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Abstract

This paper re-examines the UIP relation by estimating first a benchmark linear Cointegrated VAR including the nominal exchange rate and the interest rate differential as well as central bank announcements, and then a Cointegrated Smooth Transition VAR (CVSTAR) model incorporating nonlinearities and also taking into account the role of interest rate expectations. The analysis is conducted for five inflation targeting countries (the UK, Canada, Australia, New Zealand and Sweden) and three non-targeters (the US, the Euro-Area and Switzerland) using daily data from January 2000 to December 2020. We find that the nonlinear framework is more appropriate to capture the adjustment towards the UIP equilibrium, since the estimated speed of adjustment is substantially faster and the short-run dynamic linkages are stronger. Further, interest rate expectations play an important role: a fast adjustment only occurs when the market expects the interest rate to increase in the near future, namely central banks are perceived as more credible when sticking to their goal of keeping inflation at a low and stable rate. Also, central bank announcements have a more sizeable short-run effect in the nonlinear model. Finally, UIP holds better in inflation targeting countries, where monetary authorities appear to achieve a higher degree of credibility.

JEL-Codes: C320, F310, G150.

Keywords: UIP, exchange rate, nonlinearities, asymmetric adjustment, CVAR (Cointegrated VAR), CVSTAR (Cointegrated Smooth Transition VAR), interest rate expectations, interest rate announcements.

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1. Introduction

Uncovered Interest Rate Parity (UIP) is one of the central tenets of international finance; it links interest rate differentials to expected exchange rate changes, and, in particular, it predicts that high yield currencies should depreciate. Various methods have been used to test it empirically; these include simple Ordinary Least Squares (OLS) for estimating the slope coefficient in the UIP relation in early studies (see, for instance, Froot and Thaler, 1990; Engel, 1996), equilibrium-correction models of the term structure (Clarida and Taylor, 1997) and cointegration tests between UIP and PPP to account for the interaction of goods and capital markets (Johansen and Juselius, 1992). Most empirical papers reject the validity of UIP in the short run (see Engel, 1996; Sarno, 2005; Banerjee and Singh, 2006), and in some cases even in the long run (Lothian, 2016). These findings represent a puzzle for which a range of explanations have been offered, such as the existence of a time-varying risk premium (Li et al., 2012; Jiang et al., 2013), the occurrence of rational bubbles (Obstfeld, 1987; Canterbery, 2000), or deviations from rationality of market participants (Gregory, 1987; Chinn and Quayyum, 2012).

While there is plenty of evidence on whether or not UIP holds under various monetary policy regimes (Lacerda et al., 2010), in the case of inflation targeting the existing studies only consider emerging markets (Coulibaly and Kempf, 2019). The present paper instead examines this issue using daily data for five inflation targeting developed countries, namely the UK, Canada, Australia, New Zealand and Sweden, over the period from January 2000 to December 2020; for comparison purposes, the analysis is also carried out for three economies with alternative monetary regimes, namely the US, the Euro-Area and Switzerland (Neumann and Von Hagen, 2002). More precisely, first a linear Cointegrated Vector Autoregressive (CVAR) benchmark model (Juselius, 2018) is estimated for the UIP relation; its specification also takes into account the effects of central bank announcements of interest rate changes on the exchange rate and the interest rate differential. However, the more recent literature suggests the possible presence of nonlinearities in the UIP relation; for instance, Smooth Transition Regression models have been found to outperform linear ones in explaining the UIP puzzle (Sarno et al., 2006; Li et al., 2013). Therefore a Cointegrated Smooth Transition Vector Autoregressive (CVSTAR) model (Ripatti, 2001) is also estimated; the transition variable is interest rate expectations, which is an indicator of central bank credibility often neglected in empirical studies on inflation targeting despite its possible importance.

The layout of this paper is as follows. Section 2 briefly reviews the relevant literature; Section 3 outlines the methodology; Section 4 presents the data and discusses the empirical results; Section 5 offers some concluding remarks.

2. Literature Review

The validity of UIP has been investigated in numerous papers and from various angles. Estimation methods range from simple linear regressions (Lothian and Wu, 2011; Moore and Roche, 2010) to more complex multivariate nonlinear models (Sarno et al., 2005). As for cointegration tests, several studies have carried them out to analyse the linkages between spot and forward exchange rates and have provided mixed evidence for the empirical validity of CIP (Covered Interest Rate Parity– e.g., Brenner and Kroner, 1995; Zivot, 2000; Clarida et al., 2003); by contrast, there exists only a relatively small set of papers assessing UIP by testing for cointegration between exchange rates and interest rate differentials – again the results have been mixed (Georgoutsos, and Kouretas, 2002; Weber, 2006).

The more recent literature emphasises the importance of taking into account nonlinearities when investigating the UIP relation. For instance, Lyons (2001) estimated a nonlinear model in which deviations of UIP are highly persistent; this finding is explained by the lower Sharpe ratio of the forward rates, which move trade to more lucrative investment opportunities. Sarno et al. (2005) suggested that the forward bias commonly observed in the empirical literature might be a less suitable explanation of forward market inefficiencies than previously assumed. They applied a Smooth Transition Regression (STR) model and found evidence of significant nonlinearities in the UIP relation; in particular, asymmetric deviations from UIP are found to be small, but more persistent, the closer they are to the UIP equilibrium. Baillie and Kilic (2006) analysed nonlinearities in the context of a Logistic Smooth Transition Regression (LSTR) of the spot exchange rate and the lagged forward premium model with different transition variables; their results imply a nonlinear relation, with forward premium being the transition variable. Sarno et al. (2006) estimated a Smooth Transition Regression model for UIP with the expected excess return as the transition variable and also found that deviations from UIP exhibit significant nonlinearities. Using a LSTR model with the risk-adjusted forward premium as the transition variable, Amri (2008) found evidence of nonlinearities in the relation between expected exchange rate changes and the lagged forward premium. Applying the same

methodology, but with different transition variables related to currency trading strategies, Baillie and Chang (2011) showed that UIP holds only when carry trade strategies are perceived as profitable - when they are not, their results confirm those of Lyons (2001) and provide additional support for nonlinearities in the UIP relation. Li et al. (2013) followed a similar approach and found empirical support for UIP when using exchange rate volatility and the Sharpe ratio as transition variables, but not when using instead the interest rate differential.

Another issue investigated more recently in the context of UIP is the role of interest rate expectations, which had been found previously to affect the slope of the yield curve (Cook and Hahn, 1990), financial ratios (Chen and Ainina, 1994) and the exchange rate (Mauleón, 1998). Juselius and Stillwagon (2018) reported that interest rate forecasts are the primary source of deviations from the exchange rate and interest rate equilibrium and found an important role for speculative bubbles. Several studies provide evidence that central bank announcements strongly influence interest rate expectations (Moniz and De Jong, 2014), and that some central banks even use the content of their announcements intentionally to influence interest rate expectations (Tietz, 2019). Announcements containing policy rate decisions have been found to have a particularly strong effect on asset prices, including the exchange rate and interest rate, compared to other types of announcements (Sager and Taylor, 2004; Rosa and Verga, 2018).

3. Empirical Methodology

In order to investigate the issues of interest, as a first step we estimate a linear Cointegrated VAR as in Juselius (2018) for the UIP relation. This model requires all endogenous variables to be integrated of the same order to carry out cointegration analysis. Therefore, to establish if this condition is satisfied, prior to the estimation we perform unit root tests for the individual series, specifically the Dickey Fuller Generalised Least Squares (DF-GLS) and the Kwiatkowski–Phillips–Schmidt–Shin (KPSS) tests.

a. The Cointegrated VAR (CVAR) Model

The standard linear Cointegrated VAR model takes the following general form:

$$\Delta x_t = \Pi x_{t-1} + \sum_{i=1}^{q} \Gamma_i \Delta x_{t-i} + \Phi D_t + \varepsilon_t \quad (1)$$

where x_t is a vector with the series under examination, Δ is the difference operator, $\Pi = \theta\beta'$ is a matrix given by the product of two vectors including the adjustment and the cointegrating coefficients respectively, Γ_i is the coefficient matrix of the parameters governing the short-run behaviour of the variables, D_t is a vector of exogenous dummy variables and Φ the corresponding coefficient matrix. The model has r cointegrating relations and p endogenous variables; if cointegration holds, whenever the endogenous variables are pushed away from the long-run equilibrium by exogenous shocks, they gradually revert to it, the size of the coefficient θ representing the adjustment speed. Our empirical CVAR model is specified as follows:

$$\begin{aligned} \Delta s_t &= \theta\beta' x_{t-1} + \sum_{i=1}^{q} \gamma_{11,i} \Delta s_{t-i} + \sum_{i=1}^{q} \gamma_{12,i} \Delta \tilde{\imath}_{t-i} + \varphi_1 d_p + \varphi_2 d_n + \varepsilon_t \\ \Delta \tilde{\imath}_t &= \theta\beta' x_{t-1} + \sum_{i=1}^{q} \gamma_{21,i} \Delta s_{t-i} + \sum_{i=1}^{q} \gamma_{22,i} \Delta \tilde{\imath}_{t-i} + \varphi_1 d_p + \varphi_2 d_n + \varepsilon_t \end{aligned} \quad (2)$$

where s_t is the nominal exchange rate, $\tilde{\imath}_t = i_t - i_t^*$ is the difference between the domestic and foreign interest rates, and d_p and d_n are two dummies corresponding respectively to the announcement dates for interest rate increases and decreases – they are set equal to 1 on the announcement date and 0 elsewhere and only enter the short-run deterministic component of the model, thus capturing the transitory impulse effects of policy changes without affecting the long-run UIP mechanism (Juselius, 2018). All other variables are defined as before. The lag length is chosen using appropriate lag selection criteria, such as the Likelihood-Ratio (LR) Test, to select the most parsimonious specification which ensures that there is no serial correlation.

When estimating a CVAR model, there are two important issues to consider to specify it correctly. One is whether or not deterministic trends should be included in the short-run dynamics and/or the long-run equilibrium relations. In our case they are not required, since the exchange rate and interest rates tend to have a zero mean growth rate and any trending behaviour should be stochastic. The other issue is that model identification is only possible when appropriate restrictions are placed on the model parameters. Long-run restrictions have

to satisfy the identification rank conditions for the model (Juselius, 2018). In order for economic identification of the short-run structure to be possible, the residuals need to be uncorrelated. Therefore, we perform the Breusch-Godfrey Lagrange Multiplier (LM) test for residual serial correlation. In addition, we test the CVAR models for their stability.

b. The Smooth Transition Cointegrated VAR Model

Linear models might be unsuitable for the UIP relation as the error correction coefficient might change in a nonlinear fashion. Therefore, a nonlinear Cointegrated Smooth Transition Vector Autoregressive (CVSTAR) model (Ripatti, 2001), which allows for asymmetric dynamic adjustment to the UIP equilibrium relationship, might be more appropriate. The general model takes the following form:

$$\Delta x_t = \theta\beta' x_{t-1} \cdot G(z_t) + \left(\sum_{i=1}^{q} \Gamma_i \, \Delta x_{t-i}\right) \cdot G(z_t) + \Phi D_t \cdot G(z_t) + \varepsilon_t \qquad (3)$$

where x_t is the $(m \times 1)$ vector of the series of interest, Δ is again the difference operator, Γ_i is the $(m \times m)$ matrix of the short-run coefficients, D_t is a vector of dummy variables with a parameter matrix Φ, and as before the θ and β vectors include the adjustment speed and cointegrating coefficients respectively. $G(z_t) = diag\{G_1(\gamma_1, c_1, z_t), \dots, G_m(\gamma_m, c_m, z_t)\}$ is the transition function, where γ is the slope parameter, c is the transition value and z_t is the transition variable. The transition function allows the parameters of the model to change smoothly from one regime to the next as a function of the transition variable z_t.

The transition variable in our empirical specification is the change in the 30-day interest rate, which can be seen as an indicator of changes in interest rate expectations. Central bank meetings and decisions about changes in the interest rate generally occur in monthly cycles. Therefore the 30-day interest rate should not vary greatly over the span of a month if interest rate expectations are aligned with the official monetary policy rate (Connolly and Kohler, 2004). If instead it does, this implies a change in market expectations of the monetary policy rate in the near future and can indicate that the central bank is not perceived as fully credible. The empirical model corresponding to equation (3) can be written as follows:

$$\Delta s_t = \theta\beta' x_{t-1} \cdot G(z_t) + \left(\sum_{i=1}^{q} \gamma_{11,i}\, \Delta s_{t-i} + \sum_{i=1}^{q} \gamma_{12,i}\, \Delta \tilde{\imath}_{t-i}\right) \cdot G(z_t) + \left(\varphi_1 d_p + \varphi_2 d_n\right) \cdot G(z_t) + \varepsilon_t$$

$$\Delta \tilde{\imath}_t = \theta\beta' x_{t-1} \cdot G(z_t) + \left(\sum_{i=1}^{q} \gamma_{21,i}\, \Delta s_{t-i} + \sum_{i=1}^{q} \gamma_{22,i}\, \Delta \tilde{\imath}_{t-i}\right) \cdot G(z_t) + \left(\varphi_1 d_p + \varphi_2 d_n\right) \cdot G(z_t) + \varepsilon_t \quad (4)$$

where all variables are defined as before. The lag length is chosen using the Likelihood-Ratio (LR) Test to select the most parsimonious specification which ensures that there is no serial correlation.

c. Testing for Smooth Transition Nonlinearity

An important step prior to the estimation of the nonlinear model is performing nonlinearity tests. A suitable one in our case is a test for linearity against a STAR-type model. The null is that $\gamma = 0$ versus $\gamma > 0$, where γ is the slope parameter, which indicates the smoothness of the transition from one regime to another. Teräsvirta and Yang (2014) report that Rao's F statistic has better finite sample properties than other tests. The test statistic for the hypothesis $H_0: \theta = \theta_0$ is $RSS = S(\theta_0)'[I(\theta_0)]^{-1}S(\theta_0)$, where S is the score vector and I is the Fisher information matrix. This test follows a chi-square distribution with r degrees of freedom, where r is the number of parameter vectors (Rao, 1948). If linearity is rejected against a smooth transition nonlinearity type, one then also tests for the type of transition function. This is done by choosing a transition variable and then performing a test of the shape of the transition function. The test is based on a conventional STAR model, which can be expressed as follows:

$$y_t = \pi' X_t + F(z_{t-d}, \gamma, c) + \Theta' X_t + u_t \quad (5)$$

where $X_t = (1, y_{t-1}, \dots, y_{t-p})$ and $F(z_{t-d}, \gamma, c)$ is the transition function, z_{t-d} is the transition variable, γ is the smoothness parameter and c is the transition value. STAR-type models can either be logistic or exponential. The first order logistic transition function is:

$$F(z_{t-d}, \gamma, c) = [1 - \exp\{-\gamma(z_{t-d} - c)^2\}] \quad (6)$$

and the exponential transition function is:

$$F(z_{t-d}, \gamma, c) = \left[\{1 + \exp(-\gamma\,(z_{t-d} - c))\}^{-1} - \frac{1}{2}\right] \tag{7}$$

After the null of linearity is rejected one has to choose between a logistic and exponential transition function. For this purpose, Escribano and Jordá (2001) suggest a selection process based on the below auxiliary regression, which is a 4th order Taylor approximation of the generic transition function $F(z_{t-d}, \gamma, c)$:

$$y_t = \delta_0 + \delta_1'\tilde{x}_t + \beta_1'\tilde{x}_t z_{t-d} + \beta_2'\tilde{x}_t z_{t-d}^2 + \beta_3'\tilde{x}_t z_{t-d}^3 + \beta_4'\tilde{x}_t z_{t-d}^4 + \vartheta_{3t} \tag{8}$$

Using an F-test, the following hypotheses are tested:

$$H_{0_3}: \beta_3' = 0$$
$$H_{0_2}: \beta_2' = 0 \mid \beta_3' = 0$$
$$H_{0_1}: \beta_1' = 0 \mid \beta_2' = \beta_3' = 0$$

Escribano and Jordá (2001) suggest the use of an F-test to test the null hypothesis $H_{0_L}: \beta_2' = \beta_4' = 0$ and to obtain the p-value for the test statistic F_L, and also to test the null hypothesis $H_{0_L}: \beta_1' = \beta_3' = 0$ and obtain the p-value for the test statistic F_E. If the p-value of F_E is the minimum p-value, a logistic model should be selected; otherwise, the exponential model is more appropriate. We follow the method proposed by Escribano and Jordá (2001 – EJ henceforth) to select the most suitable transition function for each model.

d. Misspecification Tests for Smooth Transition Models

Nonlinear smooth transition models can suffer from several types of misspecification. Eitrheim and Teräsvirta (1996) develop parametric testing procedures with desirable power properties to address these issues in smooth transition models. The first is a test of no additional nonlinearity, which is an LM-type test of the null of remaining nonlinearity against the alternative of no remaining nonlinearity. The second is a parameter constancy test, which is also an LM-type test. The third is an LM test of the serial independence of the error (Lukkonen and Teräsvirta, 1988).

4. Data and Empirical Results

a. Data Description

We use daily data from 1st January 2000 to 31st December 2020 for five inflation targeting countries (the UK, Canada, Australia, New Zealand and Sweden) and also for three non-inflation targeting economies (the US, the Euro-Area and Switzerland; Neumann and Von Hagen, 2002). The nominal exchange rate series are obtained from the Pacific Exchange Rate Service database. The interest rate series and their sources are the following: for the UK the series used is the Bank of England Overnight London Interbank Offered Rate (LIBOR) based on the British Pound which is obtained from the Federal Reserve Bank of St Louis economic database; for Canada the series is the Bank of Canada Overnight Repo Rate taken from the Bank of Canada statistics database; for Australia it is the Reserve Bank of Australia Interbank Overnight Cash Rate retrieved from the Reserve Bank of Australia statistics database; for New Zealand it is the Reserve Bank of New Zealand Interbank Overnight Cash Rate reported in the Reserve Bank of New Zealand statistics database; for Sweden it is the Swedish Riksbank Deposit Rate from the Riksbank statistics database; for the US it is the Treasury Overnight London Interbank Offered Rate (LIBOR) based on the US Dollar, for Switzerland the Swiss National Bank Overnight London Interbank Offered Rate (LIBOR) based on the Swiss Franc, both series coming from the Federal Reserve Bank of St Louis economics database; finally, for the Euro-Area we use the European Central Bank EMU Convergence criteria daily interest rate series obtained from Eurostat. Central bank announcement dates are collected from the Bloomberg release calendars for individual central banks and include announcements of both positive and negative interest rate changes. The data for all 30-day interest rate series are obtained from Bloomberg. For the UK, the series is the 1-month LIBOR rate for the British pound; for Canada, the series is the 1-month Canadian banker acceptance rate; for Australia and New Zealand, the series are the 30-day interbank cash rate future contract; for Sweden, it is the 1-month interbank offered rate; for the US the 30-day Federal funds future rate; for the Euro-Area the 1-month EURIBOR rate; finally, for Switzerland the 1-month LIBOR for the Swiss franc. Daily changes are included in the model as a measure of changes in the expected interest rate over the following month.

b. Unit Root and Cointegration Tests

We first perform the DF-GLS and KPSS unit root tests on the nominal exchange rate and the interest rate differential series. The results of these tests are reported in Tables 1a and 1b and confirm that all series are integrated of order $I(1)$.

Table 1. Unit Root Test Results

	DF-GLS Test		KPSS Test	
	Level series	**Differenced series**	**Level series**	**Differenced series**
Nominal Exchange Rates				
GBPCAD	-1.981	-15.484***	89.2***	0.042
GBPAUD	-1.906	-16.760***	103***	0.0676
GBPNZD	-2.616	-16.538***	68.8***	0.0315
GBPSEK	-2.314	-14.824***	94.7***	0.0326
CADAUD	-2.532	-13.089***	51.3***	0.0292
CADNZD	-2.741	-15.218***	32.2***	0.0282
CADSEK	-2.241	-15.186***	17.4***	0.0181
AUDNZD	-2.524	-14.633***	80.7***	0.0382
AUDSEK	-2.789	-13.267***	59.2***	0.0203
NZDSEK	-2.033	-15.562***	19***	0.0133
USDEUR	-1.553	-14.132***	149***	0.0675
USDCHF	-2.005	-15.993***	140***	0.029
EURCHF	-1.598	-16.754***	97.7***	0.0653
Interest Rate Differentials				
UK-Canada	-2.038	-17.027***	40.5***	0.0061
UK-Australia	-0.056	-16.351***	133***	0.0105
UK-New Zealand	-0.443	-17.102***	123***	0.0031
UK-Sweden	-1.007	-15.722***	61.7***	0.0587
Canada-Australia	-0.357	-16.056***	138***	0.0407
Canada-New Zealand	-0.463	-17.295***	108***	0.0084
Canada-Sweden	-0.921	-16.653***	64.5***	0.0219
Australia-New Zealand	-1.517	-17.606***	74.7***	0.0098
Australia-Sweden	-0.261	-16.425***	29.8***	0.0249
New Zealand-Sweden	-0.276	-17.566***	35.3***	0.119
US- Euro Area	-0.852	-12.248***	119***	0.0782
US-Switzerland	-1.811	-17.526***	116***	0.0019
Euro Area-Switzerland	-2.231	-16.243***	25.3***	0.0012

*** significant at 1% level

DF-GLS:
H_0: variable contains a unit root
H_1: variable is stationary

KPSS:
H_0: variable is trend stationary
H_1: variable is not trend stationary

Therefore, we proceed to test for cointegration between the series. The results of the Johansen cointegration trace and eigenvalue tests are reported in Table 2 and show that the cointegration

rank is r = 1, i.e. there exists a single cointegration relation in each case which can be interpreted as the UIP equilibrium.

Table 2. Johansen Trace and Eigenvalue Tests for Cointegration

	Trace Test		Eigenvalue Test	
	Test 1	**Test 2**	**Test 1**	**Test 2**
UK-Canada	0.0003***	0.4879	0.0001***	0.4879
UK-Australia	0.0129**	0.9323	0.0023***	0.9323
UK-New Zealand	0.0130**	0.4064	0.0103***	0.4064
UK-Sweden	0.0022**	0.2151	0.0012***	0.6755
Canada-Australia	0.0252**	0.5501	0.0149***	0.5501
Canada-New Zealand	0.0246**	0.5144	0.0014***	0.5186
Canada-Sweden	0.0364**	0.8298	0.0068***	0.2032
Australia-New Zealand	0.0006***	0.6791	0.0001***	0.6791
Australia-Sweden	0.0005***	0.5822	0.0019***	0.1831
New Zealand-Sweden	0.0185**	0.9249	0.0037***	0.9249
US-Euro Area	0.0057***	0.3192	0.0005***	0.9924
US-Switzerland	0.0000***	0.5672	0.0000***	0.5672
Euro Area-Switzerland	0.0000***	0.6506	0.0000***	0.6506

Trace Test:
Test 1: $H_0: r = 0;\ H_1: r = 1$; 95% Critical value: 25.87
Test 2: $H_0: r \leq 1;\ H_1: r = 2$; 95% Critical value: 12.52

Eigenvalue Test:
Test 1: $H_0: r = 0;\ H_1: r = 1$; 95% Critical value: 19.39
Test 2: $H_0: r \leq 1;\ H_1: r = 2$; 95% Critical value: 12.52

r denotes the cointegration rank and number of significant vectors. P-vales reported for all.

c. Results for the Linear CVAR Model

Table 3 reports the results of LR tests to determine the optimal lag length for each CVAR model.

Table 3. Lag Selection in the CVAR Model

Lag	**GBPCAD**	**GBPAUD**	**GBPNZD**	**GBPSEK**	**CADAUD**	**CADNZD**	**CADSEK**
1	202.52	281.66	378.38	157.26	34.535	575.39	31.95
2	111.79	148.31	112.84	75.801	35.189	63.019	3.7235*
3	84.766*	90.054*	125.91	41.771	16.667	98.968*	1.0889
4	83.636	92.736	88.224	36.602	27.725	38.668	3.857
5	25.886	25.359	27.667	9.5262*	1.961*	16.924	0.749
6	44.641	59.112	58.974*	34.912	8.4577	9.7212	4.657
Lag	**AUDNZD**	**AUDSEK**	**NZDSEK**	**USDEUR**	**USDCHF**	**EURCHF**	
1	569.2	19.606	268.73	5.4953	789.68	791.48	
2	53.556	9.4629	11.58	28.972	243.08	212.93	
3	73.951*	4.4599*	33.226	3.1102*	100.29	79.738*	
4	64.427	16.419	16.652	14.305	263.16	278.17	
5	21.852	6.5165	9.84*	32.522	85.31*	333.98	
6	13.433	11.993	0.729	21.335	335.8	81.863	

Likelihood Ratio Test: sequential modified LR test statistic at 5%
* indicates chosen lag at which there exists no serial correlation

The estimation results for the linear Cointegrated Vector Autoregressive model are reported in Tables 4a, 4b and 4c. We find that a long-run relationship between the exchange rate and the interest rate differential exists in most cases. However, the adjustment speed is low, with a maximum value of 1.7% for the AUDNZD exchange rate. These findings indicate that deviations from UIP equilibrium are highly persistent at a daily frequency. In the short run, there is no relation between the exchange rate and the interest rate differential. Central bank announcements of an interest rate decrease generally have a negative effect on the exchange rate (an appreciation) and the interest rate differential. There is no significant difference between inflation targeting countries and the other economies.

Table 4a. Linear Cointegrated Vector Autoregressive Model Results for Non-Targeting Countries

	USDEUR		**USDCHF**		**EURCHF**	
Independent Variables	**Dependent Variables**					
	Δs_t	$\Delta \tilde{i}_t$	Δs_t	$\Delta \tilde{i}_t$	Δs_t	$\Delta \tilde{i}_t$
μ_0	0.00002	0.00021	0.00003	0.00039	0.00003	0.00017
	(0.00006)	(0.00025)	(0.00006)	(0.00181)	(0.00004)	(0.0019)
Δs_{t-1}	0.00753	-0.047	0.0273**	0.00697	0.127***	0.801
	(0.0114)	(0.05)	(0.0114)	(0.325)	(0.0114)	(0.551)
Δs_{t-2}	0.00628	0.0351	0.00788	-0.159	-0.0304***	0.118
	(0.0114)	(0.05)	(0.0114)	(0.325)	(0.0115)	(0.555)
Δs_{t-3}	-0.00048	0.0286	-0.013	0.519	-0.0164	0.0502
	(0.0114)	(0.05)	(0.0114)	(0.324)	(0.0114)	(0.551)
Δs_{t-4}			-0.0275**	0.129		
			(0.0114)	(0.324)		
Δs_{t-5}			0.0067	0.383		
			(0.0114)	(0.324)		
$\Delta \tilde{i}_{t-1}$	-0.00111	-0.0254**	0.00043	-0.444***	-0.00004	-0.365***
	(0.0026)	(0.0114)	(0.00039)	(0.0112)	(0.00024)	(0.0116)
$\Delta \tilde{i}_{t-2}$	-0.00209	-0.0599***	-0.00004	-0.295***	0.00002	-0.201***
	(0.0026)	(0.0114)	(0.00042)	(0.0119)	(0.00025)	(0.012)
$\Delta \tilde{i}_{t-3}$	0.00193	-0.0171	-0.00044	-0.234***	-0.00010	-0.100***
	(0.0026)	(0.0114)	(0.00042)	(0.0121)	(0.00024)	(0.0114)
$\Delta \tilde{i}_{t-4}$			0.00004	-0.266***		
			(0.00042)	(0.0119)		
$\Delta \tilde{i}_{t-5}$			-0.00017	-0.206***		
			(0.00039)	(0.0112)		
θ	-0.00081*	0.00008	-0.00056*	0.0118	-0.00012	0.170***
	(0.00044)	(0.0019)	(0.00033)	(0.00925)	(0.00039)	(0.0186)
d_p	0.00004	-0.0032**	0.00160***	-0.00561	0.00003	-0.00419
	(0.0003)	(0.0015)	(0.000491)	(0.014)	(0.00027)	(0.0131)
d_n	0.00026	-0.0156***	0.00259***	-0.021	0.00259***	-0.00942
	(0.0009)	(0.0039)	(0.000815)	(0.0232)	(0.00049)	(0.0236)

* significant at 10% level, ** significant at 5% level, *** significant at 1% level. Standard errors in parentheses.

Table 4b. Linear Cointegrated Vector Autoregressive Model Results for Inflation Targeting Countries

	GBPCAD		GBPAUD		CADNZD		AUDNZD		AUDSEK	
Independent Variables	**Dependent Variables**									
	Δs_t	$\Delta \tilde{\imath}_t$	Δs_t	$\Delta \tilde{\imath}_t$	Δs_t	$\Delta \tilde{\imath}_t$	Δs_t	$\Delta \tilde{\imath}_t$	Δs_t	$\Delta \tilde{\imath}_t$
μ_0	0.00004	-0.0004	0.00002	0.000069	0.000058	0.000249	0.00004	-0.00018	-0.00004	-0.00007
	(0.00006)	(0.0004)	(0.00007)	(0.00039)	(0.00007)	(0.000286)	(0.000047)	(0.00026)	(0.00007)	(0.0002)
Δs_{t-1}	0.00424	0.0819	-0.0106	-0.0918	-0.0106	-0.00956	-0.0152	0.0462	-0.0382***	-0.108***
	(0.0114)	(0.0801)	(0.0114)	(0.066)	(0.0114)	(0.0496)	(0.0114)	(0.0643)	(0.0114)	(0.0404)
Δs_{t-2}	-0.0138	0.183**	0.00969	0.00939	-0.00838	-0.0449	-0.00554	-0.0786	0.0281**	-0.036
	(0.0114)	(0.0801)	(0.0114)	(0.066)	(0.0114)	(0.0496)	(0.0114)	(0.0642)	(0.0114)	(0.0404)
Δs_{t-3}	0.015	0.113	-0.00827	0.0633	-0.00926	-0.015	-0.00888	-0.0633	-0.0246**	-0.0072
	(0.0114)	(0.0801)	(0.0114)	(0.066)	(0.0114)	(0.0495)	(0.0114)	(0.0642)	(0.0114)	(0.0404)
$\Delta \tilde{\imath}_{t-1}$	0.00002	-0.193***	-0.00264	-0.231***	-0.00257	-0.297***	0.00152	-0.300***	0.00212	-0.00134
	(0.00162)	(0.0114)	(0.00197)	(0.0114)	(0.00258)	(0.0112)	(0.00201)	(0.0113)	(0.00323)	(0.0114)
$\Delta \tilde{\imath}_{t-2}$	-0.00227	-0.134***	-0.00009	-0.161***	0.0019	-0.120***	-0.00211	-0.124***	0.00453	-0.00002
	(0.00163)	(0.0114)	(0.002)	(0.0115)	(0.00267)	(0.0116)	(0.00208)	(0.0117)	(0.00323)	(0.0114)
$\Delta \tilde{\imath}_{t-3}$	0.00169	-0.101***	-0.0006	-0.107***	-0.00356	-0.110***	-0.00254	-0.148***	-0.000345	0.00005
	(0.00161)	(0.0113)	(0.00197)	(0.0114)	(0.00258)	(0.0112)	(0.002)	(0.0113)	(0.00323)	(0.0114)
θ	0.000074	-0.0120***	-0.00144**	-0.00605*	-0.00129**	0.000702	-0.00198**	-0.0171***	-0.00237***	0.00246
	(0.00028)	(0.00196)	(0.00056)	(0.00325)	(0.000589)	(0.00255)	(0.000827)	(0.00465)	(0.000782)	(0.00277)
d_p	0.000099	-0.00064	0.000237	-0.000258	-0.000462	0.00224*	-0.000511**	0.00104	0.000121	0.000118
	(0.00024)	(0.0017)	(0.000309)	(0.00179)	(0.00030)	(0.00131)	(0.000243)	(0.00136)	(0.000301)	(0.00106)
d_n	0.000539	0.0366***	0.00201**	-0.0116**	-0.00147*	-0.0518***	-0.000161	0.0227***	0.00201***	-0.00244
	(0.00060)	(0.00421)	(0.000786)	(0.00454)	(0.000781)	(0.00339)	(0.000648)	(0.00365)	(0.000766)	(0.00271)

* significant at 10% level, ** significant at 5% level, *** significant at 1% level. Standard errors in parentheses.

Table 4c. Linear Cointegrated Vector Autoregressive Model Results for Inflation Targeting Countries

	GBPNZD		GBPSEK		CADAUD		CADSEK		AUDSEK	
Independent Variables	**Dependent Variables**									
	Δs_t	$\Delta \tilde{\imath}_t$	Δs_t	$\Delta \tilde{\imath}_t$	Δs_t	$\Delta \tilde{\imath}_t$	Δs_t	$\Delta \tilde{\imath}_t$	Δs_t	$\Delta \tilde{\imath}_t$
μ_0	0.00006	-0.00006	0.0000068	0.00001	0.00001	0.00043***	-0.00002	0.000354	-0.000074	-0.00003
	(0.00007)	(0.00045)	(0.00006)	(0.00044)	(0.00006)	(0.00015)	(0.00006)	(0.00026)	(0.00007)	(0.00034)
Δs_{t-1}	0.00828	-0.0667	0.0149	-0.123	-0.0433***	-0.0317	0.0000722	-0.0874*	-0.0214*	-0.0799
	(0.0114)	(0.0739)	(0.0114)	(0.0845)	(0.0114)	(0.0285)	(0.0114)	(0.046)	(0.0114)	(0.055)
Δs_{t-2}	-0.01	-0.0845	-0.0138	0.162*	0.0134	-0.0621**	-0.000795	0.00395	0.00314	-0.0636
	(0.0114)	(0.0738)	(0.0114)	(0.0845)	(0.0114)	(0.0285)	(0.0114)	(0.0459)	(0.0114)	(0.055)
Δs_{t-3}	0.00468	0.0193	-0.0194*	-0.0087	-0.0355***	-0.0175			-0.0174	-0.0148
	(0.0114)	(0.0738)	(0.0114)	(0.0845)	(0.0114)	(0.0284)			(0.0114)	(0.0549)
Δs_{t-4}	-0.0193*	-0.165**	-0.0199*	-0.0898	-0.0366***	-0.0182			-0.0346***	0.0102
	(0.0114)	(0.0738)	(0.0114)	(0.0845)	(0.0114)	(0.0284)			(0.0114)	(0.0549)
Δs_{t-5}	-0.00404	-0.059	-0.0135	-0.148*	0.00254	-0.0118			0.00598	-0.0152
	(0.0114)	(0.0738)	(0.0114)	(0.0845)	(0.0114)	(0.0284)			(0.0114)	(0.0549)
Δs_{t-6}	-0.00325	0.0122								
	(0.0114)	(0.0738)								
$\Delta \tilde{\imath}_{t-1}$	-0.00286	-0.285***	0.00184	-0.167***	-0.00254	-0.0483***	-0.00755***	-0.0518***	0.00118	-0.191***
	(0.00177)	(0.0114)	(0.00154)	(0.0114)	(0.0043)	(0.0107)	(0.00278)	(0.0112)	(0.00237)	(0.0114)
$\Delta \tilde{\imath}_{t-2}$	0.000159	-0.187***	0.000841	-0.115***	0.0214***	-0.0195*	0.00405	-0.0139	0.00557**	-0.0355***
	(0.00184)	(0.0119)	(0.00156)	(0.0115)	(0.0043)	(0.0107)	(0.00278)	(0.0112)	(0.00241)	(0.0116)
$\Delta \tilde{\imath}_{t-3}$	0.000822	-0.178***	-0.00058	-0.0840***	0.00193	-0.0317***			-0.00128	-0.0691***
	(0.00185)	(0.012)	(0.00157)	(0.0116)	(0.00431)	(0.0108)			(0.00241)	(0.0116)
$\Delta \tilde{\imath}_{t-4}$	-0.00167	-0.132***	-0.00105	-0.0689***	0.00778*	-0.0405***			-0.00299	-0.0288**
	(0.00185)	(0.0119)	(0.00156)	(0.0115)	(0.00431)	(0.0108)			(0.00241)	(0.0116)
$\Delta \tilde{\imath}_{t-5}$	0.00369**	-0.0803***	-0.000323	-0.0257**	0.00473	-0.00773			0.0000498	-0.00703
	(0.00183)	(0.0118)	(0.00154)	(0.0114)	(0.00431)	(0.0107)			(0.00237)	(0.0114)
$\Delta \tilde{\imath}_{t-6}$	-0.000434	-0.0873***								
	(0.00176)	(0.0114)								
θ	-0.000731	-0.00442	-0.000956*	-0.00209	-0.00290***	0.00211	-0.00369***	0.00746*	-0.00179**	0.000657
	(0.000446)	(0.00288)	(0.000529)	(0.00391)	(0.000839)	(0.00209)	(0.000946)	(0.00381)	(0.000698)	(0.00336)
d_p	0.0000431	0.00144	0.00033	-0.000196	0.000298	0.000014	0.00014	0.000156	0.000412	0.00094
	(0.000361)	(0.00233)	(0.000273)	(0.00202)	(0.000246)	(0.000614)	(0.000262)	(0.00106)	(0.000361)	(0.00174)
d_n	0.00163*	-0.00763	0.000704	-0.0170***	-0.00335***	-0.0529***	0.000297	-0.0468***	0.00230***	-0.0141***
	(0.000867)	(0.0056)	(0.000638)	(0.00472)	(0.000664)	(0.00166)	(0.000649)	(0.00261)	(0.00085)	(0.00409)

* significant at 10% level, ** significant at 5% level, *** significant at 1% level. Standard errors in parentheses.

Next we perform a series of diagnostic tests to establish whether the linear model is data congruent. These results are reported in Table 5 and show that none of the models suffer from serial correlation or parameter instability. However, given the finding of a low adjustment speed in the case of the linear models, we perform nonlinearity tests to see whether a nonlinear framework can provide stronger evidence for the empirical validity of UIP both in the short and the long run.

Table 5. Diagnostic Tests for the Linear Models

	Lag	**Breusch-Godfrey LM Test for serial correlation**	**Stability condition satisfied**
GBPCAD	3	0.51757	Stable
GBPAUD	3	0.37914	Stable
GBPNZD	6	0.22475	Stable
GBPSEK	5	0.10444	Stable
CADAUD	5	0.20724	Stable
CADNZD	3	0.05954	Stable
CADSEK	2	0.11597	Stable
AUDNZD	3	0.05554	Stable
AUDSEK	3	0.11153	Stable
NZDSEK	5	0.17796	Stable
USDEUR	3	0.28590	Stable
USDCHF	5	0.05062	Stable
EURCHF	3	0.11112	Stable

We use the Newey-West coefficient covariance matrix.
Breusch-Godfrey LM Test for serial correlation:
$H_0: no\ serial\ correlation$
$H_1: serial\ correlation$
VAR test for eigenvalue stability conditions. 'Stable' means that all eigenvalues lie inside the unit circle and the model satisfies the stability conditions

d. Nonlinearity Tests and Results of the Smooth Transition Model

We test for smooth-transition type nonlinearity by means of the Rao F-test; the results are reported in Table 6. The null of linearity is rejected for all models, which confirms that the series exhibit nonlinearities of the smooth transition type. Next we use the EJ selection method for the most appropriate transition function. The results of this test are also included in Table 6 and show in each case whether an exponential or a logistic transition function respectively should be used. Table 7 displays instead the results of the LR test used to determine the lag length for each model.

Table 6. Linearity Test: Rao F-Test; Escribano-Jordá Test and Transition Function

		Rao F-Test	Escribano-Jordá Test	Transition function
GBPCAD	Exchange Rate Equation	0.0000***	0.0000***	Exponential
	Interest Rate Equation	0.0000***	0.0000***	Logistic
GBPAUD	Exchange Rate Equation	0.0000***	0.0000***	Exponential
	Interest Rate Equation	0.0000***	0.0000***	Logistic
GBPNZD	Exchange Rate Equation	0.0000***	0.0000***	Logistic
	Interest Rate Equation	0.0000***	0.0000***	Logistic
GBPSEK	Exchange Rate Equation	0.0000***	0.0000***	Exponential
	Interest Rate Equation	0.0000***	0.0000***	Logistic
CADAUD	Exchange Rate Equation	0.0000***	0.0000***	Exponential
	Interest Rate Equation	0.0000***	0.0000***	Logistic
CADNZD	Exchange Rate Equation	0.0000***	0.0000***	Exponential
	Interest Rate Equation	0.0000***	0.0000***	Logistic
CADSEK	Exchange Rate Equation	0.0000***	0.0000***	Logistic
	Interest Rate Equation	0.0000***	0.0000***	Exponential
AUDNZD	Exchange Rate Equation	0.0000***	0.0000***	Exponential
	Interest Rate Equation	0.0000***	0.0000***	Logistic
AUDSEK	Exchange Rate Equation	0.0000***	0.0000***	Exponential
	Interest Rate Equation	0.0000***	0.0000***	Exponential
NZDSEK	Exchange Rate Equation	0.0000***	0.0000***	Exponential
	Interest Rate Equation	0.0000***	0.0000***	Logistic
USDEUR	Exchange Rate Equation	0.0000***	0.0000***	Logistic
	Interest Rate Equation	0.0000***	0.0000***	Logistic
USDCHF	Exchange Rate Equation	0.0000***	0.0000***	Exponential
	Interest Rate Equation	0.0000***	0.0000***	Exponential
EURCHF	Exchange Rate Equation	0.0000***	0.0000***	Exponential
	Interest Rate Equation	0.0000***	0.0000***	Logistic

*** significant at 1%. P-values reported for both tests.

Rao-F Test:

$H_0: linearity$

$H_1: smooth - transition\ nonlinearity$

Escribano-Jordá Test:

Logistic Transition Function:

$H_{0_L}: \beta_2' = \beta_4' = 0$

$H_{1_L}: \beta_2' \neq \beta_4' \neq 0$

Exponential Transition Function:

$H_{0_L}: \beta_1' = \beta_3' = 0$

$H_{1_L}: \beta_1' \neq \beta_3' \neq 0$

Table 7. Lag Selection for the CVSTAR Model

Lag	GBPCAD	GBPAUD	GBPNZD	GBPSEK	CADAUD	CADNZD	CADSEK
1	22.12	77.1	23.6	17.7	6.96	4.32	5.86*
2	19.48	6.14	16.16	6.52*	54.62	0.56	11.08
3	6.8*	32.4*	24.17	0.18	33.38*	9.32*	0.98
4	3.18	59.18	10.70*	3.88	4.74	2.7	3.66
5	4.06	25.12	8.724	2.46	0.56	9	3.08
6	22.12	77.1	23.6	17.7	6.96	4.32	5.86
Lag	**AUDNZD**	**AUDSEK**	**NZDSEK**	**USDEUR**	**USDCHF**	**EURCHF**	
1	14.04	129.84	16.28	5.5	6.62	7.46*	
2	3.96	13.86	13.12	19.38*	15.98*	4.98	
3	8.02*	31.14*	10.42*	42.7	8.7	97.74	
4	6.18	16.52	4.9	13.8	0.82	97.58	
5	8.5	8.56	0.06	18.4	93.62	6.82	
6	14.04	129.84	16.28	5.5	6.62	7.46	

Likelihood Ratio Test: sequential modified LR test statistic at 5%
* indicates the chosen lag at which there exists no serial correlation

The estimation results of the nonlinear model are reported in Tables 8a and 8b for the inflation targeting countries, and in Table 8c for the non-targeting ones. Unlike the linear model, the nonlinear one provides some evidence for the existence of a short-run relation between the exchange rate and the interest rate differentials in both regimes. The interest rate differential has a negative effect on the exchange rate in regime one, and a positive one in regime two, while in some countries the exchange rate affects negatively the interest rate differential in regime two. Both positive and negative central bank announcements now influence the exchange rate and the interest rate differential. Interestingly, the effect of central bank announcements on the exchange rate and the interest rate differential switches sign from one regime to the other, i.e. it appears to depend on market expectations of the interest rate. There is less evidence for a short-run relation between the exchange rate and the interest rate differential in non-targeting economies.

Table 8a. Smooth Transition Cointegrated Vector Autoregressive Model Results for Inflation Targeting Countries

	GBPCAD		GBPAUD		GBPNZD		GBPSEK		CADAUD	
Independent Variables	Dependent Variables									
	Δs_t	$\Delta \tilde{\imath}_t$	Δs_t	$\Delta \tilde{\imath}_t$	Δs_t	$\Delta \tilde{\imath}_t$	Δs_t	$\Delta \tilde{\imath}_t$	Δs_t	$\Delta \tilde{\imath}_t$
Regime 1										
μ_0	0.0002	-0.052***	0.0003	-0.028***	-0.091***	-0.034***	-0.0002*	0.013	0.001***	-0.024***
	(0.0008)	(0.005)	(0.0006)	(0.0018)	(0.005)	(0.003)	(0.0001)	(0.028)	(0.0003)	(0.002)
Δs_{t-1}	0.0127	0.557*	-0.007	-0.457***	-0.137	-0.245	-0.021	0.125***	0.256***	0.111
	(0.014)	(0.332)	(0.012)	(0.164)	(0.648)	(0.249)	(0.021)	(0.042)	(0.053)	(0.158)
Δs_{t-2}	-0.0172	1.908***	-0.013	1.122***	0.143	0.404	0.036	-0.080	0.139***	0.740***
	(0.014)	(0.364)	(0.012)	(0.197)	(0.738)	(0.297)	(0.024)	(0.067)	(0.046)	(0.198)
Δs_{t-3}	-0.0355	-0.890**	-0.005	-0.339*	0.742	-0.764**			0.243***	-5.170***
	(0.022)	(0.347)	(0.012)	(0.199)	(0.756)	(0.312)			(0.059)	(0.381)
Δs_{t-4}					-0.359	-0.871***				
					(0.714)	(0.322)				
$\Delta \tilde{\imath}_{t-1}$	-0.0018	-0.396***	-0.005**	-0.465***	-0.456***	-0.467***	0.002	0.124***	-0.067***	-0.842***
	(0.0020)	(0.041)	(0.002)	(0.027)	(0.080)	(0.038)	(0.003)	(0.019)	(0.020)	(0.247)
$\Delta \tilde{\imath}_{t-2}$	-0.0003	-0.410***	0.001	-0.523***	-0.521***	-0.663***	-0.005	0.332***	0.049***	-0.537***
	(0.0019)	(0.044)	(0.002)	(0.032)	(0.099)	(0.057)	(0.003)	(0.020)	(0.013)	(0.060)
$\Delta \tilde{\imath}_{t-3}$	0.0009	-0.104**	0.001	-0.141***	-0.345***	-0.229***			0.014	4.282***
	(0.002)	(0.044)	(0.002)	(0.033)	(0.101)	(0.047)			(0.017)	(0.665)
$\Delta \tilde{\imath}_{t-4}$					-0.390***	-0.238***				
					(0.104)	(0.048)				
θ	0.0006**	0.069***	-0.002***	0.203***	0.114***	0.169***	-0.0006	0.319***	0.009**	0.201***
	(0.0003)	(0.012)	(0.0006)	(0.015)	(0.039)	(0.021)	(0.0009)	(0.030)	(0.004)	(0.025)
d_p	-0.0009	0.012	0.001***	-0.004	-0.030	-0.017*	0.0001	-0.119***	-0.002**	0.191***
	(0.004)	(0.008)	(0.0003)	(0.005)	(0.021)	(0.010)	(0.0004)	(0.012)	(0.001)	(0.023)
d_n	-0.002***	0.011	-0.0001	-0.001	-0.048	-0.020	0.003**	-0.342	0.002	-0.053***
	(0.0008)	(0.011)	(0.0009)	(0.009)	(0.033)	(0.012)	(0.0013)	(0.881)	(0.002)	(0.015)
Regime 2										
μ_0	-0.002**	0.087***	-0.0002	0.050***	0.064***	0.058***	0.006***	-0.781***	-0.003***	0.024***
	(0.0010)	(0.008)	(0.0007)	(0.003)	(0.006)	(0.005)	(0.0002)	(0.028)	(0.0006)	(0.0019)
Δs_{t-1}	-0.1914	-0.705	0.0873	0.786***	0.363	0.450	0.098**	-0.127***	-0.582***	-0.155
	(0.1425)	(0.552)	(0.070)	(0.277)	(0.704)	(0.409)	(0.038)	(0.042)	(0.070)	(0.0016)
Δs_{t-2}	0.0645	-3.039***	1.087***	-1.908***	-0.088	-0.809	-0.140***	0.817***	-0.28***	-0.801***
	(0.132)	(0.604)	(0.311)	(0.330)	(0.786)	(0.496)	(0.043)	(0.068)	(0.093)	(0.002)
Δs_{t-3}	0.848***	1.734***	-0.231**	0.779**	-0.681	1.421***			-0.545***	5.177***
	(0.186)	(0.577)	(0.115)	(0.337)	(0.803)	(0.514)			(0.092)	(0.038)
Δs_{t-4}					0.498	1.309**				
					(0.765)	(0.542)				
$\Delta \tilde{\imath}_{t-1}$	0.0188*	0.358***	0.109***	0.476***	0.254***	0.349***	-0.0007	-0.120***	0.125***	0.806***
	(0.011)	(0.065)	(0.041)	(0.048)	(0.092)	(0.064)	(0.004)	(0.019)	(0.037)	(0.002)
$\Delta \tilde{\imath}_{t-2}$	-0.029***	0.504***	0.019	0.739***	0.432***	0.904***	0.012**	-0.328***	-0.069**	0.522***
	(0.011)	(0.070)	(0.044)	(0.056)	(0.108)	(0.093)	(0.005)	(0.020)	(0.030)	(0.061)
$\Delta \tilde{\imath}_{t-3}$	0.016	0.013	-0.095**	0.092	0.234**	0.153*			-0.023	-4.31***
	(0.018)	(0.072)	(0.044)	(0.057)	(0.110)	(0.079)			(0.033)	(0.067)
$\Delta \tilde{\imath}_{t-4}$					0.343***	0.257***				
					(0.112)	(0.080)				
θ	0.0006	-0.133***	0.005	-0.379***	-0.174***	-0.298***	-0.0013	-0.323***	-0.02***	-0.200***
	(0.003)	(0.019)	(0.006)	(0.024)	(0.041)	(0.033)	(0.002)	(0.030)	(0.0073)	(0.026)
d_p	0.0033	-0.018	-0.042***	0.012	-0.017	0.037**	0.0008	0.0011	0.003	-0.191***
	(0.005)	(0.014)	(0.014)	(0.009)	(0.023)	(0.016)	(0.0010)	(0.012)	(0.002)	(0.023)
d_n	-0.017***	-0.017	-0.013	0.007	0.056	0.027	-0.007***	0.098	-0.005	0.059***
	(0.0056)	(0.019)	(0.010)	(0.015)	(0.041)	(0.020)	(0.0019)	(0.885)	(0.004)	(0.016)

* significant at 10% level, ** significant at 5% level, *** significant at 1% level. Standard errors in parentheses.

Table 8b. Smooth Transition Cointegrated Vector Autoregressive Model Results for Inflation Targeting Countries

	CADNZD		CADSEK		AUDNZD		AUDSEK		NZDSEK	
Independent Variables	Dependent Variables									
	Δs_t	$\Delta \tilde{i}_t$	Δs_t	$\Delta \tilde{i}_t$	Δs_t	$\Delta \tilde{i}_t$	Δs_t	$\Delta \tilde{i}_t$	Δs_t	$\Delta \tilde{i}_t$
Regime 1										
μ_0	0.005***	-0.0002	0.00008	0.0007**	-0.156***	-0.034***	-0.0002	0.025	-0.0006	0.010
	(0.0002)	(0.0003)	(0.0001)	(0.0003)	(0.006)	(0.002)	(0.0009)	(0.446)	(0.0007)	(0.009)
Δs_{t-1}	0.034*	-0.0025	0.0017	0.0138	0.027***	-0.060	-0.035**	-0.066	-0.0085	0.246
	(0.021)	(0.050)	(0.0135)	(0.0555)	(0.001)	(0.437)	(0.015)	(98.843)	(0.013)	(1.413)
Δs_{t-2}	-0.025	-0.0337			0.092	-0.098	-0.129***	-0.120	-0.014	0.446
	(0.020)	(0.050)			(1.159)	(0.421)	(0.039)	(112.16)	(0.012)	(1.418)
Δs_{t-3}	0.026	-0.013			-0.016	-0.088	-0.012	1.46	-0.010	0.255
	(0.021)	(0.050)			(1.357)	(0.419)	(0.017)	(132.23)	(0.012)	(1.410)
$\Delta \tilde{i}_{t-1}$	-0.0008	-0.279***	-0.009***	-0.051***	0.096	-0.206***	0.0004	0.076	-0.0013	0.470
	(0.004)	(0.011)	(0.0034)	(0.015)	(0.271)	(0.076)	(0.005)	(108.88)	(0.003)	(0.296)
$\Delta \tilde{i}_{t-2}$	0.0014	-0.115***			0.071	-0.016	0.007	-0.146***	0.0047	0.613**
	(0.004)	(0.012)			(0.411)	(0.076)	(0.004)	(0.018)	(0.003)	(0.309)
$\Delta \tilde{i}_{t-3}$	0.003	-0.100***			0.713**	-0.067	-0.081**	-1.141***	0.0004	0.444
	(0.004)	(0.011)			(0.332)	(0.072)	(0.038)	(0.015)	(0.002)	(0.293)
θ	-0.002**	0.0021	-0.001	-0.016**	0.067	0.100***	-0.001	0.136	-0.0015	0.006
	(0.001)	(0.003)	(0.0013)	(0.0067)	(0.115)	(0.011)	(0.001)	(8.801)	(0.0008)	(0.086)
d_p	0.0009	0.0014	-0.0002	0.0011	-0.041	0.023**	0.0005	0.010	0.0002	-0.02
	(0.0005)	(0.001)	(0.0003)	(0.0013)	(0.032)	(0.009)	(0.0005)	(6.619)	(0.0004)	(0.045)
d_n	-0.004***	-0.012***	0.003***	0.025***	0.121**	-0.035	0.0009	-0.095	0.0029**	0.052
	(0.0013)	(0.004)	(0.0008)	(0.0032)	(0.055)	(0.028)	(0.0010)	(5.576)	(0.0011)	(0.108)
Regime 2										
μ_0	-0.002***	0.016***	-0.0004**	-0.014***	0.015**	0.038***	-0.0004	-0.016	0.0004**	0.010
	(0.0005)	(0.003)	(0.0002)	(0.0031)	(0.0066)	(0.005)	(0.0006)	(0.437)	(0.0002)	(0.014)
Δs_{t-1}	-0.167***	-0.046	-0.0083	-1.192***	-0.030	-1.437	-0.020	0.067	-0.055**	-0.120***
	(0.053)	(0.297)	(0.028)	(0.355)	(1.197)	(1.022)	(0.073)	(99.68)	(0.027)	(0.0163)
Δs_{t-2}	0.059	-0.050			-1.039	-0.387	1.426***	0.121	0.115***	-0.391***
	(0.066)	(0.338)			(1.177)	(1.197)	(0.195)	(112.97)	(0.032)	(0.0533)
Δs_{t-3}	-0.141**	-0.834**			0.154	-0.295	-0.130	-1.07***	-0.049	-0.138**
	(0.066)	(0.330)			(1.376)	(1.236)	(0.107)	(133.20)	(0.033)	(0.0189)
$\Delta \tilde{i}_{t-1}$	-0.009	-0.97***	0.011*	0.060	-0.256	-0.454**	0.0211	-0.076	0.010*	0.176***
	(0.014)	(0.068)	(0.006)	(0.052)	(0.275)	(0.197)	(0.037)	(109.35)	(0.006)	(0.0240)
$\Delta \tilde{i}_{t-2}$	-0.001	-0.152**			-0.846**	-0.653***	-0.013	0.158	0.002	-0.279**
	(0.013)	(0.060)			(0.414)	(0.245)	(0.012)	(0.180)	(0.005)	(0.0379)
$\Delta \tilde{i}_{t-3}$	-0.024	-0.058			-0.819**	-0.744***	0.886**	1.158	-0.016*	-0.420***
	(0.013)	(0.056)			(0.333)	(0.266)	(0.448)	(1501.1)	(0.009)	(0.0572)
θ	0.004	0.100***	-0.011***	-0.425***	0.034	-0.330***	-0.016**	-0.378***	-0.002	-0.383***
	(0.004)	(0.024)	(0.003)	(0.069)	(0.116)	(0.029)	(0.008)	(0.088)	(0.002)	(0.0522)
d_p	-0.0016	0.060***	-0.0004	0.011	0.028	0.015	-0.002	-0.010	-0.001	-0.043
	(0.002)	(0.008)	(0.0007)	(0.014)	(0.033)	(0.023)	(0.004)	(6.714)	(0.0009)	(0.0592)
d_n	0.009***	-0.12***	-0.0012	-0.049***	-0.131**	-0.025	0.004	0.097	-0.003	0.011***
	(0.003)	(0.014)	(0.0014)	(0.011)	(0.057)	(0.048)	(0.004)	(5.502)	(0.002)	(0.002)

* significant at 10% level, ** significant at 5% level, *** significant at 1% level. Standard errors in parentheses.

Table 8c. Smooth Transition Cointegrated Vector Autoregressive Model Results for Non-Targeting Economies						
	USDEUR		**USDCHF**		**EURCHF**	
Independent Variables	Dependent Variables					
	Δs_t	$\Delta \tilde{i}_t$	Δs_t	$\Delta \tilde{i}_t$	Δs_t	$\Delta \tilde{i}_t$
Regime 1						
μ_0	0.0001	0.0001	0.0002	-0.0012	-0.00005	0.0016
	(0.0002)	(0.0002)	(0.0002)	(0.0030)	(0.00005)	(0.0019)
Δs_{t-1}	0.073***	0.0022	-0.087*	-0.0829	-0.0038	0.6241
	(0.0278)	(0.0454)	(0.0346)	(0.6158)	(0.0220)	(0.6668)
Δs_{t-2}	-0.026	0.077*	-0.029	-0.236		
	(0.0316)	(0.0454)	(0.0271)	(0.4513)		
$\Delta \tilde{i}_{t-1}$	-0.009	0.049***	0.0006	0.0112	-0.0003	-0.2498***
	(0.0059)	(0.0110)	(0.0007)	(0.0397)	(0.00032)	(0.0113)
$\Delta \tilde{i}_{t-2}$	-0.008	-0.103***	0.0001	0.0119		
	(0.0055)	(0.0106)	(0.0007)	(0.0296)		
θ	-0.0003	-0.0004	-0.0009	-0.032***	0.00014	-0.0764***
	(0.0002)	(0.0004)	(0.0007)	(0.0042)	(0.00015)	(0.0053)
d_p	0.0025***	-0.0010	0.0034***	-0.025	-0.00057	-0.0095
	(0.0009)	(0.0013)	(0.0013)	(0.0363)	(0.00036)	(0.0137)
d_n	0.0041***	-0.024***	0.0002	0.0283	0.00025	-0.0177
	(0.0016)	(0.0036)	(0.0016)	(0.070)	(0.0008)	(0.0245)
Regime 2						
μ_0	-0.0001	-0.476	0.0009**	0.0007	0.00030**	-0.0627***
	(0.0002)	(0.398)	(0.0004)	(0.0038)	(0.00013)	(0.0102)
Δs_{t-1}	-0.110***	-0.880	0.244***	0.267	0.2617***	-0.768
	(0.0398)	(68.548)	(0.0461)	(0.7336)	(0.0326)	(1.3224)
Δs_{t-2}	0.047	-0.628	0.089	0.296		
	(0.0456)	(66.942)	(0.0584)	(0.6625)		
$\Delta \tilde{i}_{t-1}$	0.012	-1.775	-0.0004	-0.504***	0.00089	-0.1999***
	(0.0076)	(1.5558)	(0.0014)	(0.0419)	(0.0006)	(0.0429)
$\Delta \tilde{i}_{t-2}$	0.011	-1.40	-0.0007	-0.276***		
	(0.0076)	(1.1302)	(0.0014)	(0.0322)		
θ	0.0004	-0.209***	0.0009	-0.132***	-0.0008**	-0.1815***
	(0.0003)	(0.016)	(0.0016)	(0.0050)	(0.00035)	(0.0264)
d_p	-0.006***	-0.660	-0.008***	0.0203	0.0019**	0.1779***
	(0.0013)	(0.6038)	(0.0023)	(0.0396)	(0.0008)	(0.0496)
d_n	-0.005**	1.470	0.0041*	-0.0284	-0.00001	0.1198
	(0.0022)	(0.9988)	(0.0025)	(0.070)	(0.0012)	(0.1135)
* significant at 10% level, ** significant at 5% level, *** significant at 1% level. Standard errors in parentheses.						

Table 9 provides information about the transition function, specifically the transition parameter c and the smoothness parameter γ, and also reports the estimates of the θ coefficient (the speed of adjustment) for the two regimes - this the optimal number of regimes which is selected in all cases by using as a criterion the minimum sum of squared residuals.

Table 9. Smooth Transition Model Regimes					
		Regimes		Transition	
	Equation	Regime 1: θ	Regime 2: $\theta \cdot G_t$	c	γ
GBPCAD	Δs_t	0.0006**	0.0006	-0.055868	14.78672
	$\Delta \tilde{\imath}_t$	0.069***	-0.133***	-0.016814	22.65341
GBPAUD	Δs_t	-0.002***	0.005	-0.005186	13.16741
	$\Delta \tilde{\imath}_t$	0.203***	-0.379***	-0.006006	45.75886
GBPNZD	Δs_t	0.114***	-0.174***	-0.012500	62.36919
	$\Delta \tilde{\imath}_t$	0.169***	-0.298***	-0.012345	31.67953
GBPSEK	Δs_t	-0.0006	-0.0013	0.020142	65.02806
	$\Delta \tilde{\imath}_t$	0.319***	-0.323***	-0.272267	66.07738
CADAUD	Δs_t	0.009**	-0.02***	-0.173465	21.68449
	$\Delta \tilde{\imath}_t$	0.201***	-0.200***	-0.192480	15.45625
CADNZD	Δs_t	-0.002**	0.004	-0.050491	85.06376
	$\Delta \tilde{\imath}_t$	0.0021	0.100***	0.081161	18.91247
CADSEK	Δs_t	-0.001	-0.011***	0.009453	42.40906
	$\Delta \tilde{\imath}_t$	-0.016**	-0.425***	0.047907	16.40401
AUDNZD	Δs_t	0.067	0.034	-0.088433	88.81159
	$\Delta \tilde{\imath}_t$	0.100***	-0.330***	0.014948	46.41960
AUDSEK	Δs_t	-0.001	-0.016**	-0.107431	8.321685
	$\Delta \tilde{\imath}_t$	0.136	-0.378***	0.135389	2.311828
NZDSEK	Δs_t	-0.0015	-0.002	0.010824	13.86116
	$\Delta \tilde{\imath}_t$	0.006	-0.383***	2.131533	31.05755
USDEUR	Δs_t	-0.0003	0.0004	-0.001864	34.44399
	$\Delta \tilde{\imath}_t$	-0.0004	-0.209***	0.162205	26.28246
USDCHF	Δs_t	-0.0009	0.0009	-0.018740	12.51957
	$\Delta \tilde{\imath}_t$	-0.032***	-0.132***	0.000023	1.940000
EURCHF	Δs_t	0.00014	-0.0008**	0.003511	67.78872
	$\Delta \tilde{\imath}_t$	-0.0764***	-0.1815***	0.016260	17.30912

Transition variable z_t: change in the 30-day interest rate.

θ is the speed of adjustment parameter in regime 1; $\theta \cdot G_t$ is the speed of adjustment parameter in regime 2; c is the transition value, which indicates where the transition takes place; and γ is the smoothness parameter which indicates the speed of transition.

It can be seen that the adjustment speed in the nonlinear model is substantially faster than in the linear one: between 10% and 43% of any deviations from UIP is corrected within one day, which means that a nonlinear framework provides stronger evidence is support of UIP than a linear one. While the adjustment occurs in both the interest rate and the exchange rate equations, the speed is substantially faster in the case of the former. These findings imply that it is the interest rate differential (rather than the exchange rate) which adjusts to restore the UIP equilibrium. The adjustment is particularly fast in regime two, i.e. when the change in the expected interest rate exceeds the transition value c. This suggests that UIP tends to hold better when interest rates are expected to increase. The positive coefficient in regime one in some equations indicates that deviations from UIP are persistent when the market expects the interest rate to fall in the near future. On average the non-targeting economies seem to be characterised

by a lower adjustment speed than the inflation targeting ones, which suggests that interest rate expectations play a more important role in the adjustment towards UIP under inflation targeting. On the whole, the results in Table 9 indicate that the system moves back towards its long-run equilibrium through adjustments in the interest rate equation, but only when the market expects the central bank to adopt a contractionary monetary policy stance by raising the interest rate in the near future.

Finally, to check the adequacy of the nonlinear CVSTAR model we conduct Lagrange Multiplier (LM) Tests of serial correlation, of no remaining nonlinearity and of parameter constancy. The test statistics are reported in Table 10 and confirm the data congruency of the nonlinear specification. In particular, there is no evidence of an impact of the recent COVID-19 pandemic, which is known to have affected other financial markets (e.g., Salisu and Vo, 2020).

Table 10. Misspecification Tests for the Nonlinear CVSTAR Models

	Lag	**Serial Independence**	**No remaining nonlinearity**	**Parameter constancy**
GBPCAD	3	0.5916	0.1141	0.0531
GBPAUD	3	0.9698	0.1629	0.1800
GBPNZD	4	0.1462	0.7581	0.1623
GBPSEK	2	0.6140	0.1560	0.3158
CADAUD	3	0.5677	0.1083	0.4600
CADNZD	3	0.9876	0.7039	0.1369
CADSEK	1	0.7790	0.8870	0.9510
AUDNZD	3	0.7638	0.6959	0.0762
AUDSEK	3	0.7067	0.4491	0.3835
NZDSEK	3	0.2819	0.0704	0.1590
USDEUR	2	0.3147	0.2530	0.1393
USDCHF	2	0.9187	0.2895	0.1517
EURCHF	1	0.5752	0.2070	0.2442

Lagrange Multiplier (LM) Test of serial correlation:
$H_0: no\ serial\ correlation$
$H_1: serial\ correlation$

Lagrange Multiplier (LM) test of parameter constancy:
$H_0: parameter\ constancy$
$H_1: no\ parameter\ constancy$

Lagrange Multiplier (LM) test of no remaining nonlinearity:
$H_0: no\ remaining\ nonlinearity$
$H_1: remaining\ nonlinearity$

P-values reported for all tests.

5. Conclusions

This paper re-examines the UIP relation by estimating first a benchmark linear Cointegrated VAR including the nominal exchange rate and the interest rate differential as well as central bank announcements, and then a Cointegrated Smooth Transition VAR (CVSTAR) model incorporating nonlinearities and also taking into account the role of interest rate expectations. The analysis is conducted for five inflation targeting countries (the UK, Canada, Australia, New Zealand and Sweden) and also, for comparison purposes, for three non-targeters (the US, the Euro-Area and Switzerland) using daily data from January 2000 to December 2020.

The main findings can be summarised as follows. First, the nonlinear framework appears to be more appropriate than the linear one to capture the adjustment towards the UIP equilibrium, which is consistent with the results of other related studies (see, for example, Sarno et al., 2005; Sarno et al., 2006; Li et al., 2013). The estimated speed of adjustment is substantially faster in the nonlinear model, which lends greater support to the long-run validity of UIP than the linear one; similarly, the short-run dynamic linkages appear to be stronger in the nonlinear case. Second, interest rate expectations, a measure of central bank credibility which is often neglected in the context of UIP, play an important role. In particular, a fast adjustment only occurs when the market expects the interest rate to increase in the near future, which suggests that central banks are perceived as more credible when sticking to their goal of keeping inflation at a low and stable rate. Third, central bank announcements have a more sizeable short- run effect in the nonlinear model which also includes interest rate expectations. Fourth, UIP holds better in inflation targeting countries, where the adjustment speed is faster than in non-targeting economies. This suggests that, in general, the inflation targeting framework tends to generate a higher degree of credibility for monetary authorities, thereby reducing deviations of the exchange rate from the UIP equilibrium.

References

Amri, S., 2008. Analysing the forward premium anomaly using a Logistic Smooth Transition Regression model. *Economics Bulletin, 6*(26), pp.1-18.

Arghyrou, M.G. and Pourpourides, P., 2016. Inflation announcements and asymmetric exchange rate responses. *Journal of International Financial Markets, Institutions and Money*, *40*, pp.80-84.

Baillie, R.T. and Chang, S.S., 2011. Carry trades, momentum trading and the forward premium anomaly. *Journal of Financial Markets*, *14*(3), pp.441-464.

Baillie, R.T. and Kilic, R., 2006. Asymmetry and nonlinearity in uncovered interest rate parity. *Journal of International Money and Finance*, *25*(2), pp.22-47.

Banerjee, A. and Singh, M.M., 2006. *Testing real interest parity in emerging markets* (No. 6-249). International Monetary Fund.

Brenner, R.J. and Kroner, K.F., 1995. Arbitrage, cointegration, and testing the unbiasedness hypothesis in financial markets. *Journal of Financial and Quantitative Analysis*, pp.23-42.

Canterbery, E.R., 2000. Rational bubbles and uncovered interest-rate parity: retrospective and prospective. *Editorial Policy*, *1*(2000), pp.167-178.

Chen, C.R. and Ainina, F., 1994. Financial ratio adjustment dynamics and interest rate expectations. *Journal of Business Finance & Accounting*, *21*(8), pp.1111-1126.

Chinn, M.D. and Quayyum, S., 2012. *Long horizon uncovered interest parity re-assessed* (No. w18482). National Bureau of economic research.

Clarida, R.H., Sarno, L., Taylor, M.P. and Valente, G., 2003. The out-of-sample success of term structure models as exchange rate predictors: a step beyond. *Journal of International Economics*, *60*(1), pp.61-83.

Clarida, R.H. and Taylor, M.P., 1997. The term structure of forward exchange premiums and the forecastability of spot exchange rates: correcting the errors. *Review of Economics and Statistics*, *79*(3), pp.353-361.

Connolly, E. and Kohler, M., 2004. *News and Interest Rate Expectations: A Study of Six Central Banks*. Reserve Bank of Australia Conference – 2004.

Cook, T. and Hahn, T.K., 1990. Interest rate expectations and the slope of the money market yield curve. *FRB Richmond Economic Review*, *76*(5), pp.3-26.

Coulibaly, D. and Kempf, H., 2019. Inflation targeting and the forward bias puzzle in emerging countries. *Journal of International Money and Finance*, *90*, pp.19-33.

Eitrheim, Ø. and Teräsvirta, T., 1996. Testing the adequacy of smooth transition autoregressive models. *Journal of Econometrics*, *74*(1), pp.59-75.

Engel, C., 1996. The forward discount anomaly and the risk premium: A survey of recent evidence. *Journal of Empirical Finance*, *3*(2), pp.123-192.

Escribano, A. and Jordá, O., 2001. Testing nonlinearity: Decision rules for selecting between logistic and exponential STAR models. *Spanish Economic Review*, *3*(3), pp.193-209.

Froot, K.A. and Thaler, R.H., 1990. Anomalies: foreign exchange. *Journal of Economic Perspectives*, *4*(3), pp.179-192.

Georgoutsos, D.A. and Kouretas, G.P., 2002. Cointegration, uncovered interest parity and the term structure of interest rates: some International evidence.

Gregory, A.W., 1987. Testing interest rate parity and rational expectations for Canada and the United States. *Canadian Journal of Economics*, pp.289-305.

Jiang, C., Li, X.L., Chang, H.L. and Su, C.W., 2013. Uncovered interest parity and risk premium convergence in Central and Eastern European countries. *Economic Modelling*, *33*, pp.204-208.

Johansen, S. and Juselius, K. (1992). Testing structural hypothesis in a multivariate cointegration analysis of the PPP and the UIP for UK. *Journal of Econometrics* 53, 211-244.

Juselius, K., 2018. The cointegrated VAR methodology. In *Oxford Research Encyclopedia of Economics and Finance*.

Juselius, K. and Stillwagon, J.R., 2018. Are outcomes driving expectations or the other way around? An I (2) CVAR analysis of interest rate expectations in the dollar/pound market. *Journal of International Money and Finance*, *83*, pp.93-105.

Lacerda, M., Fedderke, J.W. and Haines, L.M., 2010. Testing for purchasing power parity and uncovered interest parity in the presence of monetary and exchange rate regime shifts. *South African Journal of Economics*, *78*(4), pp.363-382.

Li, D., Ghoshray, A. and Morley, B., 2012. Measuring the risk premium in uncovered interest parity using the component GARCH-M model. *International Review of Economics & Finance*, *24*, pp.167-176.

Li, D., Ghoshray, A. and Morley, B., 2013. An empirical study of nonlinear adjustment in the UIP model using a smooth transition regression model. *International Review of Financial Analysis*, *30*, pp.109-120.

Lothian, J.R., 2016. Uncovered interest parity: The long and the short of it. *Journal of Empirical Finance*, *36*, pp.1-7.

Lothian, J.R. and Wu, L., 2011. Uncovered interest-rate parity over the past two centuries. *Journal of International Money and Finance*, *30*(3), pp.448-473.

Lukkonen, R.S., P. and Teräsvirta, T. 1988. Testing Linearity Against Smooth Transition Autoregressive Models. *Biometrica*, *75*(3), pp.491-499.

Lyons, R.K., 2001. *The microstructure approach to exchange rates* (Vol. 333). Cambridge, MA: MIT press.

Mauleón, I., 1998. Interest rate expectations and the exchange rate. *International Advances in Economic Research*, *4*(2), pp.179-191.

Moniz, A. and de Jong, F., 2014, May. Predicting the impact of central bank communications on financial market investors' interest rate expectations. In *European Semantic Web Conference* (pp. 144-155). Springer, Cham.

Moore, M.J. and Roche, M.J., 2010. Solving exchange rate puzzles with neither sticky prices nor trade costs. *Journal of International Money and Finance*, *29*(6), pp.1151-1170.

Neumann, M.J. and Von Hagen, J., 2002. *Does inflation targeting matter?* (No. B 01-2002). ZEI working paper.

Obstfeld, M., 1987. *Peso problems, bubbles, and risk in the empirical assessment of exchange-rate behavior* (No. w2203). National Bureau of Economic Research.

Rao, C.R., 1948. Tests of significance in multivariate analysis. *Biometrika*, *35*(1/2), pp.58-79.

Ripatti, A., 2001. Vector autoregressive processes with nonlinear time trends in cointegrating relations. Macroeconomic Dynamics, 5(4), pp.577-597.

Rosa, C. and Verga, G., 2018. The impact of central bank announcements on asset prices in real time. *Thirteenth issue (June 2008) of the International Journal of Central Banking*.

Sager, M.J. and Taylor, M.P., 2004. The impact of European Central Bank Governing Council announcements on the foreign exchange market: a microstructural analysis. *Journal of International Money and Finance*, *23*(7-8), pp.1043-1051.

Salisu, A.A., and Vo, X.V. (2020). Predicting stock returns in the presence of COVID-19 pandemic: The role of health news. International Review of Financial Analysis, 71. https://doi.org/10.1016/j.irfa.2020.101546

Sarno, L., 2005. Towards a solution to the puzzles in exchange rate economics: Where do we stand?. *Canadian Journal of Economics/Revue canadienne d'économique*, *38*(3), pp.673-708.

Sarno, L., Valente, G. and Leon, H., 2005. *The forward bias puzzle and nonlinearity in deviations from uncovered interest parity, a new perspective*. Mimeo, University Of Warwick.

Sarno, L., Valente, G. and Leon, H., 2006. Nonlinearity in deviations from uncovered interest parity: an explanation of the forward bias puzzle. *Review of Finance*, *10*(3), pp.443-482.

Teräsvirta, T. and Yang, Y., 2014. *Linearity and misspecification tests for vector smooth transition regression models*. CREATES Research Papers 2014-04, Department of Economics and Business Economics, Aarhus University.

Tietz, R., 2019. How does the Fed manage interest rate expectations?. *Available at SSRN 3254094*.

Weber, E., 2006. *British interest rate convergence between the US and Europe: A recursive cointegration analysis* (No. 2006, 005). SFB 649 Discussion Paper.

Zivot, E., 2000. Cointegration and forward and spot exchange rate regressions. *Journal of International Money and Finance*, *19*(6), pp.785-812.