qualidade informacional.

A sequência do MCS baseia-se nos seguintes passos:

(i) $M = M_0$.

(ii) Testar a hipótese $H_{0,M}$ usando δM ao nível de confiança α.

(iii) Se $H_{0,M}$ é aceita, então; $M\hat{*}1-\propto = M$, caso contrário, o modelo é eliminado pela regra eM.

(iv) O processo é repetido para todos os modelos, a partir do passo (ii).

5. Base de Dados

Os dados para a análise correspondem ao intervalo de tempo de 1977 até 2006 em base anual, para Japão (JP), Reino Unido (UK) e Estados Unidos (US), foram extraídos da base de dados KLEMS disponível em http://www.euklems.net/, Federal Reserve Saint Louis disponível em http://research.stlouisfed.org/fred2/ e do International Monetary Fund disponível em www.imf.org.

Os dados extraídos para Japão, Estados Unidos e Reino Unido foram:

Tabela (01) – Séries de dados Estados Unidos

SÉRIE	**DESCRIÇÃO**
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

Fonte: Elaborada pelos autores

Tabela (02) – Séries de dados Japão

SÉRIE	DESCRIÇÃO
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

Fonte: Elaborada pelos autores

Tabela (03) – Séries de dados Reino Unido

SÉRIE	DESCRIÇÃO
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

Fonte: Elaborada pelos autores

A partir dos dados originais dos países foram desenvolvidas variáveis, oriundas de transformações logarítmicas utilizadas nas avaliações dos pares de países Japão-Estados Unidos, Japão-Reino Unido, Reino Unidos-Estados Unidos (todas as novas variáveis estão em primeira diferença, para serem estacionárias).

Tabela (04) – Variáveis criadas para Japão – Estados Unidos

SÉRIE	DESCRIÇÃO
DJPUS_ER	DIFERENÇA ENTRE AS TAXAS DE CÂMBIO
DJPUS_CPI	DIFERENÇA ENTRE OS ÍNDICES DE PREÇOS AO CONSUMIDOR
DJPUS_DEFL_VA	DIFERENÇA ENTRE OS DEFLATORES DE VALORES AGREGADOS
DJPUS_GO_P	DIFERENÇA ENTRE OS DEFLATORES DE PRODUÇÃO TOTAL
DJPUS_PROD_EMP	DIFERENÇA ENTRE AS PRODUTIVIDADES DE MÃO DE OBRA EM ATIVIDADE
DJPUS_PROD_EMPE	DIFERENÇA ENTRE AS PRODUTIVIDADES DE MÃO DE OBRA RELACIONADA

Fonte: Elaborada pelos autores

Tabela (05) – Variáveis criadas para Japão – Reino Unido

SÉRIE	DESCRIÇÃO
DJPUK_ER	DIFERENÇA ENTRE AS TAXAS DE CÂMBIO
DJPUK_CPI	DIFERENÇA ENTRE OS ÍNDICES DE PREÇOS AO CONSUMIDOR
DJPUK_DEFL_VA	DIFERENÇA ENTRE OS DEFLATORES DE VALORES AGREGADOS
DJPUK_GO_P	DIFERENÇA ENTRE OS DEFLATORES DE PRODUÇÃO TOTAL
DJPUK_PROD_EMP	DIFERENÇA ENTRE AS PRODUTIVIDADES DE MÃO DE OBRA EM ATIVIDADE
DJPUK_PROD_EMPE	DIFERENÇA ENTRE AS PRODUTIVIDADES DE MÃO DE OBRA RELACIONADA

Fonte: Elaborada pelos autores

Tabela (06) – Variáveis criadas para Reino Unido – Estados Unidos

SÉRIE	DESCRIÇÃO
DUKUS_ER	DIFERENÇA ENTRE AS TAXAS DE CÂMBIO
DUKUS_CPI	DIFERENÇA ENTRE OS ÍNDICES DE PREÇOS AO CONSUMIDOR
DUKUS_DEFL_VA	DIFERENÇA ENTRE OS DEFLATORES DE VALORES AGREGADOS
DUKUS_GO_P	DIFERENÇA ENTRE OS DEFLATORES DE PRODUÇÃO TOTAL
DUKUS_PROD_EMP	DIFERENÇA ENTRE AS PRODUTIVIDADES DE MÃO DE OBRA EM ATIVIDADE
DUKUS_PROD_EMPE	DIFERENÇA ENTRE AS PRODUTIVIDADES DE MÃO DE OBRA RELACIONADA

Fonte: Elaborada pelos autores

Cada uma das variáveis GDP_TI; H_EMP; H_EMPE; DEFL_VA; GO_P e CPI, foi obtida a partir de dados de 96 setores da economia, agregados em dez setores e agrupados em um valor total final (ver classificação econômica da EU KLEMS no Apêndice A).

Os dados do CPI que estavam disponíveis com base 100 no ano 2005 foram convertidos para base 100 no ano 1995, compatibilizando-o com os outros deflatores que tinham como base 100 o ano de 1995.

Para se testar PPP, de acordo com a equação (08), usa-se o índice de preço de valor agregado (DEFL_VA), índice de preços da produção bruta (GO_P) e o índice de preço ao consumidor (CPI), criando variáveis específicas.

A partir dos dados, foram desenvolvidas as variáveis de trabalho para o modelo de Basso (2008), no qual a produção total bruta (GDP_TI) foi deflacionada pelo DEFL_VA, pelo GO_P e pelo CPI, criando assim variáveis deflacionadas.

As variáveis foram convertidas para dólar americano, pela taxa de final de período e então transformadas em produtividade, dividindo-as por horas trabalhadas do total de empregados (H_EMPE) e do total de mão de obra disponível (H_EMP).

Os modelos foram executados no *software* STATA-12 e as análises do MCS foram feitas no OXMETRICS-6.

6. Resultados dos testes com as variáveis

Para PPP relativa, as equações de cointegração (ver Apêndice B) geraram os seguintes resultados:

Na dupla de países Japão – Estados Unidos a taxa de câmbio (JPUS_ER) não cointegra com nenhum dos índices de preço utilizados (JPUS_CPI, JPUS_DEFL_VA e JPUS_GO_P), mostrando que a teoria da paridade do poder de compra não é corroborada para Japão e Estados Unidos.

Para a dupla de países Japão – Reino Unido a taxa de câmbio (JPUK_ER) apresenta cointegração somente com o índice de preço da produção bruta (JPUK _GO_P).

Na dupla de países Reino Unido – Estados Unidos a taxa de câmbio (UKUS_ER) não cointegra com UKUS_CPI, UKUS_DEFL_VA e UKUS_GO_P, logo não existe modelo de PPP entre Reino Unido e Estados Unidos que possa ser explicável com estas variáveis.

No modelo proposto por Basso (2008):

Foram encontradas cointegração entre todos os sistemas de equações para:

6.1. Equações de cointegração para cada modelo

Tabela (07) – Número de equações de cointegração

	MODELO	EQ. DE COINTEGRAÇÃO		
		JPUS	JPUK	USUK
1	Dif. Tx de cambio, dif CPI, dif produtividade empe	1	0	1
2	Dif. Tx de cambio, dif CPI, dif produtividade emp	1	1	1
3	Dif. Tx de cambio, dif defl. VA, dif produtividade empe	1	1	0
4	Dif. Tx de cambio, dif defl. VA, dif produtividade emp	1	0	0
5	Dif. Tx de cambio, dif defl. PIB, dif produtividade empe	1	1	1
6	Dif. Tx de cambio, dif defl. PIB, dif produtividade emp	1	1	1

Fonte: elaborada pelos autores

Para a dupla de países Japão – Estados Unidos (JPUS) não se pode rejeitar a hipótese de existência de uma equação de cointegração, para todas combinações de variáveis (1 a 6), ao nível de 5%.

Para a dupla de países Japão – Reino Unido (JPUK) não existe cointegração para as combinações de variáveis 1 e 4 e não se pode rejeitar a hipótese de existência de uma equação de cointegração, para as combinações de variáveis 2, 3, 5 e 6, ao nível de 5%;

Para a dupla de países Reino Unido – Estados Unidos (UKUS) não existe cointegração para as combinações de variáveis 3 e 4 e não se pode rejeitar a hipótese de existência de uma equação de cointegração, para as combinações de variáveis 1, 2, 5 e 6, ao nível de 5%;

6.2. Testes de Raízes Unitárias

6.2.1. Teste de Dickey Fuller

Tabela (08) – Teste ADF de Raízes Unitárias para Japão – Estados Unidos

SISTEMA JAPÃO - ESTADOS UNIDOS						
	NO NÍVEL		1ª Diferença		2ª Diferença	
Variável	Estatística	p-value	Estatística	p-value	Estatística	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	-	-

Fonte: elaborada pelos autores

Os valores críticos para o teste de Dickey Fuller são:

1% : -3.7230

5% : -2.9890

10% : -2.6250

Utilizando-se o teste de Dickey Fuller no sistema Japão-Estados Unidos, observa-se que todas as variáveis são estacionárias em primeira diferença, à exceção da variável JPUS_DEFL_VA (diferença entre os deflatores de valor agregado de Japão e Estados Unidos) que é estacionária em segunda diferença.

Tabela (09) – Teste ADF de Raízes Unitárias para Japão – Reino Unido

SISTEMA JAPÃO - REINO UNIDO						
	NO NÍVEL		1ª Diferença		2ª Diferença	
Variável	Estatística	p-value	Estatística	p-value	Estatística	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	-	-	-	-

Fonte: elaborada pelos autores

Utilizando-se o teste de Dickey Fuller no sistema Japão – Reino Unido, observa-se que são estacionárias em nível as variáveis JPUK_CPI (diferença entre os CPI do Japão e Reino Unido), JPUK_DEFL_VA (diferença entre os deflatores de valor agregado dos dois países) e JPUK_GO_P (diferença entre os deflatores de PIB dos dois países) e são estacionárias em primeira diferença as variáveis JPUK_ER (diferença entre as taxas de câmbio dos dois países), JPUK_PROD_EMPE (diferença entre pessoal relacionado) e JPUK_EMP (diferença entre pessoal empregado).

Tabela (10) – Teste ADF de Raízes Unitárias para Reino Unido – Estados Unidos

SISTEMA REINO UNIDO - ESTADOS UNIDOS						
	NO NÍVEL		1ª Diferença		2ª Diferença	
Variável	Estatística	p-value	Estatística	p-value	Estatística	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	-	-	-	-

Fonte: elaborada pelos autores

Empregando-se o teste de Dickey Fuller no sistema Reino Unido – Estados Unidos, observa-se que é estacionária em primeira diferença a variável UKUS_ER (diferença entre as taxas de câmbio) e todas as demais são estacionárias no nível.

6.2.2. Teste de Phillips - Perron

Os valores críticos para o teste de Phillips-Perron são:

1% : -3.7230

5% : -2.9890

10% : -2.6250

Tabela (11) – Teste PP de Raízes Unitárias para Japão – Estados Unidos

SISTEMA JAPÃO - ESTADOS UNIDOS

	NO NÍVEL		1ª Diferença		2ª Diferença	
Variável	Estatística	p-value	Estatística	p-value	Estatística	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	-	-

Fonte: elaborada pelos autores

Usando-se o teste de Phillips-Perron no sistema Japão-Estados Unidos, observa-se que todas as variáveis são estacionárias em primeira diferença, à exceção da variável JPUS_DEFL_VA (diferença entre os deflatores de valor agregado) que é estacionária em segunda diferença.

Tabela (12) – Teste PP de Raízes Unitárias para Japão – Reino Unido

SISTEMA JAPÃO - REINO UNIDO						
	NO NÍVEL		1ª Diferença		2ª Diferença	
Variável	Estatística	p-value	Estatística	p-value	Estatística	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	-	-

Fonte: elaborada pelos autores

Para o sistema Japão – Reino Unido, utilizando-se o teste de Phillips – Perron observa-se que são estacionárias em nível as variáveis JPUK_CPI (diferença entre os CPI do Japão e Reino Unido), JPUK_DEFL_VA (diferença entre os deflatores de valor agregado dos dois países) e JPUK_GO_P (diferença entre os deflatores de PIB dos dois países) e são estacionárias em primeira diferença as variáveis JPUK_ER (diferença entre as taxas de câmbio dos dois países), JPUK_PROD_EMPE (diferença de produtividade do pessoal relacionado) e JPUK_EMP (diferença de produtividade do pessoal empregado).

Tabela (13) – Teste PP de Raízes Unitárias para Reino Unido – Estados Unidos

SISTEMA REINO UNIDO - ESTADOS UNIDOS						
	NO NÍVEL		1ª Diferença		2ª Diferença	
Variável	Estatística	p-value	Estatística	p-value	Estatística	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	-	-

Fonte: elaborada pelos autores

No sistema Reino Unido – Estados Unidos, não se pode rejeitar a hipótese de que as séries são estacionárias em primeira diferença ao nível de 5%.

6.3. Número de Defasagens

Tabela (14) – Número de defasagens Japão – Estados Unidos

	SISTEMA JAPÃO - ESTADOS UNIDOS			
	VARIÁVEIS			NÚMERO DE DEFASAGENS
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

Fonte: elaborada pelos autores

Tabela (15) – Número de defasagens Japão – Reino Unido

	SISTEMA JAPÃO – REINO UNIDO			
	VARIÁVEIS			NÚMERO DE DEFASAGENS
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

Fonte: elaborada pelos autores

Tabela (16) – Número de defasagens Reino Unido – Estados Unidos

	SISTEMA REINO UNIDO - ESTADOS UNIDOS			
	VARIÁVEIS			NÚMERO DE DEFASAGENS
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

Fonte: elaborada pelos autores

7. Análise dos Resultados

Para cada combinação de variáveis, para cada sistema de dois países, foram utilizados VAR e VEC com as respectivas defasagens e ajustes das variáveis, com diferenciações nas séries para indução de estacionariedade. Assim, foram feitas 12 regressões (6 VAR e 6 VEC) para cada par de países.

Para a produção dos resultados foram utilizados os softwares STATA-12, que executou os modelos e o OXMETRICS-6 para a análise do *model confidence set*, via pacote MULCOM.

A amostra foi dividida ao meio e as regressões VAR e VEC foram feitas com o sistema *rolling regression* projetando os valores da metade da amostra até o final. A análise final para decidir a utilidade dos modelos foi feita com erro quadrático médio e o MCS. Os sistemas que produziram os resultados para análise são os descritos nas tabelas (14, 15 e 16)

Os resultados projetados foram utilizados para gerar os erros quadráticos, que foram analisados por dois critérios, o erro quadrático médio e o MCS.

A análise pelo critério do *Model Confidence Set* apontou:

Sistema Japão – Reino Unido: Inconclusivo. Nenhum sistema apresentou qualidade informacional que o qualificasse como satisfatório para realizar projeções.

Sistema Japão – Estados Unidos: Inconclusivo. Nenhum sistema apresentou qualidade informacional que o qualificasse como satisfatório para realizar projeções.

Sistema Reino Unido – Estados Unidos: Foram encontrados cinco sistemas de projeções que produzem projeções com mesma qualidade informacional.

Tabela (17) – Sistemas e variáveis para Reino Unido – Estados Unidos (UKUS)

SISTEMA	VARIÁVEIS
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

Fonte: elaborada pelos autores

O sistema UKUS_VAR_5 é composto pelas variáveis:

Diferença entre as taxas de câmbio do Reino Unido e dos Estados Unidos, em primeira diferença (DUKUS_ER);

Diferença entre os Deflatores das produções brutas do Reino Unido e dos Estados Unidos em nível (UKUS_GO_P);

Diferença entre as Produtividades das pessoas empregadas do Reino Unido e dos Estados Unidos, em nível (UKUS_PROD_EMP).

O sistema UKUS_VAR_6 é composto pelas variáveis:

Diferença entre as taxas de câmbio do Reino Unido e dos Estados Unidos, em primeira diferença (DUKUS_ER);

Diferença entre os Deflatores da produção bruta do Reino Unido e dos Estados Unidos, em nível (UKUS_GO_P);

Diferença entre as Produtividades das pessoas relacionadas do Reino Unido e dos Estados Unidos, em nível (UKUS_PROD_EMPE).

O sistema UKUS_VEC_3 é composto pelas variáveis:

Diferença entre as taxas de câmbio do Reino Unido e dos Estados Unidos, em primeira diferença (DUKUS_ER);

Diferença entre os Deflatores dos valores agregados do Reino Unido e dos Estados Unidos em nível (UKUS_DEFL_VA);

Diferença entre as Produtividades das pessoas relacionadas do Reino Unido e dos Estados Unidos, em nível (UKUS_PROD_EMPE).

O sistema UKUS_VEC_4 é composto pelas variáveis:

Diferença entre as taxas de câmbio do Reino Unido e dos Estados Unidos, em primeira diferença (DUKUS_ER);

Diferença entre os Deflatores dos valores agregados do Reino Unido e dos Estados Unidos, em nível (UKUS_DEFL_VA);

Produtividade das pessoas empregadas (UKUS_PROD_EMP).

O sistema UKUS_VEC_5 é composto pelas variáveis:

Diferença entre as taxas de câmbio do Reino Unido e dos Estados Unidos, em primeira diferença (DUKUS_ER);

Diferença entre os Deflatores das produções brutas do Reino Unido e dos Estados Unidos, em nível (UKUS_GO_P);

Diferença entre as Produtividades das pessoas relacionadas do Reino Unido e dos Estados Unidos, em nível (UKUS_PROD_EMP).

8. Conclusão

O objetivo deste trabalho foi verificar se PPP se mantem ao longo do tempo e se a hipótese apresentada por BASSO (2008), que o diferencial de produtividade pode afetar a taxa de câmbio entre dois países encontra suporte empírico.

Para os testes foram utilizadas as informações do Japão, Reino Unido e Estados Unidos, em bases anuais, no período de 1977 a 2006.

Para PPP e para o modelo de Basso (2008), aplicou-se os testes de raízes unitárias (Augmented Dickey-Fuller e Phillips-Perron), nas variáveis e criadas variáveis com as necessárias induções de estacionariedades. As hipóteses foram testadas utilizando regressões VAR (Vector autoregression) e VEC (Vector Error Correction) ajustados com os lags adequados, indicados pelos critérios de informações de AIC (Akaike), SBC (Schwarz Bayesian Criterion) e HQ (Hannan-Quinn). As regressões foram feitam com o processo de *rolling regression* tendo como espaço amostral a primeira metade dos dados.

Para os pares de países em que se aplicou PPP, apenas o par Japão - Reino Unido apresentou cointegração com um único índice de preços (JPUK _GO_P).

Com as projeções produzidas para o modelo de Basso (2008), foram geradas séries com os erros quadráticos para cada projeção VAR e VEC e estes levados para a análise com o MCS, nele, as análises para Japão - Estados Unidos e Japão - Reino Unido não apresentam evidências de que as variáveis selecionadas apresentam poder preditivo para a taxa de câmbio de longo prazo.

Para o sistema Reino Unido – Estados Unidos foram encontradas evidências que sustentam a hipótese proposta por BASSO (2008), em cinco regressões,

UKUS_VAR_5; UKUS_VAR_6; UKUS_VEC_3; UKUS_VEC_4 e UKUS_VEC_5, de um total de doze, entretanto os mesmos modelos não apresentaram qualidade preditiva para as outras duplas de países, levando-se a concluir que as evidências encontradas não permitem ainda uma teoria generalizável para todos os pares de países.

A próxima tarefa consiste em refazer os testes melhorando a classificação de setores comercializáveis e não comercializáveis e construindo variáveis setoriais deflacionadas por índices de preços setoriais.

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APÊNDICE A

A EU KLEMS apresenta seguinte classificação para os setores da economia, que podem ser integrados no setores 1, 6, 14, 62, 67, 68, 72, 73, 80 e 94, onde apenas os setores 1, 6, e 14 são de bens transacionáveis e os demais são classificados como não transacionáveis.

	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 DEFENCE; 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 activites
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

APÊNDICE B

TESTES DE COINTEGRAÇÃO:

SISTEMA JAPÃO – ESTADOS UNIDOS

TESTE ENTRE 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
-------------------------------------------------------------------------------
```

TESTE ENTRE 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
-------------------------------------------------------------------------------
```

TESTE ENTRE 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
-------------------------------------------------------------------------------
```

SISTEMA JAPÃO - REINO UNIDO

TESTE ENTRE 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
-------------------------------------------------------------------------------
```

TESTE ENTRE 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
-------------------------------------------------------------------------------
```

TESTE ENTRE 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
```

```
-------------------------------------------------------------------------------
```

SISTEMA REINO UNIDO – ESTADOS UNIDOS

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
-------------------------------------------------------------------------------
```

TESTE ENTRE 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
-------------------------------------------------------------------------------
```

TESTE ENTRE 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
-------------------------------------------------------------------------------
```

RAIZES UNITÁRIAS:

SISTEMA JAPÃO – ESTADOS UNIDOS

```
.         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
```

SISTEMA JAPÃO – REINO UNIDO

```
.         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
```

SISTEMA REINO UNIDO – ESTADOS UNIDOS

```
.        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
```

NÚMERO DE DAFASAGENS:

SISTEMA JAPÃO - ESTADOS UNIDOS

DEFASAGENS COM 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  |
  +---------------------------------------------------------------------------+
```

DEFASAGENS COM 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

DEFASAGENS COM 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

SISTEMA JAPÃO - REINO UNIDOS

DEFASAGENS COM 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

DEFASAGENS COM 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*
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

DEFASAGENS 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

SISTEMA REINO UNIDO – ESTADOS UNIDOS

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

DEFASAGENS COM 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

DEFASAGENS COM 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

Seção II

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's 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. 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:

$$e = P \,/\, P^* \qquad (02)$$

$$P = e \, . P^{*} \quad (03)$$

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:

$$\theta = \frac{e \, . \, P*}{P} \quad (04)$$

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:

$$q_t = s_t - p_t + p_t^{*} = 0 \quad (05)$$

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:

$$\hat{P} = \hat{e} + \hat{P}^{*} \quad (06)$$

$$\hat{e} = \hat{P} - \hat{P}^{*} \quad (07)$$

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):

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

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

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):

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

d) 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:

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

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

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:

$$\hat{E} = \hat{P} + \widehat{Prod} - \hat{P}^* - \widehat{Prod}^* \quad (21)$$

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

$$\hat{E} = \Delta E/E\,; \hat{P} = \Delta P/P\,;\ \widehat{Prod} = \Delta Prod/Prod \quad (23)$$

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.

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

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

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

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).

4. 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:

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

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 ρ=β=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 μ=0. The statistic Φ_2 tests whether (ρ=β=μ=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

$$X_t=A_1x_{t-1}+A_2x_{t-2}+...+A_kx_{t-k}+\varepsilon_t \qquad (26)$$

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 ε_t ~ 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 ~ CI (1.1):

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

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.

$$\Pi=\alpha\beta' \qquad (29)$$

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., εt~ N (0, Ω) 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).

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

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

$\hat{\lambda}_i$ 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 $x_{1t},\ x_{2t}, \ldots.\ x_{nt}$, 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

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

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:

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

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

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

MCS produces descriptive levels for each model that has been subject to the elimination rule. For each model i $\in M^0$, 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; $\hat{M*}1-\propto = M$, otherwise, the model is eliminated by rule eM.

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

5. 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.

6. 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

7. 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).

8. 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

maximum rank	parms	LL	eigenvalue	trace statistic	5% critical 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

maximum rank	parms	LL	eigenvalue	trace statistic	5% critical 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

maximum rank	parms	LL	eigenvalue	trace statistic	5% critical 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

maximum rank	parms	LL	eigenvalue	trace statistic	5% critical 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

maximum rank	parms	LL	eigenvalue	trace statistic	5% critical 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

maximum rank	parms	LL	eigenvalue	trace statistic	5% critical 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

maximum rank	parms	LL	eigenvalue	trace statistic	5% critical 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

maximum rank	parms	LL	eigenvalue	trace statistic	5% critical 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

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

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

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

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

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

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

	Test Statistic	1% Critical Value	5% Critical Value	10% Critical 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

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

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

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

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

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

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

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

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

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

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

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

lag	LL	LR	df	p	FPE	AIC	HQIC	SBIC
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*
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

Seção III

Is it possible to beat the random walk model in exchange rate forecasting? More evidence for the Brazilian case

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EMERSON FERNANDES MARÇAL[2]

ABSTRACT

This study verifies whether it is possible to surpass the random walk model to predict the Brazilian nominal exchange rate and to assess the comparative predictive power of the Brazilian currency against the US dollar, Japanese yen and British Pound Sterling over the 1995-2011 period with data of quarterly frequency. The models analyzed are similar to the seminal study of Meese and Rogoff. The performance outside the sample of models is appraised for several forecast horizons. The best model is chosen using the model confidence set technique proposed by Hansen et alli. The results obtained suggest that for shorter time horizons the forecasts generated are surpassed by the random walk model. In the longer horizons the random walk model is surpassed by some models that use projection bias correction, suggesting that structural changes in the mean can explain the poor performance of a fundamental–based model for the Brazilian case.

JEL Codes: E37, F31, F41.

Keywords: foreign exchange, VAR, VEC, structural models, random walk, model confidence set

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1 - INTRODUCTION

When the Bretton Woods system of adjustable fixed exchange rates collapsed in March 1973, most nations shifted their exchange-rate regime to dirty float. At the same time, the development of banking automation facilitated transfers of international funds for payments resulting from the international trade in goods and services, speeding up the movement of money between countries. Since then the behavior of nominal exchange rates has grown closer to that of a financial asset.

According to Visser (VISSER, 2004), surveys performed by the Bank of International Settlements (BIS) in April 2001 with 48 central banks, recorded an average daily volume of spot transaction exchange rates (US dollar), US dollar forward rates and foreign exchange swaps of US$ 1.2 trillion, of which US$ 387 billion US dollars were from spot transactions (Triennial Central Bank Survey, 2002).

The same survey ascertained that the value added of annual global exports of goods and services reached US$ 7,465 trillion (IMF, 2002, p. 185). Such a value is equal to the volume of foreign currency traded on some days. With this new reality, of volume and speed of movement of foreign currency, exchange rate determination theories began to be reconsidered and different classes of model were developed in an attempt to explain the erratic behavior of exchange rates.

After 19999 the Brazilian economy began to operate in a foreign exchange regime very close to that of dirty float, experiencing greater macroeconomic stability. The Brazilian currency has been gaining international trade volume, for which reason we must ask ourselves to what extent the results of Meese and Rogoff (MEESE and ROGOFF, 1983) apply to Brazil.

The aim of this study is to investigate whether the conclusions of Meese and Rogoff (MEESE and ROGOFF, 1983) are applicable to the Brazilian market, and also to discuss the reasons for the difficulty of forecasting with this macroeconomic variable.

2 – LITERATURE REVIEW

The seminal study on exchange rate projections of Messe and Rogoff (MEESE and ROGOFF, 1983), in which the authors compare the outcomes of projections of models based on economic theory against random walk. The performance of the random walk model proved to be as good as or often better than the other models. In the study the authors use the flexible price monetary model of Frankel and Bilson (FRENKEL, 1976), Bilson (BILSON, 1978), the sticky-price monetary model of Dornbush and Frankel (DORNBUSCH, 1976) and Frankel (FRANKEL, 1979) and the sticky-price asset model of Hooper and Morton (HOOPER and MORTON, 1982) and ascertain that none of the models produces better results than random walk.

A series of studies sought to evaluate the robustness of the conclusions of the abovementioned article. The results in literature suggest that it is extremely hard to beat the random walk model. The study by Mark (MARK, 1995) verifies that long-term changes in the exchange rate can be predictable through an analysis carried out using the 1973-1991 quotations of the US dollar, Canadian dollar, German mark, Swiss franc and Japanese yen. The author observes that exchange rate fundamentals derive from monetary models, based on relations between currency inventory and relative real income. The projections outside the sample suggest the existence of a predictable component in the exchange rate for the Swiss franc, Japanese yen and German mark. The study also affirms that the exchange rate can deviate from its fundamentals constantly, but returns to them in the long term. This convergence is not detectable by econometric models. Thus when the exchange rate is below its fundamentals it will rise, and if it is above its fundamentals, it will drop. The author also observes that projections up to 4 quarters are not accurate and that for longer time horizons the models manage to surpass the *random walk*.

Faust et alii (FAUST, ROGERS and WRIGHT, 2003) disagree with the results of Meese and Rogoff (MEESE and ROGOFF, 1983) due to the use of historical data of the explanatory variables in the models. They use the monetary model proposed by Mark (MARK, 1995), yet feed it with values obtained in real time to perform the projections. The author produced evidence in favor of long-term projections showing that structural models are not better than the *random walk* for the short term, indicating that the performance of this class of models is better for the long term. The results of the study that indicated a certain predictability for the Swiss currency were also refuted.

When the models of Messe and Rogoff (MEESE and ROGOFF, 1983) are fed with real-time data, the results are also unclear, but suggest that the *random walk* produces better results than structural and monetary models.

Cheung et alii (CHEUNG, CHINN and PASCUAL, 2002) compare several projections of different models against the *random walk*. The study focuses on the stick-price model of Dornbusch and Frankel. It also analyzes whether models are based on productivity (Balassa-Samuelson) and interest rate parity. The models were used to evaluate several currencies for different forecasting horizons. The authors observed that no model is better than the random walk for short-term projections. For the long term, the structural models show a slight improvement in relation to the *random walk*.

Evans and Lyons (EVANS and LYONS, 2005) study microfounded models in which information arrives at the agents that determine prices, affecting their expectations. The study performs a performance comparison between a microfounded model, a macroeconomic model and the *random walk*, for short-term time horizons ranging from 1 to 30 days. In the microfounded models it is assumed that the agents who determine prices obtain the primary information directly in the transactions, the site where there is information about fundamentals. The combinations of all the transactions create information of a macro nature, which at any given time is only available to the agents and is not public. The authors verify that the macro models are always poor in performance. Microfounded models have a better performance than the *random walk*, over longer periods of time.

A comprehensive survey on the literature that followed the study of Meese and Rogoff is conducted by Rossi (ROSSI, 2013). The author performs an extensive review of literature about exchange rate projections. Her main conclusions are given by the following points:

(i) there is a consensus in literature that models based on the Taylor rule and that use the net foreign assets position produce better forecasts outside the sample than other traditional fundamentals such as interest rates, inflation, gross domestic product and differentials between monetary aggregates. The monetary fundamentals in long horizons and the interest rate differentials in short horizons have predictive power in some studies, but not in others.

However, there are differences of opinion regarding whether monetary fundamentals are not useful, as suggested by Meese and Rogoff.

(ii) – Among all the classes of model, those with the best performance are linear and error correction models. For models of a single equation, the choice of explanatory variables is more relevant than the use of lagged, contemporary or historical data.

(iii) – Data transformations, such as seasonal adjustments, lags, detrending and differentiations can substantially affect the predictive power of the model and can explain the reason why there are differences in results between studies. For example, the forecasting ability of the monetary model in long horizons. Another fact found is that for some fundamentals, the forecasting ability changes significantly when we replace historical data with real time data. For some models, the forecasting ability also appears to depend on the chosen country. With few exceptions, the frequency of data and whether they are historical or projected, appear not to affect the forecasting ability of the model.

(iv) – The choice of the benchmark, projection time horizon, data sample and projection method are very important. The *random walk* with drift was the most difficult benchmark to beat.

(v) – On one hand the empirical analysis confirms most of the foreign exchange studies:

- Sundry variables have forecasting ability within the sample and do not have projection relevance outside the sample, due to instability in the parameters of the models used.

- The predictive power of models varies between countries, models and variables used, period of time analyzed and data sample.

- Although the Taylor and the net foreign assets variable have forecasting ability for short periods of time and other models based on monetary fundamentals (error correction models) have forecasting ability for longer time horizons, none of them appears to discard the hypothesis of Meese and Rogoff.

In the Brazilian case the study by Perdomo and Botelho (PERDOMO and BOTELHO, 2007) tests the random walk hypothesis comparing the error of exchange rate projections performed by banks, consulting firms and financial institutions, obtained in the top-5 ranking of the Brazilian Central Bank, with the projections of a random walk model for three forecast horizons. The authors conclude that the random walk is more accurate than the models used by financial institutions, increasing with the projection period.

3 – ECONOMETRIC METHOD

There are several ways of assessing the relative quality of projections obtained by alternative models. A more traditional method consists of evaluating mean squared prediction errors. However, this method is subject to the criticism that the model of least error does not always have the best predictive performance, but may have been chosen for factors such as choice of the forecasting window.

Aiming to fill this gap in the study of Diebold and Mariano, the authors provide a formal test to compare the forecasting ability of two models. This study had a major impact on prediction literature. The study by Hansen et al. recently generalized the test proposed by Diebold and Mariano towards allowing the simultaneous comparison of a wide array of models. The technique is called model confidence set and is briefly explained in this article.

MODEL CONFIDENCE SET (MCS)

The Model Confidence Set (MCS) is a model selection technique developed by Hansen, Lunde and Nason (HANSEN, LUNDE and MASON, 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.

MCS estimates a set $\widehat{M^*}$, which is the set 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 eM 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:

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

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

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

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

$\hat{M}$*1−∝ = M,

otherwise,

the model is eliminated by the rule eM

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

MCS will be used to evaluate the forecasts generated from a wide array of econometric models.

3.1 MODEL USED IN THE FORECASTING EXERCISE

In this study the goal is to compare forecasts obtained from the random walk models with and without drift against a wide array of econometric models.

The random walk model with drift is given by

$$y_t = y_{t-1} + a \quad + \varepsilon_t \tag{4}$$

in which ε_t is one with zero mean and independent over time. The model without drift can be obtained assuming that a=0.

The forecast k steps ahead is given by

$$E_t[\mathrm{y_{t+k}}] = \mathrm{y_t} + a * k \tag{23}$$

In addition to the aforementioned random walk models, the study will use vector autoregressive models with and without error correction mechanism. See Johansen 1995 for further details.

The choice of explanatory variables to make up the models is made based on the economic models of the eighties and nineties that served as a basis for the article of Meese and Roggoff. A review of these models can be found in Frenkel (FRENKEL, 1976), Bilson (BILSON, 1978), Dornbusch (DORNBUSCH, 1976) and Frankel (FRANKEL, 1979).

4 – Description of the database

The study sought to analyze the forecasting ability of a set of models to predict the nominal exchange rates between Real and a set of currencies. The Real-Yen, Real-Dollar and Real-Pound pairs are analyzed.

The data that constituted the bases for analysis were obtained in the DATASTREAM data system (Thomson-Reuters) and IFS-IMF (International Monetary Fund). The reasons for the choice of these currencies are important in the world. The absence of the Euro is due to the relatively small sample.

Data were collected for all the countries on quarterly bases, for the 1995-2011 period. These data included: Exchange Rate, Gross Domestic Product, Monetary Aggregates M1 and M2, IPC (Consumer Price Index). The net foreign asset position was only drawn up for Brazil.

The data gathered from the countries were used to create thirteen combinations between models to be used in the models and to perform the projections, for comparison with the *random walk* models with and without drift. The analysis consisted of two parts. In the first half it is used to estimate the models, and the second half is used to evaluate the forecasts performed in various horizons. The exercise performed simulates a real-time operation, using all the information available at the time of the generation of the forecast to estimate the parameters of the estimated models, i.e., the models were reestimated at each point.

In each model it generated forecasts for up to 6 quarters (a year and a half). All the projections performed by the models were grouped according to time horizons used for the projections. Thus there were 6 groups, one with the projections for a quarter generated by all models, the other group with the projections of two quarters, and so on. The model confidence set was used for each grouping to select the best group of projections. The data of the international investment position were gathered in Milesi-Ferretti (MILESI-FERRETTI and LANE, 2001) and updated in IFS-FMI.

All the models were estimated using the STATA-12 program. The analysis of the results produced and the choice of the best models were performed via model confidence set (HANSEN, LUNDE and MASON, 2011), implemented in the Oxmetrics 5 program through the code made available by the authors at http://mit.econ.au.dk/vip_htm/alunde/MULCOM/MULCOM.HTM.

5 - RESULTS

The outcomes of the forecasting exercises performed are reported in this section. A total of 291 systems were created for the analysis whose detailed description can be found in table 8, in the appendix. The models used all the possible combinations of econometric techniques with autoregressive vectors and a set of information described in the previous section. In addition, a model with and without projection bias correction was estimated for each model. An example of application made to Brazil is provided by Issler and Lima (ISSLER and LIMA, 2007).

The projections were performed for a sample of quarterly data for the 1995-2011 time span, with a total of 64 data.

The sample was split in half. The second part was used to assess the projections generated. Projections were performed for 1, 2, 3 and 4 quarters after the estimation of the model. The value projected for 1 quarter was included in the sample, the model was executed once again and new projections were performed up to the possible projection limit for the various time horizons. After this all the projections were submitted to the MCS analysis.

The results obtained are summarized in Tables 1, 2 and 3:

Table 1 – Best models – Brazil – Japan

	PROJECTIONS OF THE STRUCTURAL MODELS - BRAZIL x JAPAN					
Horizon	1	2	3	4	5	6
	Large group of models with random walk included	Large group of models with random walk included	Random walk with drift	Random walk with drift	Random walk with drift	Random walk with drift
						var1_cs_b_n
					var1_ss_b_n	var1_ss_b_n
					var1_ss_p_b_n	var1_ss_p_b_n
						var3_cs_b_n
					var3_ss_b_n	var3_ss_b_n
					var5_cs_b_n	var5_cs_b_n
					var5_ss_b_n	var5_ss_b_n
						vec8_cs_b_n
					var8_ss_b_n	vec8_ss_b_n

Source: prepared by the author

In the Brazil-Japan system, for the horizons of projections of 1 and 2 quarters the results are inconclusive on the choice of a model. For the horizon of 3 and 4 quarters the random walk with drift was the best model. Several models occurred for 5 and 6 quarters, but with the presence of random walk with drift between them.

Table 2 - Best models – Brazil – United Kingdom

	PROJECTIONS OF THE STRUCTURAL MODELS - BRAZIL x UNITED KINGDOM					
Horizon	1	2	3	4	5	6
	Large group of models with random walk included	Random walk with drift	Large group of models with random walk included	Large group of models with random walk included	Large group of models with random walk included	Large group of models with random walk included

Source: prepared by the author

In the Brazil - United Kingdom system, for the period of 2 quarters, the best model was the random walk with drift, while for the other periods the results were inconclusive, for the choice of a model.

Table 3 - Best models – Brazil – United States

	PROJECTIONS OF THE STRUCTURAL MODELS - BRAZIL x UNITED STATES					
Horizon	1	2	3	4	5	6
	Random walk with drift	Large group of models with random walk included	Large group of models with random walk included	Random walk with drift		
				var3_ss_b_n		
				var4_cs_b_n		
				var4_ss_b_n		
				var5_cs_b_n		
				var5_ss_b_n		
				var8_cs_b_n	var8_cs_b_n	
				var8_ss_b_n	var8_ss_b_n	var8_ss_b_n

Source: prepared by the author

With the models for the Brazil – United States case, for the horizon of 1 quarter, random walk with drift managed to surpass the others. The forecast of the random walk with drift dominates all the others. In horizons 2 and 3, a wide array of models was selected that included random walk with drift.

For the horizon of quarters, various models were selected as finalists, including the random walk com drift. In terms of forecast errors, the random walk model was the one with the least forecast error.

For the horizons of 5 and 6 quarters neither random walk with or without drift were selected.

The tables below show the results in terms of. The random walk with drift model is not selected as best only in the longer horizons.

Table 4 – Best models – Mean squared error

PROJECTIONS OF THE STRUCTURAL MODELS – MEAN SQUARED ERROR

	1 quarter	2 quarters	3 quarters	4 quarters	5 quarters	6 quarters
Brazil x JP	RW with drift	RW with drift	RW with drift	RW with drift	RW with drift	RW with drift
Brazil x UK	RW with drift	RW with drift	RW with drift	var8_cs_b_n	var8_ss_b_n	var8_ss_b_n
Brazil x USA	RW with drift	RW with drift	RW with drift	RW with drift	var8_ss_b_n	var8_ss_b_n

Source: prepared by the author

The study by Rossi (ROSSI, 2013), verifies that there is prediction power of some models, which manage to surpass the *random walk* satisfactorily for VAR models, for models that use NFA and for the Taylor series. Efficiency is more of an item in long time horizons.

In this study, the models that surpassed the *random walk* were the projections for the time horizons of 3 quarters and 4 quarters for the United Kingdom and of 4 quarters for the United States, coinciding with the study by Rossi (ROSSI, 2013) which also identifies efficiency for the longer time horizons. In all the cases, the same model prevailed and there was forecasting bias correction.

6 - CONCLUSION

The study by Meese and Rogoff (MEESE and ROGOFF, 1983) launched a challenge to econometric analysis, in the search for models capable of surpassing the *random walk* as an exchange rate predictor.

Numerous studies conclude that the models tend to produce successful projections more often in longer time horizons, while for shorter horizons the task becomes more difficult. The results obtained in the models of this study corroborate the literature analyzed and confirm that the *random walk* model effectively surpasses the projection quality of any other structural models used.

This study analyzed the exchange rate projection possibilities using structural models for macroeconomic variables of Brazil against Japan, the United States and the United Kingdom.

In this study the participants selected the models with best forecasting ability through the model confidence set method. The results of Meese and Rogoff (MEESE and ROGOFF, 1983) were confirmed for Brazil in the shorter forecasting horizon. In longer horizons, the forecasts of the random walk model are not necessarily the best, losing ground to models with prediction that use forecasting bias correction. Such a result suggests that the presence of structural changes in the mean can explain the poor performance of traditional models in the forecast of the Brazilian exchange rate.

7 - BIBLIOGRAPHY

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ATTACHMENT 1

Table 5 - VARIABLES - BRAZIL x JAPAN

VARIABLE	**DESCRIPTION**
Lipcbr	Consumer Price Index – Brazil
Lbrer	Exchange rate R$/¥$
Lbrgdp	Gross national product of Brazil
lbrm1	Monetary Aggregate M1 – Brazil
lbrm2	Monetary Aggregate M2 – Brazil
Nfabr	Net foreign assets in relation to the gross domestic product - Brazil
ljpm1	Monetary Aggregate M1 – Japan
Ljpgdp	Gross national product of Japan
ljpm2	Monetary Aggregate M2 – Japan
Lbrjpgdp	Difference between the GDPs of Brazil and Japan
lbrjpm1	Difference between the M1 of Brazil and Japan
lbrjpm2	Difference between the M2 of Brazil and Japan
Lipcjp	Consumer Price Index – Japan

Table 6 - VARIABLES - BRAZIL x UNITED KINGDOM

VARIABLE	DESCRIPTION
lipcbr	Consumer Price Index – Brazil
lbrer	Exchange rate of Brazil in relation to the United Kingdom
lbrgdp	Gross national product of Brazil
lbrm1	Monetary Aggregate M1 – Brazil
lbrm2	Monetary Aggregate M2 – Brazil
nfabr	Net foreign assets in relation to the gross domestic product - Brazil
lukm1	Monetary Aggregate M1 - United Kingdom
lukgdp	Gross domestic product of the United Kingdom
lukm2	Monetary Aggregate M2 - United Kingdom
lbrukgdp	Difference between the GDP of Brazil and the United Kingdom
lbrukm1	Difference between the M1 of Brazil and the United Kingdom
lbrukm2	Difference between the M2 of Brazil and the United Kingdom
lipcuk	Consumer Price Index - United Kingdom

Table 7 - VARIABLES - BRAZIL x UNITED STATES

VARIABLE	DESCRIPTION
lipcbr	Consumer Price Index – Brazil
lbrer	Exchange rate of Brazil in relation to the United States
lbrgdp	Gross national product of Brazil
lbrm1	Monetary Aggregate M1 – Brazil
lbrm2	Monetary Aggregate M2 – Brazil
nfabr	Net foreign assets in relation to the gross domestic product - Brazil
lusm1	Monetary Aggregate M1 - United States
lusgdp	Gross domestic product of the United States
lusm2	Monetary Aggregate M2 - United States
lbrusgdp	Difference between the GDP of Brazil and the United States
lbrusm1	Difference between the M1 of Brazil and the United States
lbrusm2	Difference between the M2 of Brazil and the United States
lipcus	Consumer Price Index - United States

Table 8 – GROUPS OF DATA

GROUP OF DATA	**BRAZIL - JAPAN**	**BRAZIL - UNITED KINGDOM**	**BRAZIL - UNITED STATES**
[1]	lbrer ljpgdp lbrgdp lbrm1 ljpm1	lbrer lukgdp lbrgdp lbrm1 lukm1	lbrer lusgdp lbrgdp lbrm1 lusm1
[2]	lbrer ljpgdp lbrgdp lbrm2 ljpm2	lbrer lukgdp lbrgdp lbrm2 lukm2	lbrer lusgdp lbrgdp lbrm2 lusm2
[3]	lbrer lbrjpgdp lbrjpm1	lbrer lbrukgdp lbrukm1	lbrer lbrusgdp lbrusm1
[4]	lbrer lbrjpgdp lbrjpm2	lbrer lbrukgdp lbrukm2	lbrer lbrusgdp lbrusm2
[5]	lbrer lbrm1 ljpm1	lbrer lbrm1lukm1	lbrer lbrm1lusm1
[6]	lbrer lbrm2 ljpm2	lbrer lbrm2 lukm2	lbrer lbrm2 lusm2
[7]	lbrer lbrm1 ljpm1 lbrir ljpir	lbrer lbrm1 lukm1 lbrir lukir	lbrer lbrm1 lusm1 lbrir lusir
[8]	lbrer lbrjpm1 lbrjpir	lbrer lbrukm1 lbrukir	lbrer lbrusm1 lbrusir
[9]	lbrer lipcbr lipcjp	lbrer lipcbr lipcuk	lbrer lipcbr lipcus
[10]	lbrer	lbrer	lbrer